A

MENTAL ARITHMETIC

BY

THE INDUCTIVE METHOD,

FOR USE IN

ELEMENTARY AND HIGHER SCHOOLS.

BY

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PREFACE.

THE great importance of Mental Arithmetic in the school curriculum of to-day is a settled question. But the nature of the work given under this head is a matter upon which educators have not always agreed, and hence in this great diversity of opinion we have had a widely differing class of problems "for mental work" given to the teachers of this country during the last half century.

The author does not assume that the *vexata quæstio* is an easy one to solve, nor that he has solved it; but he issues this book in the hope that a step toward the solution, at least, has been made. To this end he has tried to make the lessons herein progressive and practical in their character and adapted to the requirements of the pupils of elementary schools.

Three objects, which are of paramount importance in mental arithmetic, have been kept constantly in view in the preparation of this book, namely—illustration of principles, developments of the reasoning powers, and a careful gradation of problems; this last being so highly essential to the pupil in his efforts to master that *power of analysis* which is the great desideratum in the study of all mathematics.

The author desires to express his thanks to the earnest principals and superintendents who have read the manuscript of these lessons and who have given many valuable suggestions in the preparation of the book, and believes that his efforts shall have been adequately remunerated if he has contributed, in any degree, toward the perfection of school work or school methods.

W. J. M.

PHILADA., PA., June 1, 1900.

CONTENTS.

PUBLISHERS' NOTE.

In recognition of well-known pedagogical principles of passing from the known to the related unknown, and from the simple to the complex, this book is given to the public. It is believed that the lessons herein given carry out, in an eminent degree, the above cardinal principle. A careful and extensive study of the ability of children to deal with mental problems has been the guidance in the preparation of this skilfully arranged series of lessons, and in the belief that it will aid teachers in their arduous work, it is published by this house.

MENTAL ARITHMETIC.

ADDITION.

1.

1. A girl has 1 doll and her mother gives her 1 more; how many dolls has she?

2. I have 2 cents in one hand and 1 in another; how many cents have I?

3. Susan has 2 books and her sister has 2; how many have they together?

4. Helen had 3 apples and her brother gave her 1 more; how many had she then?

5. A boy had 3 dollars and his brother gave him 2 more; how many dollars had he then?

6. John found 2 pears and Horace found 3; how many did they both find?

7. A pencil cost 4 cents and a ruler 3 cents; how much did they both cost?

8. A cat caught 3 mice to-day and 3 yesterday; how many did he catch in both days?

9. Mary had 5 books and bought 5 more; how many had she then?

10. How many are 6 apples and 1 apple?

11. In one room there are 4 windows and in another 4 windows; how many are there in both rooms?

12. William has 5 dollars and Samuel has 3 dollars; how many have they together?

13. How many are 6 dollars and 2 dollars?

14. How many are 7 cents and 1 cent?

15. Henry had 8 cents and his brother gave him 1 more; how many had he then?

16. George picked 7 quarts of berries at one time and 2 more at another; how many did he then have?

17. A pound of sugar cost 4 cents and a loaf of bread cost 5 cents; what did they both cost?

18. A boy paid 6 cents for a pencil and 3 cents for a pen; how much did he pay for both?

19. How many are 2 apples and 7 apples?

20. Kate paid 5 cents for some ribbon and 5 cents for some candy; how many cents did she spend?

21. There are 4 lilies in one bunch and 3 in another; how many are there in both bunches?

22. A man has 7 sheep and 3 cows; how many animals has he?

23. James has 8 turkeys and 2 ducks; how many fowls has he?

24. A man earns 9 dollars in a week and his son earns 1 dollar; how much do they earn together?

25. How many are 9 dollars and 1 dollar? 6 sheep and 4 sheep? 7 pears and 3 pears? 2 weeks and 8 weeks?

26. How many are—

2 and 1?	3 and 3?	2 and 4?	2 and 5?
3 and 1?	1 and 4?	5 and 1?	4 and 4?
4 and 1?	3 and 2?	4 and 2?	1 and 6?
1 and 1?	2 and 3?	4 and 3?	3 and 5?

27. How many are—

2 and 6?	8 and 2?	1 and 9?	8 and 1?
2 and 7?	7 and 3?	6 and 4?	3 and 6?
7 and 1?	3 and 4?	5 and 5?	5 and 4?

28. How many are—

3 and 7?	3 and 2?	5 and 1?	3 and 3?
4 and 5?	2 and 5?	7 and 2?	4 and 2?
4 and 6?	6 and 2?	5 and 4?	7 and 1?

2.

1. John had 10 marbles and found 1; how many had he then?

2. There are 10 apples on one tree and 2 on another; how many apples are on both trees?

3. There are 10 horses in one field and 3 in another field; how many horses in both fields?

4. There are 10 boys in one class and 4 in another; how many pupils in both classes?

5. A man's shoes cost 10 dollars and his hat 5 dollars; how much did both cost?

6. A girl had 11 dollars and earned 1 more; how many dollars had she then?

7. A boy caught 11 fish and bought 2 more; how many had he then?

8. Charles paid 11 cents for a book and 3 cents for a pencil; how much did he pay for both?

9. Helen had 11 apples in her basket and Lizzie gave her 4 more; how many did she then have?

10. George walked 12 miles in the forenoon and 1 mile in the afternoon; how far did he walk?

11. A drover sold 12 cows to one man and 2 to another; how many cows did he sell?

12. Helen was absent from school 12 days this month and 3 days last month; how many days was she absent altogether?

13. There are 13 trees in the orchard and 1 in the yard; how many trees are there?

14. Henry rode 13 miles and John rode 2 miles; how many miles did they both travel?

15. A farmer sowed 14 acres of oats and 1 acre of rye; how many acres did he sow?

16. How many are 10 acres and 2 acres? 3 sheep and 10 sheep? 10 boys and 4 boys? 5 desks and 10 desks?

17. How many are 1 desk and 11 desks? 2 chairs and 11 chairs? 11 boys and 3 boys? 4 girls and 11 girls?

18. How many are 1 pen and 12 pens? 3 cents and 12 cents? 2 cups and 12 cups?

19. How many are 1 pencil and 13 pencils? 1 book and 14 books? 2 sheep and 13 sheep?

20. How many are 9 girls and 3 girls? 9 boys and 4 boys? 9 desks and 5 desks? 6 sheep and 9 sheep?

21. How many are 6 eggs and 5 eggs? 6 hens and 9 hens? 8 cows and 6 cows? 7 boys and 7 boys?

22. How many are 7 lamps and 5 lamps? 6 windows and 7 windows? 7 flags and 8 flags?

23. How many are 8 roses and 4 roses? 6 pinks and 8 pinks? 8 lilies and 5 lilies? 8 daisies and 7 daisies?

24. Add to 6—

8, 2, 3, 9, 5, 8, 3, 6, 8, 7, 3, 9, 3, 7, 4, 2, 9, 5, 6, 5.

25. Add to 5—

7, 6, 5, 4, 9, 3, 8, 6, 2, 7, 9, 3, 2, 5, 8, 2, 7, 4, 6, 5.

26. Add to 4—

6, 3, 7, 8, 5, 9, 2, 8, 6, 3, 5, 4, 2, 8, 6, 5, 3, 7, 8, 4.

27. How many are—

5 and 6?	6 and 7?	7 and 4?	8 and 5?
5 and 7?	6 and 8?	7 and 5?	8 and 6?
5 and 8?	6 and 9?	7 and 6?	8 and 7?

28. How many are—

9 and 2?	10 and 5?	11 and 3?	12 and 2?
9 and 3?	10 and 6?	11 and 4?	12 and 3?
9 and 4?	10 and 7?	11 and 5?	12 and 4?

3.

1. George had 15 cents and found 1 more; how many had he then?

2. A suit cost 15 dollars and a hat 2 dollars; how much did they both cost?

3. Jane had 15 apples and her sister gave her 3 more; how many had she then?

4. George, having 15 dollars, found 2 more; how many had he then?

5. Helen had 4 dresses and her sister 15 dresses; how many did they have together?

6. A merchant, having 16 horses, bought 3 more; how many did he then have?

7. There are 16 cows in one field and 2 in another; how many cows in both fields?

8. There are 4 birds on the fence and 16 on the ground; how many birds in all?

9. There are 17 posts in one pile and 2 in another; how many in both piles?

10. James had 17 cents in one pocket and 3 in another; how many had he in both?

11. A saddle cost 18 dollars and a bridle cost 2 dollars; how much did they both cost?

12. How many are 15 boys and 1 boy? 15 apples and 2 apples? 15 men and 3 men? 15 girls and 4 girls?

13. How many are 4 dollars and 16 dollars? 16 pins and 2 pins? 3 books and 16 books?

14. How many are 17 minutes and 1 minute? 17 apples and 2 apples? 17 pears and 3 pears?

15. How many are 2 weeks and 18 weeks? 18 hours and 1 hour?

16. How many are 10 dollars and 10 dollars? 8 cents and 8 cents? 8 sheep and 10 sheep? 10 cows and 8 cows?

17. How many are 10 boys and 9 boys? 10 girls and 8 girls? 9 desks and 7 desks? 6 men and 12 men?

18. How many are 8 knives and 9 knives? 7 glasses and 9 glasses? 8 spoons and 7 spoons?

19. How many are 9 geese and 5 geese? 10 sheep and 6 sheep? 14 horses and 5 horses?

20. How many are—

6 and 11?	9 and 7?	8 and 8?	7 and 13?
7 and 9?	9 and 8?	7 and 8?	6 and 13?
5 and 12?	11 and 7?	10 and 8?	5 and 13?

21. How many are—

7 + 8?	9 + 8?	5 + 10?	3 + 16?	4 + 16?
7 + 9?	4 + 12?	5 + 11?	16 + 3?	14 + 4?
7 + 10?	4 + 14?	5 + 15?	14 + 3?	15 + 3?

NOTE.—This sign + is called *plus*, and means, when placed between two numbers, that those numbers are to be added. Thus, 2 + 2 means 2 and 2.

4.

1. Horace has 5 dollars, William has 7 dollars, and Harry has 4 dollars; how many have they together?

SOLUTION.—If Horace has 5 dollars, William 7, and Harry 4, they together have 5 dollars and 7 dollars and 4 dollars, which are 16 dollars.

2. There are 3 sheep in one pen, 5 in another, and 7 in another; how many sheep are there altogether?

3. I paid 6 dollars for a hat, 5 dollars for a coat, and 4 dollars for a vest; what did I pay for all?

4. A man gave 5 cents to one boy, 3 cents to another, and 6 cents to another; how many cents did he give to all?

5. I paid 6 cents for a ball, 8 cents for a bat, and 5 cents for a top; how many cents did I give for all?

6. William paid 10 dollars for a sheep, 8 dollars for a pig, and 4 dollars for some chickens; how much did he pay for all?

7. There are 15 boys in one room, 12 in another, and 3 in another; how many boys are there in all?

8. Rose's mother gave her 6 dollars, her father gave her 5 dollars, and her aunt gave her 12 dollars; how many dollars did they all give her?

9. A hunter's coat cost 6 dollars, his boots 4 dollars, and his powder and shot 5 dollars; how much did they all cost?

10. Henry has 5 geese, William has 8 geese, and James 12 geese; how many have they all?

11. Helen walked 8 miles, Mabel 9, and Mary 10; how many miles did they all walk?

12. A slate cost 12 cents, and a book 10 cents; what did they both cost?

13. George has 5 fingers on one hand and 4 on another; how many fingers has he?

14. Russell gave 14 cents for a top and 7 cents for a whistle; how much did he spend for both?

15. In the eighth grade there are 13 girls and 12 boys; how many pupils in the class?

16. John shot 22 quail and 8 snipe; how many birds did he shoot?

17. Silas had 9 cows in the stable, 10 in the yard, and bought 8 more; how many cows did he then have?

18. Rose had 12 blocks in one pile, 10 in another, and 6 in another; how many blocks had she in all?

19. Louisa has 10 cents, Mary has 9 cents, and their brother has 12; how many cents have they all?

20. The head of a fish is 6 inches long, the tail 8 inches long, and the body 13 inches long; how long is the fish?

21. Lizzie bought 7 yards of silk for a cloak, 10 yards for one dress, and 15 yards for another; how many yards did she buy in all?

22. A man paid 10 cents for a robin, 4 cents for a wren, and 8 cents for a jay; how much did he pay for all?

23. I paid 5 dollars for coal, 12 dollars for wood, and 10 dollars for hauling; how much did I pay for all?

24. A merchant travelled 8 miles by stage, 9 miles by rail, and 22 miles by boat; how far did he travel?

25. A miller bought some wheat for 15 dollars, some rye for 10 dollars, and some corn for 6 dollars; how much did he pay for all?

5.

1. There are 18 boys in one room and 13 in another; how many boys in the school?

2. A merchant sold some rice for 19 dollars and some sugar for 8 dollars; how much did he receive?

3. A lady earned 20 cents in one hour and her daughter 6 cents in one hour; how much did they both earn in one hour?

4. Addie has 13 roses, 7 lilies, and 12 pinks; how many flowers has she?

5. A lady gave 8 cents for some needles, 12 cents for some thread, and 13 cents for some muslin; how much did she pay for all?

6. How many are 8 boys and 17 boys? 10 girls and 10 girls? 17 cents and 15 cents?

7. How many are 14 boys and 12 boys? 13 sheep and 14 sheep? 15 chestnuts and 16 chestnuts?

8. How many are 13 men and 11 men? 12 boys and 13 boys? 14 girls and 15 girls?

9. How many are 15 cords of wood and 14 cords of wood? 15 pounds of sugar and 12 pounds of sugar? 11 months and 15 months?

10. How many are 16 pigs and 10 pigs? 10 robins and 19 robins? 16 pigeons and 14 pigeons?

11. How many are 18 geese and 12 geese? 8 books and 22 books? 8 cups and 9 cups?

12. How many are 10 geese and 10 geese? 8 chestnuts and 17 chestnuts? 25 cups and 5 cups?

13. How many are 17 dollars and 10 dollars? 11 cents and 17 cents? 13 posts and 15 posts?

14. How many are 21 peaches and 9 peaches? 8 apples and 19 apples? 21 plums and 9 plums?

15. How many are 8 apples, 12 apples, and 10 apples?

16. How many are 4 dollars, 5 dollars, and 8 dollars?

17. How many are 8 girls, 9 girls, and 3 girls?

18. How many are 12 horses, 8 horses, and 9 horses?

19. How many are 16 desks, 9 desks, and 15 desks?

20. How many are 9 cats, 10 cats, and 11 cats?

21. How many are—

12 + 8?	18 + 9?	17 + 3?	18 + 8?	21 + 9?
16 + 7?	14 + 7?	19 + 10?	16 + 6?	23 + 7?
13 + 9?	16 + 8?	15 + 7?	13 + 12?	16 + 9?

22. How many are—

15 + 13?	10 + 18?	17 + 4?	19 + 8?	12 + 18?
16 + 14?	12 + 14?	16 + 5?	19 + 9?	12 + 17?
13 + 14?	13 + 16?	18 + 5?	18 + 11?	17 + 11?

23. How many are—

4 + 3 + 4?	6 + 4 + 4?	8 + 6 + 4?	9 + 2 + 8?
5 + 2 + 6?	7 + 3 + 4?	6 + 3 + 7?	8 + 3 + 6?
3 + 5 + 4?	8 + 4 + 6?	7 + 1 + 9?	9 + 9 + 2?

24. How many are—

8 + 8 + 5?	9 + 5 + 6?	9 + 8 + 7?	10 + 7 + 8?
7 + 6 + 9?	8 + 9 + 2?	7 + 6 + 10?	9 + 7 + 7?
6 + 7 + 8?	9 + 7 + 5?	8 + 6 + 9?	8 + 9 + 10?

25. How many are—

11 + 4 + 8?	12 + 4 + 9?	17 + 6 + 3?	14 + 7 + 8?
12 + 5 + 6?	16 + 4 + 9?	18 + 2 + 9?	14 + 2 + 6?
10 + 12 + 6?	13 + 2 + 4?	16 + 12 + 4?	16 + 9 + 2?

26. Add 7 to—

6, 3, 4, 2, 8, 9, 6, 7, 4, 3, 5, 7, 6, 4, 3, 6, 7, 9, 8.

27. Add 8 to—

4, 6, 3, 7, 8, 9, 4, 6, 3, 2, 8, 9, 4, 3, 7, 6, 4, 7, 6.

28. Give the sums of the following columns as the teacher indicates the columns: thus, the teacher will say, "give the sum of column 'a,'" and the pupil will answer rapidly, "13".

I.

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)
7	8	4	5	3	6	2	1	4	8	7	3	2	5	4	7	6
4	3	2	6	4	3	8	7	6	4	3	8	9	4	7	6	8
2	4	7	4	3	3	6	6	5	4	6	4	6	7	4	6	4

II.

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)
9	8	6	7	6	5	7	8	9	4	6	5	8	7	4	6	8
7	6	8	9	8	6	4	9	8	6	9	4	7	6	8	7	9
3	4	8	9	4	8	7	8	6	4	8	7	8	9	6	7	8

III.

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)
2	4	3	6	4	8	9	6	4	5	3	2	1	6	4	1	2
6	8	9	4	3	2	8	7	6	4	3	6	7	3	8	9	4
3	4	2	6	8	7	2	1	5	3	7	8	9	4	2	1	6
7	8	9	4	6	7	3	2	4	8	6	7	4	9	6	8	8

IV.

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)
4	3	2	1	6	7	5	4	3	2	8	9	4	3	6	5	4
6	7	8	9	4	3	5	8	6	7	8	2	6	5	8	9	5
6	8	8	6	7	8	4	3	9	8	2	4	4	7	8	3	6
8	7	4	6	8	6	4	5	6	7	8	7	6	7	3	8	4

V.

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)
3	2	4	6	7	3	2	8	4	9	6	8	4	3	2	1	8
7	6	2	4	3	7	8	6	4	3	2	1	6	4	1	2	3
8	4	9	6	8	4	3	2	7	6	8	9	4	8	9	8	6
7	8	9	4	3	2	8	6	8	4	7	2	9	4	6	3	2
4	2	7	8	6	9	4	8	7	9	6	3	2	5	8	4	3

SUBTRACTION.

6.

1. Kate had 2 apples and ate 1 of them; how many had she remaining?

SOLUTION.—If Kate had 2 apples and ate 1 of them, she had remaining the difference between 2 apples and 1 apple, which is 1 apple.

2. Harry had 3 marbles and lost 1 of them; how many had he remaining?

3. A girl had 4 chestnuts and gave 2 of them away; how many had she remaining?

4. There are 5 plums on a dish and a girl eats 3 of them; how many remain?

5. A boy had 6 pencils, but lost 3 of them; how many had he left?

6. There were 6 posts in a pile and a man took away 4 of them; how many remained?

7. William had 7 books and he lost 4 of them; how many had he remaining?

8. Helen had 7 peaches and ate 3 of them; how many remained?

9. There were 7 birds on a fence and 2 flew away; how many remained?

10. Margaret had 10 cents and paid 5 cents for a spool of thread; how many cents had she left?

11. How many are 4 apples less 1 apple? 6 pears less 2 pears? 8 oranges less 4 oranges? 9 cents less 4 cents?

12. How many are 8 desks less 2 desks? 10 caps less 5 caps? 6 books less 3 books?

13. How many are 10 girls less 4 girls? 10 girls less 3 girls? 10 girls less 2 girls? 10 girls less 1 girl? 10 girls less 7 girls?

14. How many are 9 pears less 8 pears? 9 pears less 6 pears? 9 pears less 7 pears? 9 pears less 3 pears?

15. How many are 10 peaches less 5 peaches? 10 peaches less 7 peaches? 10 peaches less 6 peaches?

16. How many are—

6 less 2?	4 less 2?	8 less 3?	9 less 5?
6 less 3?	4 less 3?	8 less 4?	8 less 3?
6 less 4?	4 less 1?	8 less 5?	10 less 7?

17. How many are—

10 less 3?	9 less 2?	8 less 6?	7 less 6?
10 less 4?	9 less 3?	8 less 7?	7 less 5?
10 less 5?	9 less 4?	8 less 2?	7 less 4?

7.

1. A man had 20 cows and sold 10 of them; how many did he have then?

2. Harry had 18 peaches and gave away 6; how many had he remaining?

3. A man paid 19 dollars for a watch and sold it for 14 dollars; how many dollars did he lose?

4. A man paid 14 dollars for a watch and sold it for 19 dollars; how much did he gain?

5. Helen is 6 years old and Mabel is 11 years old; how many years older than Helen is Mabel?

6. A boy found 20 quarts of chestnuts and sold 12 quarts; how many quarts had he remaining?

7. Thomas had 16 sheep and 5 of them died; how many had he remaining?

8. Margaret picked 17 roses from a bush and gave away 11 of them; how many had she left?

9. William bought 18 lemons and gave Horace 9 of them; how many did he keep?

10. Susan, finding 14 cents, spent 6 of them; how many cents had she remaining?

11. In a school of 20 pupils only 15 are present; how many are absent?

12. A boy, who had 15 marbles, lost 5 of them; how many had he remaining?

13. George is 14 years old; in how many more years will he be 19?

14. A farmer had 13 lambs in his flock and a dog killed 4 of them; how many of them remained?

15. How many are 17 tops less 4 tops? 16 pencils less 8 pencils? 19 boys less 6 boys?

16. How many are 20 girls less 8 girls? 16 geese less 11 geese? 18 ducks less 12 ducks?

17. How many are 17 years less 7 years? 20 weeks less 9 weeks? 15 days less 11 days?

18. How many are 19 marbles less 7 marbles? 20 balls less 8 balls? 16 minutes less 9 minutes?

19. How many are 20 eggs less 7 eggs? 13 hens less 6 hens? 17 turkeys less 4 turkeys?

20. How many are—

20 less 4?	17 less 7?	13 less 5?	13 less 6?
19 less 5?	16 less 6?	12 less 7?	12 less 8?
18 less 6?	15 less 7?	11 less 8?	14 less 9?

21. How many are—

15 less 4?	16 less 8?	19 less 4?	19 less 15?
16 less 5?	17 less 4?	20 less 6?	19 less 17?
17 less 9?	18 less 5?	20 less 10?	18 less 9?

22. How many are—

12 − 4?	16 − 7?	17 − 4?	20 − 14?
11 − 6?	14 − 8?	13 − 7?	14 − 9?
15 − 5?	18 − 6?	19 − 11?	15 − 12?

NOTE.—This sign − is read *minus*, and when placed between two numbers means that the second number is to be taken from the first. Thus, 10 − 5 means that 5 is to be taken from 10.

8.

1. Harry had 20 cents and gave 10 cents for a book; how many cents had he remaining?

2. There were 20 crows on a tree and 8 flew away; how many remained?

3. A pupil received 24 words and missed 8 of them; how many did he spell correctly?

4. A boy found 30 eggs in a barn and broke 18 of them; how many of them remained unbroken?

5. Harold earns 25 dollars a week and spends 7 of them; how many does he save?

6. A watch was bought for 25 dollars and sold for 30 dollars; how much was gained?

7. Mary had 30 pins and used 7 of them in her doll's dress; how many remained?

8. A boy caught 20 fish on Tuesday and 12 fish on Wednesday; how many more fish did he catch on Tuesday than on Wednesday?

9. A farmer had 29 cows in a field and 11 jumped out; how many remained in the field?

10. Henry is 24 years old and his sister is 16 years younger; how old is she?

11. A merchant sold 20 yards of ribbon from a piece containing 40 yards; how many yards were not sold?

12. I have 36 dollars; how many dollars can I spend and have 24 dollars remaining?

13. James has 32 dollars; how many more dollars must he have to buy a 45-dollar suit?

14. A lady paid 15 dollars for a cloak; how much will she gain by selling it for 23 dollars?

15. Helen is 16 years old; in how many more years will she be 23?

16. A man whose weekly wages were 35 dollars spent 16 dollars on Friday night and the remainder on Saturday night; how much did he spend on Saturday night?

17. Bought a watch for 43 dollars and sold it for 28 dollars; how much did I lose?

18. A farmer had 33 turkeys and killed 14 of them; how many had he remaining?

19. At the beginning of the year a man had 45 turkeys, but some died, and now he has only 36; how many died?

20. A tailor had a piece of cloth containing 39 yards, from which he used 16 yards; how much had he remaining?

21. A man is 46 years old; how old was he 15 years ago?

22. You are now 20 years old; in how many years will you be 42 years of age?

23. How many are 36 cents less 16 cents? 42 dollars less 20 dollars? 42 desks less 26 desks?

24. How many are 29 apples less 18 apples? 48 pencils less 18 pencils? 32 books less 16 books?

25. How many are 45 dollars less 16 dollars? 43 minutes less 17 minutes?

26. How many are 32 less than 44? 22 less than 30?

27. How many are—

50 − 16?	49 − 16?	44 − 12?	33 − 11?
48 − 14?	47 − 21?	40 − 19?	41 − 20?
42 − 15?	45 − 23?	32 − 16?	44 − 14?

28. How many are—

28 − 14?	36 − 18?	25 − 13?
38 − 29?	47 − 12?	27 − 16?
37 − 16?	33 − 13?	29 − 13?
35 − 22?	32 − 25?	39 − 19?

29. Count from 1 to 100 by 3's; 4's; 5's; 6's; 8's; 10's.

30. Count from 100 to 3 by 3's; 4's; 5's; 6's; 8's; 10's.

ADDITION AND SUBTRACTION.

9.

1. A farmer had 4 cows, then bought 10 cows, and afterward sold 8 cows; how many cows had he then?

SOLUTION.—If a farmer had 4 cows at first and then bought 10 cows, he then had 4 cows plus 10 cows, which are 14 cows; if he then sold 8 cows, he had 14 cows minus 8 cows, which are 6 cows.

2. Silas, having 10 dollars, earned 15 dollars more; if he spent 14 dollars, how many had he remaining?

3. A boy, having 16 peaches, ate 4 and gave his sister 6; how many peaches had he remaining?

4. A man paid 12 dollars for a sheep and 16 dollars for a pig, and then sold both for 40 dollars; how much did he gain?

5. John earned 12 cents and found 5 cents, and his father gave him enough to make 25; how many cents did his father give him?

6. Bought a coat for 30 dollars and a hat for 3 dollars: I sold both for 40 dollars; how much did I gain?

7. A man having 30 cows bought 20 more and then sold 25; how many had he remaining?

8. Mr. Smith, having 22 dollars, earned 18 more, and then bought a watch for 16 dollars; how much money had he remaining?

9. Two boys commenced playing with 14 marbles each: at the close of the game one had 16; how many had the other?

10. A man bought a horse for 25 dollars and paid 5 dollars to have him taken home; for how much must he sell the horse to gain 8 dollars?

11. Frank, having a certain number of books, bought 10 more, and, giving 25 to his sister, had none remaining; how many books had he at first?

12. Mr. Smith paid 15 dollars for carpet and 12 dollars for chairs; how much change will he get out of 50 dollars?

13. In an orchard there are 50 trees: 25 are apple trees, and 15 pear trees, and the remainder are quince; how many are quince?

14. A gunner shot 14 quail the first day, 15 the second day, and 16 the third day: he sent 10 to his father and 12 to his uncle; how many birds did he take to his home?

15. A man bought a horse for 50 dollars, a saddle and bridle for 20 dollars more, and afterward sold them for 90 dollars; how much did he gain?

16. A man having 50 barrels of flour sold 23 to one man, 16 to another, and 5 to another; how many barrels had he remaining?

17. From a tub of butter containing 46 pounds, 5 pounds were sold to one customer, 10 to another, and 12 to another; how much remained unsold?

18. A boy had 25 marbles: he sold 15 of them and then bought 25 more; how many did he then have?

19. In one field there are 24 sheep, in a second field there are 8, and in a third field there are enough to make the entire number 40 sheep; how many sheep are there in the third field?

20. Two men owe some money: one owes 25 dollars and the other 5 dollars less; how much do they both owe?

21. The distance from Philadelphia to New York is 90 miles: a man travels 65 miles of this distance on the first day and then comes back 15 miles; how far is he from where he started?

22. A man, who has 125 dollars in his pocket, earns 50 dollars more, and then pays his grocer 30 dollars; how much has he remaining?

23. A man sold 45 sheep, then bought 15, and then had 25; how many had he at first?

24. A boy, having 45 cents in the morning, earned some during the day, when he found he had 60 cents; how much did he earn?

25. A boy, wishing to buy a ball for 70 cents and a bat for 40 cents, saved 55 cents and his father gave him 30; how many more cents did he need?

26. A drover bought 50 cows and then sold 12 to one man and 24 to another; how many remained?

27. There are 2 pens containing 50 hogs each: 20 are sold from one pen and 25 from another; how many hogs remain unsold?

28. What is the value of $6 + 5 - 2$?
29. What is the value of $7 + 9 - 5$?
30. What is the value of $12 + 13 - 10$?
31. What is the value of $14 + 16 - 12$?
32. What is the value of $16 + 18 - 14$?
33. What is the value of $18 + 20 - 10$?
34. What is the value of $20 + 25 - 16$?
35. What is the value of $20 + 12 - 18$?
36. What is the value of $24 + 20 - 18$?
37. What is the value of $28 + 22 - 20$?
38. What is the value of $30 + 25 - 15$?
39. What is the value of $40 - 20 + 10$?
40. What is the value of $45 - 20 + 10$?
41. What is the value of $50 + 25 - 40$?
42. What is the value of $60 - 50 + 21$?
43. What is the value of $70 - 20 + 12$?
44. What is the value of $80 - 30 + 20$?
45. How many are 8 plus 3 minus 4?
46. How many are 30 minus 16 plus 4?
47. How many are 40 plus 10 minus 20?
48. How many are 65 minus 15 minus 25?
49. How many are 75 plus 20 minus 35?
50. How many are 70 minus 30 plus 10?

MULTIPLICATION.

10.

1. What will 4 apples cost at 2 cents apiece?

SOLUTION.—If one apple cost 2 cents, 4 apples will cost 4 times 2 cents, which are 8 cents.

2. How much will 2 pears cost at 2 cents apiece?
3. What will 2 melons cost at 2 cents apiece?
4. What will 5 sheep cost at 2 dollars apiece?
5. What will 7 turkeys cost at 2 dollars apiece?
6. What will 8 pictures cost at 2 dollars apiece?
7. How many are 2 times 2 boys? 2 times 5 girls? 2 times 7 days? 2 times 8 weeks?
8. How many are—

2 times 2?	2 times 5?	2 times 8?	2 times 11?
2 times 3?	2 times 6?	2 times 9?	2 times 12?
2 times 4?	2 times 7?	2 times 10?	2 times 13?

9. If an apple cost 3 cents, what will 3 apples cost?
10. If an orange cost 3 cents, what will 4 oranges cost?
11. How much will 3 oranges cost at 5 cents apiece?
12. At the rate of 6 dollars a barrel, what will 3 barrels of flour cost?
13. How many are 3 times 7 oranges? 3 times 8 cents?
14. How many are 3 times 11 months? 3 times 12 months?
15. How many are 3 times 9 weeks? 3 times 10 weeks?
16. How many are—

3 times 1?	3 times 4?	3 times 7?	3 times 10?
3 times 2?	3 times 5?	3 times 8?	3 times 11?
3 times 3?	3 times 6?	3 times 9?	3 times 12?

17. How much will 4 sheep cost at 2 dollars each?
18. At 4 dollars each, what will 5 sheep cost?
19. What will 6 pounds of candles cost at 4 cents a pound?

20. What will 10 barrels of fish cost at 10 dollars a barrel?

21. How many are 4 times 3 dollars? 4 times 5 dollars? 4 times 8 dollars?

22. How many are 4 times 7 cows? 4 times 9 horses?

23. How many are 4 times 12 pinks? 4 times 11 lilies?

24. How many are—

4 times 1?	4 times 4?	4 times 7?	4 times 10?
4 times 2?	4 times 5?	4 times 8?	4 times 11?
4 times 3?	4 times 6?	4 times 9?	4 times 12?

NOTE.—This sign × is read *times*, and means that the two numbers between which it stands are to be multiplied. Thus, 8×3 is read 3 *times* 8.

25. If one pair of shoes cost 2 dollars, how much will 5 pairs cost?

26. If a slate cost 5 cents, what will 7 slates cost?

27. How much will 5 hats cost at 5 dollars apiece?

28. If there are 5 rails in one panel of a fence, how many are there in 7 panels?

29. How many are 5 times 4 boys? 5 times 5 boys?

30. How many are 5 times 6 girls? 5 times 7 girls?

31. How many are 5 times 10 desks? 5 times 9 desks? 5 times 12 desks?

32. How many are—

5 times 1?	5 times 4?	5 times 7?	5 times 10?
5 times 2?	5 times 5?	5 times 8?	5 times 11?
5 times 3?	5 times 6?	5 times 9?	5 times 12?

33. At 3 dollars a ton, what will 3 tons of coal cost?

34. If one orange cost 5 cents, what will 6 cost?

35. If a duck weighs 8 pounds, how many pounds will 7 ducks weigh?

36. How many are 6 times 3 girls? 6 times 5 girls?

37. How many are 6 times 7 cups? 6 times 8 cups?

38. How many are 6 times 9 apples? 6 times 10 apples?

39. How many are 6 times 11 sheep? 6 times 12 sheep?

40. How many are—

6 times 1? 6 times 4? 6 times 7? 6 times 10?
6 times 2? 6 times 5? 6 times 8? 6 times 11?
6 times 3? 6 times 6? 6 times 9? 6 times 12?

41. How much will 7 apples cost at 5 cents each?

42. How much will 7 books cost at 12 cents each?

43. There are 4 weeks in a month; how many weeks in 7 months?

44. How many are 7 times 3 peaches? 7 times 8 tops?

45. How many are 7 times 7 pins? 7 times 9 dolls?

46. How many are 7 times 5 pencils? 7 times 10 cents?

47. How many are 7 times 6 roses? 7 times 12 oranges?

48. How many are—

7 times 1? 7 times 4? 7 times 7? 7 times 10?
7 times 2? 7 times 5? 7 times 8? 7 times 11?
7 times 3? 7 times 6? 7 times 9? 7 times 12?

49. What will 6 tablets cost at 8 cents each?

50. Mary found 8 pins and bought 10 times as many; how many pins did she buy? How many pins had she then?

51. How many are 8 times 6 slates? 8 times 7 books?

52. How many are 8 times 9 horses? 8 times 12 cows?

53. How many are 8 times 4 desks? 8 times 5 tops?

54. How many are 8 times 2 dresses? 8 times 3 coats?

55. How many are 8 times 10 days? 8 times 11 days?

56. How many are—

8 times 1? 8 times 4? 8 times 7? 8 times 10?
8 times 2? 8 times 5? 8 times 8? 8 times 11?
8 times 3? 8 times 6? 8 times 9? 8 times 12?

57. If one orange cost 9 cents, how much will 4 cost?

58. At the rate of 9 dollars a week, how much can I earn in 5 weeks?

59. How many are 9 times 3 miles? 9 times 2 hours?

60. How many are 9 times 6 sheep? 9 times 7 cows? 9 times 8 chickens?

61. How many are 9 times 8 girls? 9 times 10 horses? 9 times 11 books?

62. How many are 9 times 7 loaves? 9 times 9 marbles?

63. How many are—

9 times 1? 9 times 4? 9 times 7? 9 times 10?
9 times 2? 9 times 5? 9 times 8? 9 times 11?
9 times 3? 9 times 6? 9 times 9? 9 times 12?

64. A horse has 4 legs. How many legs have 10 horses?

65. If one book cost 10 cents, how much will 7 books cost?

66. There are 10 eggs in one nest; how many eggs in 12 nests?

67. How many are 10 times 5 sheep? 10 times 3 sheep? 10 times 4 sheep?

68. How many are 10 times 7 turkeys? 10 times 8 turkeys? 10 times 9 turkeys?

69. How many are 10 times 11 hens? 10 times 12 hens?

70. How many are—

10 times 1? 10 times 4? 10 times 7? 10 times 10?
10 times 2? 10 times 5? 10 times 8? 10 times 11?
10 times 3? 10 times 6? 10 times 9? 10 times 12?

71. If a boy earns 5 dollars in one week, how many dollars will he earn in 11 weeks?

72. How much will 11 slates cost at 8 cents each?

73. How many are 11 times 2 chairs? 11 times 3 chairs? 11 times 4 chairs?

74. How many are 11 times 8 ducks? 11 times 9 ducks?

75. How many are 11 times 10 pins? 11 times 11 pins? 11 times 12 pins?

76. How many are—

11 times 1? 11 times 4? 11 times 7? 11 times 10?
11 times 2? 11 times 5? 11 times 8? 11 times 11?
11 times 3? 11 times 6? 11 times 9? 11 times 12?

77. How much will 12 coats cost at 5 dollars each?

78. If a melon cost 12 cents, what will 9 cost?

79. If a house rents for 12 dollars a month, how much will the rent be for 7 months?

80. How many are 12 times 2 pages? 12 times 4 pages? 12 times 6 pages?

81. How many are 12 times 9 rods? 12 times 10 rods? 12 times 11 rods?

82. How many are—

12 times 1?	12 times 4?	12 times 7?	12 times 10?
12 times 2?	12 times 5?	12 times 8?	12 times 11?
12 times 3?	12 times 6?	12 times 9?	12 times 12?

83. How many are—

3×8?	5×6?	3×9?	6×9?	9×12?
4×9?	4×7?	5×8?	7×6?	10×12?
6×7?	5×8?	7×7?	5×9?	11×12?

NOTE.—The teacher will drill on the following elementary products until they are thoroughly known by the pupils:

$2 \times 1 = 2$	$3 \times 1 = 3$	$4 \times 1 = 4$	$5 \times 1 = 5$
$2 \times 2 = 4$	$3 \times 2 = 6$	$4 \times 2 = 8$	$5 \times 2 = 10$
$2 \times 3 = 6$	$3 \times 3 = 9$	$4 \times 3 = 12$	$5 \times 3 = 15$
$2 \times 4 = 8$	$3 \times 4 = 12$	$4 \times 4 = 16$	$5 \times 4 = 20$
$2 \times 5 = 10$	$3 \times 5 = 15$	$4 \times 5 = 20$	$5 \times 5 = 25$
$2 \times 6 = 12$	$3 \times 6 = 18$	$4 \times 6 = 24$	$5 \times 6 = 30$
$2 \times 7 = 14$	$3 \times 7 = 21$	$4 \times 7 = 28$	$5 \times 7 = 35$
$2 \times 8 = 16$	$3 \times 8 = 24$	$4 \times 8 = 32$	$5 \times 8 = 40$
$2 \times 9 = 18$	$3 \times 9 = 27$	$4 \times 9 = 36$	$5 \times 9 = 45$
$6 \times 1 = 6$	$7 \times 1 = 7$	$8 \times 1 = 8$	$9 \times 1 = 9$
$6 \times 2 = 12$	$7 \times 2 = 14$	$8 \times 2 = 16$	$9 \times 2 = 18$
$6 \times 3 = 18$	$7 \times 3 = 21$	$8 \times 3 = 24$	$9 \times 3 = 27$
$6 \times 4 = 24$	$7 \times 4 = 28$	$8 \times 4 = 32$	$9 \times 4 = 36$
$6 \times 5 = 30$	$7 \times 5 = 35$	$8 \times 5 = 40$	$9 \times 5 = 45$
$6 \times 6 = 36$	$7 \times 6 = 42$	$8 \times 6 = 48$	$9 \times 6 = 54$
$6 \times 7 = 42$	$7 \times 7 = 49$	$8 \times 7 = 56$	$9 \times 7 = 63$
$6 \times 8 = 48$	$7 \times 8 = 56$	$8 \times 8 = 64$	$9 \times 8 = 72$
$6 \times 9 = 54$	$7 \times 9 = 63$	$8 \times 9 = 72$	$9 \times 9 = 81$

11.

1. How much will 4 balls cost at 30 cents apiece?
2. What will 5 melons cost at 22 cents apiece?
3. What will 25 sheep cost at 5 dollars apiece?
4. What will 5 pounds of rice cost at 12 cents a pound?
5. What will 20 shad cost at 16 cents apiece?
6. At 25 cents each how much will 9 books cost?
7. At 50 dollars each how much will 5 coats cost?
8. A boy can ride 15 miles an hour on his bicycle; how far will he ride in 3 hours?
9. Helen bought 25 yards of gingham at 10 cents a yard; how much did it cost?
10. Mary bought 28 yards of ribbon at 3 cents a yard; what did she pay for it?
11. How much will 20 yards of carpet cost at 50 cents a yard?
12. A farmer bought 22 ducks at 40 cents apiece; how much did they cost?
13. If 10 men can do a piece of work in 20 days, how long will it take 1 man to do it?
14. If 5 men can mow a piece of grass in 7 days, how long will it take 1 man to mow the same?
15. If 15 men can do a piece of work in 20 days, how long will it take 1 man to do it?
16. If 6 men can plow a field in 2 days, how many men will it take to plow it in 1 day?
17. If a train of cars goes 20 miles in 1 hour, how far will it go in 5 hours?
18. If 10 men earn 100 dollars in a week, how many dollars will 1 man earn?
19. Frank bought 20 pairs of chickens at 40 cents a pair; how much did they cost?

20. What is the cost of 30 yards of carpet at 3 dollars a yard?

21. There are 12 inches in a foot; how many inches in 12 feet? In 20 feet? In 25 feet?

22. There are 12 months in a year; how many months are there in 8 years? In 20 years? In 30 years?

23. There are 60 minutes in an hour; how many minutes in 6 hours? In 12 hours? In 20 hours?

24. A boy bought 3 slates at 10 cents apiece and 3 copy-books at 5 cents apiece; how much did he pay for all?

25. Mary has 11 apples and her sister has 7 times as many; how many has her sister?

26. A man travels 12 miles a day; how many miles will he travel in 8 days? In 9 days?

27. A man sold 3 sheep at 6 dollars each and 5 hogs at 4 dollars each; how much did he get for all?

28. George has 12 apples and 4 times as many peaches; how many peaches has he?

29. A man sold 12 horses and then bought 8 times as many as he sold; how many did he buy?

30. A boy, in gunning, saw 8 flocks of quail, 20 in each flock; how many birds did he see?

31. A man has 3 barrels of vinegar, each barrel containing 30 gallons; how much is it worth at 10 cents a gallon?

32. A man has 8 crates of strawberries, each crate containing 10 quart-boxes; how much are they worth at 15 cents a quart?

33. A lady bought 10 yards of muslin at 8 cents a yard, 7 yards of ribbon at 3 cents a yard, and 2 pounds of coffee at 25 cents a pound; how much did she pay for all?

34. In an orchard there are 4 rows of pear trees, each row containing 20 trees, and 2 rows of apple trees, each row containing 30 trees; how many trees are there in the orchard?

35. A merchant, having 10 melons and 20 apples, sold the melons for 6 cents apiece and the apples for 5 cents apiece; how much did he get for both?

36. A man whose salary is 60 dollars a month, paid 3 dollars a week board and 2 dollars for his room; how much did he save in a month?

37. George travelled 4 miles an hour and Francis travelled 6 miles an hour; how many miles farther will Francis travel in 12 hours than George?

38. Helen bought 3 apples for 10 cents and sold them at 4 cents each; how much did she gain?

39. A man bought a roll of carpet containing 90 yards: he cut from it 20 yards for one room and 30 for another; how many yards remained in the roll?

40. A man bought for a suit of clothes 15 yards of cloth at 2 dollars a yard: he paid 10 dollars for making the coat, 5 dollars for making the trousers, and 2 dollars for making the vest; how much did the suit cost him?

41. Mr. A. bought 3 cows at 25 dollars each, and 10 hogs at 5 dollars each; he sold them all for 100 dollars; how much did he lose?

42. Frank and Thomas started from the same place and travelled in the same direction: Frank travelled at the rate of 5 miles an hour and Thomas at the rate of 6 miles an hour; how far apart were they in 6 hours? In 8 hours?

43. Harry and George start at the same place and travel in opposite directions: Harry at the rate of 6 miles an hour and George at the rate of 8 miles an hour; how far apart will they be in 4 hours? In 10 hours?

44. A grocer sells 5 pounds of sugar at 8 cents a pound, 6 pounds of rice at 10 cents a pound, and 2 gallons of molasses at 50 cents a gallon: his customer gives him a 5-dollar bill; how much change will he receive?

45. A farmer exchanges 12 dozens of eggs at 20 cents a dozen for 5 pounds of coffee at 25 cents a pound; how much cash should he receive?

46. From a hogshead of vinegar containing 63 gallons a grocer sells 3 casks: the first containing 5 gallons, the second 10 gallons, and the third 15 gallons; how many gallons did he sell? How many gallons remained in the hogshead?

47. The distance from Philadelphia to New York is 90 miles: a man starts at Philadelphia and drives 3 days at the rate of 12 miles a day; how far is he from New York at the end of the third day?

48. From a cask of molasses containing 98 gallons, 53 gallons leaked out and the remainder was sold for 60 cents a gallon; how much money was received for the remainder?

49. A man bought 2 pairs of shoes at 2 dollars a pair and 10 yards of muslin at 10 cents a yard; how much change did he get from a 10-dollar bill?

50. A woman sold 6 dozens of eggs on Tuesday and 10 dozens on Wednesday at 25 cents a dozen: she received in payment 8 pounds of coffee worth 30 cents a pound; how much was still due her?

51. George plowed 4 acres of ground and Henry 4 times as much; how many acres did they both plow? How many acres remained to be plowed in a 30-acre field?

52. What is the value of 20 bushels of wheat at 50 cents a bushel?

53. What is the value of 10 bushels of rye at 45 cents a bushel?

54. What is the value of 8 bushels of potatoes at 60 cents a bushel?

55. What is the value of 40 yards of cloth at 22 cents a yard?

56. How many are $8 \times 8, + 7$? $15 \times 5, + 18$?

57. How many are $6 \times 15, + 12$? $8 \times 25, - 40$?

58. How many are $9 \times 3, + 30$? $10 \times 5, - 27$?

59. How many are $6 \times 10, + 20 \times 2$?

60. How many are $12 \times 20, - 10 \times 4$?

61. How many are $16 \times 5, + 15, + 10, - 30$?

62. How many are $20 + 10, \times 6, - 50$?

NOTE.—In examples like the above, perform the work, as indicated, up to each comma. As in No. 61, multiply 16 by 5, then add 15, then add 10, and then subtract 30.

DIVISION.

12.

1. How many times are 2 apples contained in 4 apples?

SOLUTION.—2 apples are contained in 4 apples 2 times, since 2 times 2 apples are 4 apples.

2. How many times are 2 cents contained in 6 cents?

3. How many times are 3 dollars contained in 12 dollars?

4. How many times are 4 books contained in 12 books?

5. How many times are 5 sheep contained in 10 sheep?

6. How many times are 5 desks contained in 15 desks?

7. How many times are 4 pencils contained in 16 pencils?

8. How many times are 5 dollars contained in 20 dollars?

9. At 2 cents apiece, how many plums can I buy for 10 cents?

SOLUTION.—If 1 plum cost 2 cents, for 10 cents I can buy as many plums as 2 cents is contained times in 10 cents, which is 5 times, or 5 plums.

10. How many tops at 3 cents each can I get for 12 cents?

11. At 4 dollars each how many sheep can I buy for 16 dollars?

12. At 5 cents each how many books can I buy for 20 cents? For 25 cents?

13. For 30 cents how many yards of ribbon can I buy at 5 cents a yard?

14. How many yards of silk can I buy, at 6 dollars a yard, for 30 dollars?

15. How many years in 36 months? In 48 months?

16. A boy paid 36 cents for oranges, at 4 cents apiece; how many oranges did he buy?

17. There are 8 quarts in a peck; how many pecks in 40 quarts?

18. There are 48 quarts of oats in a box; how many pecks are there?

19. A man spends 25 cents for chestnuts, at 5 cents a quart; how many quarts did he buy?

20. A pair of pants costs 6 dollars; how many pairs can be bought for 48 dollars?

21. A man drives 7 miles an hour; how many hours will it take him to drive 42 miles?

22. How many lilies, at 6 cents each, can be bought for 54 cents?

23. An express train runs 30 miles an hour; how long will it take it to run 90 miles?

24. If a man saves 10 dollars a week, how many weeks will it take him to save 70 dollars?

25. How many dresses will 54 yards of cloth make, if it requires 9 yards to make 1 dress?

26. If a pound of meat is worth 10 cents, how many pounds can be bought for 80 cents?

27. How many barrels of flour, worth 6 dollars a barrel, can you buy for 72 dollars?

28. A man digs 9 rods of ditch in 1 day; how many days will it take him to dig 54 rods?

29. When knives are worth 10 cents each, how many can I buy for 90 cents?

30. When wood sells at 11 dollars a cord, how many cords can I buy for 88 dollars?

31. There are 96 pinks on a stalk; how many dozens are there?

32. How many slates, at 11 cents each, can I buy for 99 cents?

33. If a book cost 12 cents, how many can I buy for 96 cents?

34. At 12 cents a yard, how many yards of calico can I buy for 60 cents? For 72 cents?

35. At 12 dollars a week, in what time can a man earn 84 dollars? 108 dollars? 120 dollars?

36. How many 10-gallon casks can I fill with 120 gallons?

37. In 10 feet there are 120 inches; how many inches in 1 foot?

38. In 12 hours a man rode 108 miles on a bicycle; what was his rate per hour?

39. A man bought flour for 84 dollars, at the rate of 7 dollars a barrel; how many barrels did he purchase?

40. A drover sold 6 sheep for 72 dollars; how much did they bring apiece?

41. If 108 acres were divided into 9 lots, how many acres did each lot contain?

42. Mary is 15 years old and Helen is 5 years old; how many times Helen's age is Mary's?

43. 16 dimes are how many times 4 dimes? 8 dimes?

44. 18 men are how many times 6 men? 9 men?

45. How many times 8 knives are 24 knives?

46. 30 cents are how many times 5 cents? 6 cents? 10 cents?

47. A boy has 36 marbles; how many times 9 marbles has he? 12 marbles?

48. 60 dolls are how many times 10 dolls? 12 dolls? 15 dolls? 20 dolls?

49. 84 melons contain 7 melons how many times? 12 melons?

50. In 20 how many 4's? 5's? 10's?

51. In 30 how many 3's? 5's? 6's? 10's?

52. In 60 how many 5's? 6's? 10's? 12's?
53. How many 9's in 54? 72? 81? 108?
54. How many 12's in 60? 84? 96? 120?
55. How many 20's in 80? 100? 140? 160?

13.

1. How many times is 2 contained in 8? 18? 30? 36?
2. How many times is 3 contained in 9? 18? 27? 36?
3. How many times is 4 contained in 16? 24? 36? 48?
4. How many times is 5 contained in 30? 40? 55? 60?
5. How many times is 6 contained in 24? 36? 48? 54?
6. How many times is 7 contained in 28? 42? 49? 63?
7. A boy has 56 marbles; how many groups of 8 marbles each can he make?
8. How many 8's in 32? 40? 56? 72?
9. How many 9's in 45? 63? 81? 99?
10. How many 10's in 50? 80? 100? 120?
11. How many times is 11 contained in 44? 66? 88? 110?
12. How many times is 12 contained in 48? 72? 108? 144?
13. If 9 peaches fill a basket, how many baskets will 99 peaches fill?
14. If there are 7 days in a week, how many weeks will 84 days make?
15. A drover expended 120 dollars for sheep, at 10 dollars apiece; how many did he buy?
16. A man drives 10 miles an hour; how many hours will it take him to drive 140 miles?
17. There are 144 books in my library, each shelf containing 12 books; how many shelves are there?
18. How many 4's in 15?

SOLUTION.—In 15 there are three 4's and 3 remaining.

19. How many 3's in 7? 8? 10? 12? 15? 16?

20. How many 4's in 5? 6? 9? 12? 14? 16? 18?
21. How many 5's in 12? 14? 18? 20? 24? 30?
22. How many 6's in 8? 13? 15? 19? 25? 33?
23. How many 7's in 9? 12? 16? 20? 30? 40?
24. How many 8's in 16? 18? 19? 30? 40? 44?
25. How many 9's in 30? 40? 50? 60? 70? 80?
26. How many 10's in 25? 33? 42? 72? 90? 101?
27. How many 11's in 12? 16? 19? 23? 40? 72?
28. How many 12's in 50? 60? 70? 75? 80? 90?
29. How many 15's in 46? 62? 76? 95? 120? 130?
30. How many 20's in 30? 50? 70? 90? 100? 160?

14.

1. If 3 men plow 12 acres, how much does 1 man plow?

SOLUTION.—If 3 men plow 12 acres, 1 man will plow as many acres as 3 is contained in 12, which are 4 times, or 4 acres. Therefore 1 man will plow 4 acres.

2. At 5 cents a yard how many yards of ribbon can I buy for 25 cents?

3. If 5 oranges cost 30 cents, what will 1 orange cost?

4. Mr. Smith gave 8 dollars to his 4 children for Christmas; how many dollars did each receive?

5. How many apples can I buy for 32 cents, at the rate of 8 cents each?

6. If 9 sheep cost 45 dollars, how much will 1 sheep cost?

7. I paid 11 cents a quart for molasses; how many quarts can I buy for 44 cents?

8. A man walks 36 miles in 9 hours; how many miles does he walk in 1 hour?

9. There are 7 days in a week; how many weeks are there in 49 days?

10. How many yards of lace can I buy for 63 cents, at the rate of 9 cents a yard?

11. How many lambs worth 3 dollars each can I get for 5 sheep worth 6 dollars each?

12. How many yards of muslin at 10 cents a yard can be bought for 2 dozens of eggs, at 15 cents a dozen?

13. How many pounds of sugar at 6 cents a pound will cost as much as 9 yards of calico, at 8 cents a yard?

14. How many sheep, at 6 dollars each, must be given for 4 cows at 15 dollars a head?

15. I gave 4 loads of corn worth 10 dollars a load for coal at 5 dollars a ton; how many tons did I get?

16. A lady sold 9 pounds of lard, at 10 cents a pound, and took in exchange some rice, at 6 cents a pound; how many pounds did she receive?

17. A carpenter receives 20 cents an hour for work and his son receives 10 cents an hour; how much will both receive for 5 hours' work?

18. A storekeeper exchanged 4 lamps worth 90 cents each for potatoes, at 60 cents per bushel; how many bushels did he get?

19. If sugar is worth 7 dollars a barrel, how many barrels can be bought for 5 dollars, and 6 lambs at 5 dollars each?

20. Helen bought 9 yards of ribbon at 7 cents a yard, for which she gave the storekeeper 13 cents and 5 dozens of eggs; how much were the eggs worth a dozen?

21. A boy gave 8 quarts of berries, at 10 cents a quart for 3 yards of cloth, at 25 cents a yard; how much money should he receive?

22. How many are 8 plus 10, divided by 6? 10 plus 10, divided by 5? 11 plus 11, divided by 2?

23. How many are 10 plus 15, divided by 5? 20 plus 12, divided by 8? 18 plus 12, divided by 6?

24. How many are 20 plus 16, divided by 9? 20 plus 15, divided by 7? 20 plus 30, divided by 10?

25. Find the value of $18 + 9, \div 3$. $25 + 10, \div 7$. $25 + 25, \div 10$. $16 + 18, \div 2$.

26. How many are 20 minus 2, divided by 3? 30 minus 9, divided by 3? 30 minus 6, divided by 4?

NOTE.—This sign $\div$ is the sign of division, and is read *divided by*, as $12 \div 3$ is read 12 divided by 3.

27. How many are $50 - 14, \div 9$? $60 - 20, \div 8$? $70 - 15, \div 11$?

28. How many are $60 - 30, \div 5$? $60 - 10, \div 10$? $100 - 4, \div 12$?

29. How many are $9 \times 9, \div 3$? $5 \times 15, \div 25$? $110 - 10, \div 10$?

30. How many are $4 \times 22, \div 11$? $4 \times 14, \div 8$? $2 \times 18, \div 9$?

31. A dime is 10 cents; how many dimes will pay for 2 pairs of gloves at 50 cents a pair?

32. A man buys 1 dozen of collars for 48 dimes; how much will he gain on each collar if he sells them at 50 cents apiece?

33. William had 20 cents and his father gave him 16 cents more; how many oranges can he buy at 4 cents each?

34. Harry had 80 cents, but on his way to school lost 14; how many pounds of candy at 22 cents a pound can he buy with what remains?

35. A man whose monthly salary is 80 dollars, paid his rent, which is 20 dollars, and a store bill of 15 dollars; how many yards of cloth can he buy at 3 dollars a yard with the remainder?

36. How many are 90 minus 9, divided by 9? 99 minus 9, divided by 10? 150 minus 18, divided by 12?

37. Three times Margaret's age, multiplied by 6, divided by 9 equals 14 years; how old is she?

38. Three times Susan's age, + 4 times her age is 28 years; how old is she?

39. Five times a number, + 4 times the number, − 3 times the number, + 6 times the number is 72; what is the number?

40. Bought a horse for 50 dollars and sold him for 3 times that amount + 10 dollars; what did he sell for?

41. $28 + 4, -2, \times 2, \div 10, \times 4, \div 8$ equals how many?

NOTE.—In problems such as No. 41 there are various ways of indicating the work to be done (see Note, p. 34). The *Vinculum*, ————, or *Parentheses*, ( ), denotes that the numbers covered by the former or included in the latter are to be subjected to the same operation. Thus, $(8+4-6)\times 3$ may be written $\overline{8+4-6}\times 3$, which indicates that the value of $8+4-6$, is to be multiplied by 3. Whenever the signs +, −, ×, and ÷ occur in an example, the meaning may be ambiguous unless indicated by one of the above ways. In the problem $36 \div 6 \times 3$ the result may be $\frac{36}{6}\times 3$, or 18, or it may be $\frac{36}{6\times 3}$, or 2.

In problems in which the *comma*, *parentheses*, or *vinculum* is not used, the multiplication or division should be performed *before* the additions or subtractions are made.

What is the value—

42. Of $3 + 5, -3, \times 2$?
43. Of $4 + 10, \div 7, \times 6$?
44. Of $6 + 8, -3, \times 3$?
45. Of $8 - 4, \times 5, \div 2$?
46. Of $7 + 5, \times 3, \div 4$?
47. Of $7 + (5 \times 3)$?
48. Of $8 + (6 \div 3)$?
49. Of $(18 \div 6) \times 4$?
50. Of $(20 \div 5) \times 6$?
51. $(6 \times 5) \div 10$?
52. $(8 \times 4) \div 16$?
53. $(8 \div 4) \times 9$?
54. $(45 \div 9) \times 5$?
55. $(72 \div 8) \times (8 - 3)$?
56. $\overline{16 - 4} \div 3$?
57. $\overline{36 \div 9} \times 2$?
58. $\overline{45 \div 15} \times \overline{6 \div 2}$?
59. $\overline{48 \div 12} + 4$?

Find the value of the following—

60. $20 \times 2 - (5 \times 3) \div 5 + 6 - 3$.
61. $30 - 4 \times 5 + 6 \times 10 - 4 - 2$.
62. $60 \div (3 \times 4) + 20 \times 4 - 14 \div 2$.
63. $120 \div 12 + 5 \times 4 - 27 \div 9 - 2$.
64. $150 \div 10 + 5 \times 6 + 15 \div 12$.
65. $80 \times 2 - 60 + 20 \times 3 + 10$.

PROPERTIES OF NUMBERS.

15.

FACTORS.

1. What numbers multiplied together will produce 4? 6? 8? 10? 12? 16?

2. What numbers multiplied together will produce 18? 25? 35? 45? 65? 77? 91? 99?

Whenever numbers greater than a unit, being multiplied together, will produce a given number, they are said to be the *Factors* of that number.

3. What two factors will produce 4? 6? 8? 12? 16? 20? 40? 60? 90?

4. What two factors will produce 21? 27? 33? 35? 42? 65? 66? 81? 90? 91?

5. What two factors will produce 20? 30? 35? 40? 45? 50? 60? 70?

6. What three factors will produce 12? 18? 24? 30? 36? 70?

7. What four factors will produce 24? 40? 60? 64? 72? 84? 90?

8. What are the 4 factors of 16? 24? 36? 40? 48? 56?

A number which has no factors is called a *Prime Number;* any other number is called a *Composite Number.*

9. Name the prime numbers in the following: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25.

10. Name the composite numbers in the following: 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37.

11. Name the numbers between 1 and 30, which are exactly divisible by 2. Such numbers are *Even Numbers.*

12. Name the numbers between 30 and 50 which are not divisible by 2. Such numbers are *Odd Numbers.*

13. What prime numbers multiplied together will produce 25? 35? 49? 57?

14. What prime numbers multiplied together will produce 33? 42? 45? 55? 60? 75?

Whenever the factors of a number are prime numbers they are called *Prime Factors.*

15. What are the prime factors of 15? 21? 27? 33? 45? 52? 54?

16. What are the prime factors of 70? 80? 90? 93? 96?

16.

DIVISORS.

1. Name the divisors of 12? Of 15? Of 18? Of 24? Of 30?

2. Name a divisor that will divide 6 and 12? 8 and 12? 12 and 18?

Whenever a divisor will exactly divide two or more numbers it is called a *Common Divisor.*

Name a common divisor—

3. Of 4 and 6.
4. Of 6 and 8.
5. Of 6 and 12.
6. Of 8 and 12.
7. Of 10 and 15.
8. Of 12 and 15.
9. Of 12 and 18.
10. Of 12 and 24.
11. Of 16 and 24.
12. Of 24 and 30.
13. Of 24 and 32.
14. Of 30 and 36.

The greatest number that will exactly divide two or more numbers is called the *Greatest Common Divisor.*

Name the greatest common divisor—

15. Of 8 and 12.
16. Of 8 and 16.
17. Of 10 and 15.
18. Of 12 and 15.
19. Of 18 and 24.
20. Of 20 and 25.
21. Of 24 and 30.
22. Of 30 and 36.
23. Of 42 and 49.
24. Of 56 and 64.
25. Of 60 and 75.
26. Of 60 and 84.

17.

MULTIPLES.

1. Name a number that will exactly contain 3; 4; 5; 6.

Whenever a number will contain another an exact number of times it is called a *Multiple* of that number.

2. Name a multiple of 4? Of 6? Of 8? Of 10? Of 12?

3. Name a number that will exactly contain 3 and 4; 5 and 4; 5 and 6.

Whenever a number will contain two or more numbers an exact number of times it is called their *Common Multiple.*

Name a common multiple—

4. Of 3 and 4.
5. Of 4 and 6.
6. Of 6 and 8.
7. Of 5 and 10.
8. Of 8 and 12.
9. Of 10 and 15.
10. Of 12 and 15.
11. Of 12 and 18.

12. Name the least number that will contain 3 and 4; 4 and 5; 4 and 6.

The least number which will contain two or more numbers an exact number of times is called their *Least Common Multiple.*

Name the least common multiple—

13. Of 4 and 5.
14. Of 3 and 6.
15. Of 4 and 8.
16. Of 6 and 8.
17. Of 8 and 12.
18. Of 12 and 18.
19. Of 20 and 25.
20. Of 25 and 30.

Name the least common multiple—

21. Of 3, 4, and 6.
22. Of 2, 4, and 6.
23. Of 2, 3, and 4.
24. Of 4, 6, and 8.
25. Of 3, 6, and 8.
26. Of 6, 8, and 12.
27. Of 8, 12, and 24.
28. Of 5, 7, and 10.
29. Of 4, 5, and 8.
30. Of 5, 7, and 8.

UNITED STATES MONEY.

United States Money is the legal currency of the United States.

In most business transactions the terms dollars and cents are generally used. A point (.) is placed between the figures representing dollars and those representing cents. Thus, $7.24 is read 7 dollars and 24 cents. This $ is the dollar-mark.

The following is the table:

TABLE.

10 mills (m.)	= 1 cent,	ct.
10 cents	= 1 dime,	d.
10 dimes	= 1 dollar,	$.
10 dollars	= 1 eagle,	E.

18.

1. How many mills in 5 cents?

SOLUTION.—There are 10 mills in one cent, and in 5 cents there are 5 times 10 mills, or 50 mills. Therefore, in 5 cents there are 50 mills.

2. How many mills in 6 cents? In 8 cents? In 10 cents?

3. How many cents in 30 mills? In 80 mills? In 120 mills?

4. How many cents in 4 dimes? In 8 dimes? In 10 dimes?

5. How many dimes in 100 cents? In 150 cents? In 200 cents?

6. How many cents in 2 dollars? In 3 dollars?

7. How many dimes in $2? In $3? In $5?

8. How many dollars in 20 dimes? In 50 dimes? In 90 dimes?

9. How many cents in $7.24? In $8.25? In $9.50?

10. How many dollars in 5 eagles? In 10 eagles?

11. How many eagles in $100? In 500 dimes?

12. Harry bought a book for 50 cents and a bag for 75 cents; what did he pay for both?

13. Helen bought a hat for 80 cents and some trimmings for 70 cents; how much did both cost?

14. Horace bought a sled for $1.00 and a pair of gum boots for $1.50; how much did he pay for all?

15. Mary paid $2.25 for some books and $3.25 for a pair of shoes; how much did she pay for all?

16. Susan paid $6.40 for a dress and $5.60 for the making; how much did the dress cost her?

17. Mr. A. bought a horse for $125 and 2 cows for $37.50 each; what did he pay for all?

18. Mr. Smith bought a cow for $75 and sold her for $50.50; what did he lose?

19. Mr. Jones paid $45.50 for his car ticket from Philadelphia to Chicago and his son paid $22.75; how much more did the father pay than the son?

20. A merchant buys cloth at $1.90 per yard and sells for $2.10; what does he gain per yard?

21. A grocer bought potatoes at 60 cents a bushel and sells them at 90 cents; what is his gain on 11 bushels?

22. Bought a coat for $10.50, a hat for $3.50, and a pair of trousers for $6.50; how much did all cost?

23. Bought a horse for $150 and some sheep for $60; how much will be gained by selling them for $250?

24. A man earned $45.50 in June, $30.50 in July, and $24 in August. If his board cost him $15 per month, how much had he remaining?

25. Kate paid $62.50 for a cloak and $32.25 for a dress; how much more did she pay for her cloak than for her dress?

26. What will 5 ducks cost at 30 cents each?

27. What will 8 neckties cost at 25 cents each?

28. If a bushel of apples cost 80 cents, how much will 3 bushels cost?

29. What will 5 tons of coal cost at $4.50 a ton?

30. What will 10 pigs cost at $4.50 each?

31. How much will 15 cords of wood cost at $4.50 a cord?

32. What will 20 sheep cost at $6.50 a head?

33. A lady bought 10 pounds of coffee at 30 cents a pound, and 20 pounds of lard at 18 cents; how much did she pay for all?

34. If 5 tons of coal cost $25.50, how much does 1 ton cost?

35. Mr. A. bought 7 sheep for $70.35; how much was that apiece?

36. If I buy 10 washing machines for $100 and sell them at $12.50 apiece, how much do I gain?

37. What will 10 cows cost at $37.50 each?

38. If Harry earns $1.50 a week, how much will he earn in 8 weeks? In 12 weeks?

39. If William earns $48.40 in 4 weeks, how much is that a week?

40. Frank saves $96.48 in a year; how much does he save in 1 month? In 4 months?

41. Upon reaching the store I found I had $62.50 in my purse: I bought 10 yards of cloth at 60 cents a yard, a shovel at $1.25, and groceries to the amount of $5.25; how much money did I have remaining?

42. Bought oranges for 20 cents a dozen and sold them at the rate of 2 oranges for 5 cents; how much did I gain a dozen?

43. I bought a carriage for $24.25 and paid 4 times as much for the horse; how much did I pay for the horse? How much for both?

44. A drover bought 10 horses for $1200 and sold them at $150 per head; how much did he gain?

FRACTIONS.

NATURE OF FRACTIONS.

If you divide anything into *two* equal parts, one of these equal parts is called a *half*, and is written $\frac{1}{2}$; if into *three* equal parts, one of these equal parts is called a *third*, and is written $\frac{1}{3}$; and two of such equal parts would be called *two-thirds*, and written $\frac{2}{3}$; if into *four* equal parts, one of these equal parts would be called a *fourth*, and written $\frac{1}{4}$; *two* of such equal parts would be called *two-fourths*, and written $\frac{2}{4}$; and *three* such equal parts would be called *three-fourths*, and written $\frac{3}{4}$, and so on. These equal parts of anything are called **fractions**.

19.

1. How many halves in 1 pear? In 2 pears? In 3 pears? In 4 pears?

2. How many halves equal 1 pear? 2 pears? 3 pears?

3. What is 1 half of 4 apples?

SOLUTION.—One-half of 4 apples is 2 apples, since 2 times 2 apples are 4 apples.

4. What is 1 half of 4 men? Of 6 books? Of 10 sheep?

5. What is 1 half of 12 ducks? Of 14 hens? Of 40 turkeys?

6. What is 1 half of 20 desks? Of 24 teachers? Of 40 cups?

7. What is 1 half of 44? Of 50? Of 60? Of 72? Of 100?

8. If a pound of butter costs 40 cents, how much will 1 half of a pound cost?

9. If half a pound of coffee costs 20 cents, what will one pound cost?

10. What will 1 half a ton of steel cost at $60 a ton?

11. How many halves in $2? In $3? In $2½? In $2.50?

12. How many pears in 4 half pears? In 5 half pears?

20.

1. How many thirds in 1 orange? In 2 oranges? In 3 oranges?

2. What is 1 third of 6 dollars? Of 9 dollars? Of 12 dollars?

3. What is 1 third of 15 cows? Of 24 sheep? Of 30 horses?

4. What is 1 third of 36? Of 48? Of 60? Of 75? Of 90?

5. If a cow costs $45 and a calf 1 third as much, how much does the calf cost?

6. The fare from Philadelphia to Chicago is $60, and to Columbus 1 third as much; what is the fare to Columbus?

7. Horace has 48 cents and William has 1 third as much; how many cents has William?

8. A horse cost $90, and a sleigh 1 third as much; how much did the sleigh cost?

9. What are 2 thirds of 9 sheep?

SOLUTION.—One-third of 9 sheep is 3 sheep, and 2 thirds of 9 sheep are 2 times 3 sheep, which are 6 sheep. Therefore, 2 thirds of 9 sheep are 6 sheep.

10. What are 2 thirds of 15 cups? 24 knives? 36 forks?

11. How many are 2 thirds of 48 roses? 60 pinks? 90 lilies?

12. How many are 2 thirds of 75? Of 120? Of 240?

13. A box of candy cost 30 cents and a box of nuts 2 thirds as much; how much did the nuts cost?

14. Bought a yard of cloth for 60 cents; how much will 2 thirds of a yard cost?

15. There are 3 feet in a yard; how many feet in 2 thirds of a yard?

16. If Amy lost 1 third of her money, how many thirds had she left?

17. If Amy had $66 and lost 2 thirds of it, how many dollars did she lose? How many dollars had she left?

18. If a man earns $90 a month, how many dollars will he earn in 2 thirds of a month?

19. How many thirds in $2? In $2⅓? In $2⅔?

21.

1. How many fourths in 1 orange? In 2 oranges? In 3 oranges?

2. What is 1 fourth of 4 hens? Of 12 cents? Of 16 dollars? Of 20 turkeys?

3. What is 1 fourth of 28? Of 36? Of 48? Of 60? Of 80? Of 100?

4. A box of figs costs 60 cents; how much will 1 fourth of a box cost?

5. An acre of land cost 80 dollars; how much will 1 fourth of an acre cost?

6. If a house rents for 100 dollars a year, how much will the rent be for 1 fourth of a year?

7. How much is 3 fourths of 12 cents?

SOLUTION.—One-fourth of 12 cents is 3 cents, and 3 fourths of 12 cents are 3 times 3 cents, which are 9 cents. Therefore, 3 fourths of 12 cents are 9 cents.

8. How much is 3 fourths of 24 cents? Of 48 dollars? Of 60 sheep?

9. How many fourths in 3? In 4? In 3¾? In 4¾?

10. How many ones in 16 fourths? In 12 fourths? In 10 fourths?

11. If a box of candy cost 60 cents, how much will 3 fourths of a box cost?

12. A load of potatoes contains 80 bushels; how many bushels in 3 fourths of a load?

13. There are 4 quarts in 1 gallon; how many quarts in 3 fourths of 16 gallons?

14. How many eggs in 1 half of a dozen? In 1 third of a dozen? In 1 fourth of a dozen?

15. A man earns 60 dollars in a month; how many dollars will he earn in 1 half of a month? In 2 thirds of a month?

16. How much is 3 fourths of 16? Of 20? Of 36? Of 80? Of 100?

17. Henry is 40 years old and William is 3 fourths as old; how old is William?

18. If there are 4 pecks in a bushel, what part of a bushel is 3 pecks?

19. How many fourths in \$2? In \$2¼? In \$3¼?

20. How much is 1 fourth of 60 cents? 3 fourths of 60 cents? 1 third of 60 cents? 2 thirds of 60 cents? 1 half of 60 cents?

21. How much is 2 thirds of 60? Of 72? Of 81?

22. How much is 3 fourths of 60? Of 72? Of 100?

22.

1. How many fifths in 1 pear? In 3 pears? In 5 pears?

2. What is 1 fifth of 20 pears? Of 30 pears? Of 40 pears?

3. If a man paid 10 cents for a pie, how much will he pay for 1 fifth of a pie?

4. Horace had 15 apples and gave away 1 fifth of them; how many did he give away? How many did he keep?

5. How much is 1 fifth of 55? Of 65? Of 80? Of 90?

6. How much is 2 fifths of 30? Of 40? Of 50? Of 60?

7. What are 3 fifths of 20? Of 35? Of 50? Of 60?

8. What are 4 fifths of 25? Of 40? Of 55? Of 75?

9. Harry paid 2 fifths of 50 dollars for a suit; how much did the suit cost?

10. If a coat cost 20 dollars, and a pair of trousers cost 3 fifths as much; how much did the trousers cost?

11. Margaret had 25 cents and spent 3 fifths of it; how much did she spend?

12. Amy had 65 cents and spent 4 fifths of it; how much did she spend?

13. Mr. B. owned a farm of 120 acres and sold 3 fifths of it to Mr. C.; how many acres did he sell? How many acres had he remaining?

14. There are 60 minutes in an hour; how many minutes in 3 fifths of an hour?

23.

1. The teacher divided a crayon into 6 equal parts; what is one of these parts called? Two of them? Three of them? Four of them? Five of them?

2. How many sixths in the whole crayon?

3. What part of the whole crayon do 3 of these parts make?

4. How many sixths are there in 1 apple? In 3 apples? In 6 apples?

5. How many ones in 36 sixths? In 42 sixths? In 72 sixths? In 84 sixths?

6. What is 1 sixth of 18? Of 24? Of 48? Of 60?

7. What are 2 sixths of 12? Of 18? Of 24? Of 30? Of 36?

8. How many are 3 sixths of 42? Of 48? Of 78?

9. How many are 4 sixths of 60? Of 66? Of 72? Of 84?

10. How many are 5 sixths of 36? Of 54? Of 90? Of 120?

11. A watch cost 60 dollars and the chain cost 2 sixths as much; how much did the chain cost?

12. A farmer has 84 sheep and his neighbor has 3 sixths as many; how many has his neighbor?

13. Mary has 90 roses and her sister has 4 sixths as many; how many roses has her sister?

14. A watch cost 54 dollars and the chain cost 5 sixths as much; what did the chain cost?

15. Frank received 1 sixth of 18 marbles and Harry received 2 sixths; how many marbles did each receive? How many did both receive?

16. How many sixths of 30 are equal to one-half of 30?

17. How many sixths in 3 apples? In $5\frac{2}{6}$ apples? In $10\frac{4}{6}$ apples?

18. In 24 sixths how many 1's? In 36 sixths? In 40 sixths?

24.

1. If a slate pencil is divided into 7 equal parts, what is one of these parts called? 2 parts? 3 parts? 4 parts? 5 parts?

2. How many sevenths in a whole pencil?

3. What part of the whole pencil do 4 of these equal parts make?

4. How many sevenths are there in 2 pencils? In 3 pencils? In 4 pencils?

5. How many sevenths in 4? In 5? In 6? In 8? In $3\frac{2}{7}$?

6. How many ones in 35 sevenths? In 49 sevenths?

7. What is 1 seventh of 35 bags? 42 boys? 63 books?

8. How many are 2 sevenths of 21? Of 35? Of 63? Of 77?

9. How many are 3 sevenths of 21? Of 35? Of 63? Of 77?

10. How many are 4 sevenths of 21? Of 35? Of 63? Of 77?

11. How many are 5 sevenths of 21? Of 35? Of 63? Of 77?

12. How many are 6 sevenths of 21? Of 35? Of 63? Of 77?

13. A horse was bought for 63 dollars, and sold for 6 sevenths of this amount; for how much was he sold?

14. If I buy a lot for 77 dollars and sell it for 5 sevenths of this amount; how much do I receive for it? How much do I lose?

15. A newsboy had 98 papers and sold 4 sevenths of them; how many did he sell?

16. I bought a horse for $147 and sold him for 3 sevenths of this amount; how much did I receive for him? How much did I lose?

17. Mr. Jones bought a carriage for 98 dollars and harness for 2 sevenths as much; how much did the harness cost?

18. A farmer had 63 sheep in a field, and 2 sevenths of them and 10 more jumped out; how many jumped out? How many remained in the field?

19. A man paid 4 sevenths of 63 dollars for 9 tons of coal; how much did he pay for 1 ton?

25.

1. If I divide an apple into 8 equal parts, what is one of these parts called? 2 parts? 3 parts? 4 parts?

2. How many eighths are there in a whole pie? In 2 pies? In 3 pies?

3. What is $\frac{1}{8}$ of 24 slates? Of 40 pencils? Of 56 books?

4. What is $\frac{1}{8}$ of 16? Of 24? Of 32? Of 48?

5. What are $\frac{2}{8}$ of 32? Of 40? Of 48? Of 56?

6. What are $\frac{3}{8}$ of 24? Of 64? Of 96?

7. What are $\frac{5}{8}$ of 8? Of 16? Of 24? Of 32?

8. What are $\frac{7}{8}$ of 64? Of 80? Of 96? Of 120?

9. If a ton of coal cost 8 dollars, what will $\frac{1}{8}$ of a ton cost?

10. If a man earns 24 dollars in 1 week, what will he earn in $\frac{2}{8}$ of a week?

11. If a furnace consumes 40 tons of coal in a week, how much coal will it consume in $\frac{3}{8}$ of a week?

12. Charles has 72 marbles and his brother has $\frac{5}{8}$ as many; how many has his brother?

13. If 80 peaches are divided so that Charles receives $\frac{5}{8}$ of them and Henry the remainder, how many more peaches will Charles receive than Henry?

14. How many eighths are there in 2? In 3? In $2\frac{1}{8}$? In $2\frac{3}{8}$?

15. How many 1's are there in 16 eighths? In 24 eighths? In 30 eighths? In 35 eighths?

26.

1. If I divide a peach into 9 equal parts, what is one of these parts called?

2. How many ninths in 1 peach? In 2 peaches? In 3 peaches? In 4 peaches?

3. What is $\frac{1}{9}$ of 18 birds? Of 36 turkeys? Of 54 geese?

4. What is $\frac{1}{9}$ of 36? Of 45? Of 81? Of 90?

5. What are $\frac{2}{9}$ of 27? Of 63? Of 72? Of 81?

6. What are $\frac{3}{9}$ of 45? Of 54? Of 99? Of 108?

7. What are $\frac{5}{9}$ of 9? Of 18? Of 27? Of 36? Of 45?

8. What are $\frac{6}{9}$ of 45? Of 54? Of 63? Of 72?

9. What are $\frac{7}{9}$ of 81? Of 90? Of 99? Of 108?

10. What are $\frac{8}{9}$ of 72? Of 54? Of 36? Of 18?

11. A turkey cost 90 cents and a hen cost $\frac{2}{9}$ as much; what is the cost of the hen?

12. A suit of clothes costs 27 dollars and a silk hat $\frac{3}{9}$ as much; what is the cost of the hat?

13. Paid 45 dollars for a cow and $\frac{4}{9}$ as much for a calf; what did the calf cost?

14. William saved 90 dollars in January and $\frac{5}{9}$ as much in February; what did he save in February?

15. Rebecca had 90 roses and gave away $\frac{6}{9}$ of them; how many did she give away? How many had she remaining?

16. A farmer bought an acre of ground for 99 dollars and sold it for $\frac{7}{9}$ of this amount; how much did he receive for it?

17. A girl had 36 peaches and her sister had $\frac{8}{9}$ as many and 3 more; how many had her sister?

18. How many ninths in 2? In 3? In $2\frac{8}{9}$?

19. How many 1's in 18 ninths? In 27 ninths? In 30 ninths?

27.

1. If I divide an apple into 10 equal parts, what is one of these parts called? 2 parts? 3 parts?

2. How many tenths in 1 apple?

3. What is $\frac{1}{10}$ of 20 apples? Of 30 apples?

4. What is $\frac{1}{10}$ of 50? Of 60? Of 70? Of 80?

5. What is $\frac{2}{10}$ of 30? $\frac{3}{10}$ of 40? $\frac{4}{10}$ of 50? $\frac{5}{10}$ of 60? $\frac{6}{10}$ of 70? $\frac{7}{10}$ of 80? $\frac{8}{10}$ of 90? $\frac{9}{10}$ of 100?

6. If the surface of a floor contains 60 square feet and that of the hall $\frac{7}{10}$ as much, how many square feet in the hall?

7. A man paid 120 dollars for a horse and $\frac{8}{10}$ of this amount less 12 dollars for a carriage; what is the cost of the carriage?

8. A boy had 80 marbles, and in one game he lost $\frac{3}{10}$ of them and in another $\frac{4}{10}$ of them; how many did he have remaining?

9. Seven-tenths of 40 potatoes is 8 more than the number in a basket; how many potatoes in the basket?

10. How many tenths in 2? In 3? In 4? In $4\frac{3}{10}$? In $3\frac{6}{10}$?

11. How many 1's in 30 tenths? In 40 tenths? In 60 tenths? In 65 tenths?

28.

MISCELLANEOUS PROBLEMS.

1. What is $\frac{2}{3}$ of 18? Of 24? Of 36? Of 30?

2. What is $\frac{3}{4}$ of 16? Of 20? Of 24? Of 28?

3. What is $\frac{5}{6}$ of 12? Of 18? Of 36? Of 42?
4. What is $\frac{3}{7}$ of 28? Of 35? Of 42? Of 49?
5. What is $\frac{6}{7}$ of 56? Of 63? Of 70? Of 77?
6. What is $\frac{5}{8}$ of 40? Of 56? Of 72? Of 88?
7. What is $\frac{4}{5}$ of 18? Of 27? Of 36? Of 45?
8. What is $\frac{7}{10}$ of 30? Of 40? Of 60? Of 90?
9. How many are $10 + \frac{2}{3}$ of 24?
10. How many are $\frac{3}{4}$ of $12 + 9$?
11. Five-sixths of 30 are how many times 5?

SOLUTION.—$\frac{1}{6}$ of 30 is 5, and $\frac{5}{6}$ are 5 times 5, which are 25, and 25 are as many times 5 as 5 is contained in 25, which are 5 times. Therefore, $\frac{5}{6}$ of 30 are 5 times 5.

12. $\frac{4}{7}$ of 49 are how many times 4?
13. $\frac{3}{8}$ of 32 are how many times 6?
14. $\frac{5}{8}$ of 96 are how many times 15?
15. $\frac{7}{9}$ of 54 are how many times 6?
16. $\frac{7}{9}$ of 90 are how many times $\frac{1}{3}$ of 30?
17. $\frac{3}{10}$ of 100 are how many times $\frac{1}{2}$ of 10?
18. $\frac{9}{10}$ of 80 are how many times $\frac{2}{3}$ of 36?
19. $\frac{5}{8}$ of 96 are how many times $\frac{3}{4}$ of 16?
20. $\frac{7}{8}$ of 64 are how many times $\frac{2}{7}$ of 49?

DEFINITIONS OF FRACTIONS.

A **Fraction** is one or more of the equal parts of any single thing. It is expressed by writing one number above another and a horizontal line between; thus, $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, etc.

The **Numerator** is the number written above the line, as in $\frac{2}{3}$, the figure 2 is the *numerator*.

The **Denominator** is the number written below the line, as in $\frac{3}{4}$, the figure 4 is the *denominator*.

A **Proper Fraction** is a fraction whose value is less than a unit, as $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, etc.

An **Improper Fraction** is a fraction whose value is more than a unit, as $\frac{5}{4}$, $\frac{6}{5}$, $\frac{4}{2}$, etc.

A Mixed Number is a whole number and a fraction, as $3\frac{1}{4}$, $4\frac{5}{6}$, etc.

NOTE.—1. In a fraction the denominator names the fraction and indicates into how many parts the unit is divided.

2. The numerator denotes how many parts of the unit have been taken; thus in the fraction $\frac{5}{6}$ of a pie, 6, the denominator, indicates that the pie has been divided into *six* equal parts, and 5, the numerator, indicates that *five* of those parts have been taken.

29.

NUMBERS TO FRACTIONS.

1. How many halves in 2 apples?

SOLUTION.—In 1 apple there are 2 halves and in 2 apples there are 2 times 2 halves, which are 4 halves.

2. How many halves in 3? In 4? In 5? In 6?
3. How many thirds in 3? In 4? In 5? In 6?
4. How many fourths in 2? In 3? In 4? In 5? In 6?
5. How many fifths in 2? In 3? In 4? In 5? In 6?
6. How many sixths in 2? In 3? In 4? In 5? In 6?
7. How many sevenths in 2? In 3? In 4? In 5? In 6?
8. How many eighths in 4? In 5? In 6? In 7?
9. How many ninths in 2? In 3? In 4? In 5? In 6?
10. How many tenths in 2? In 3? In 4? In 5? In 6?
11. How many halves in $2\frac{1}{2}$?

SOLUTION.—In 1 there are 2 halves, and in 2 there are 2 times 2 halves, which are 4 halves; and 4 halves plus 1 half are 5 halves. Therefore, in $2\frac{1}{2}$ there are 5 halves.

12. How many halves in $3\frac{1}{2}$? $4\frac{1}{2}$? $5\frac{1}{2}$?
13. How many thirds in $2\frac{1}{3}$? In $2\frac{2}{3}$? In $3\frac{2}{3}$? In $4\frac{2}{3}$?
14. How many fourths in $4\frac{3}{4}$? In $5\frac{3}{4}$? In $6\frac{1}{4}$?
15. How many fifths in $2\frac{1}{5}$? In $2\frac{2}{5}$? In $3\frac{3}{5}$? In $4\frac{3}{5}$?
16. How many sixths in $2\frac{1}{6}$? In $3\frac{2}{6}$? In $5\frac{2}{6}$? In $6\frac{5}{6}$?
17. How many sevenths in $2\frac{1}{7}$? In $3\frac{1}{7}$? In $4\frac{2}{7}$? In $2\frac{5}{7}$?
18. How many eighths in $2\frac{1}{8}$? In $3\frac{2}{8}$? In $4\frac{4}{8}$? In $5\frac{5}{8}$?

19. How many ninths in $2\frac{2}{3}$? In $3\frac{2}{3}$? In $4\frac{2}{3}$? In $5\frac{2}{3}$?

20. How many tenths in $2\frac{3}{10}$? In $4\frac{6}{10}$? In $5\frac{7}{10}$?

21. If 1 yard of muslin costs $2\frac{1}{2}$ cents, what will 5 yards cost?

SOLUTION.—If 1 yard of muslin costs 5 half cents, 5 yards will cost 5 times 5 half cents, which are 25 half cents, or $12\frac{1}{2}$ cents.

22. What will 4 hats cost at $2\frac{1}{4}$ dollars each?

23. If 1 pair of shoes costs $6\frac{2}{3}$ dollars, what will 2 pairs cost?

24. If 4 boys can earn $6\frac{2}{3}$ dollars in a week, how much does 1 boy earn?

25. If Ruth bought 7 handkerchiefs for $5\frac{1}{4}$ dollars, how much is that apiece?

26. If 3 boys eat $3\frac{1}{4}$ pounds of meat in a day, how much does 1 boy eat?

27. If 7 nutmegs cost $3\frac{1}{5}$ cents, what will 1 nutmeg cost?

28. If 5 quail weigh $3\frac{5}{10}$ pounds, what will 1 quail weigh?

29. If $2\frac{1}{2}$ tons of coal cost 10 dollars, what will 1 ton cost?

SOLUTION.—In $2\frac{1}{2}$ tons there are 5 half tons. If 5 half tons cost 10 dollars, $\frac{1}{2}$ ton will cost $\frac{1}{5}$ of 10 dollars, which are 2 dollars, and 2 halves, or a ton, will cost 2 times 2 dollars, which are 4 dollars.

30. If $8\frac{1}{3}$ pounds of sugar cost 50 cents, what will 1 pound cost?

31. If $9\frac{1}{2}$ pounds of rice cost 57 cents, what will 2 pounds cost?

32. I paid 66 cents for $3\frac{2}{3}$ pounds of rice; how much will 4 pounds cost?

33. If $5\frac{2}{4}$ pounds of cake cost 69 cents, what will $2\frac{1}{2}$ pounds cost?

34. If $5\frac{1}{5}$ cords of wood cost 52 dollars, what will $3\frac{1}{2}$ cords cost?

35. William saved 88 dollars in $6\frac{2}{7}$ months; how much will he save in 10 months?

36. I paid \$1.46 for $8\frac{1}{5}$ pounds of coffee; how much will $3\frac{1}{5}$ pounds cost?

37. How far can Harry walk in 6 hours, if he walks $6\frac{4}{5}$ miles in 2 hours?

38. Reduce to improper fractions $3\frac{1}{2}$; $5\frac{2}{3}$; $6\frac{3}{4}$; $4\frac{2}{5}$.

39. Reduce to improper fractions $5\frac{1}{3}$; $4\frac{5}{6}$; $3\frac{3}{7}$; $8\frac{1}{3}$.

40. Reduce to improper fractions $4\frac{3}{4}$; $6\frac{2}{5}$; $5\frac{1}{7}$; $9\frac{1}{4}$.

41. Reduce to improper fractions $7\frac{1}{2}$; $8\frac{5}{8}$; $6\frac{3}{8}$; $9\frac{2}{5}$.

NOTE.—To reduce a mixed number to an improper fraction, multiply the whole number by the denominator of the fraction, and then add the numerator and write the sum over the denominator.

30.

FRACTIONS TO WHOLE OR MIXED NUMBERS.

1. How many 1's in 4 halves?

SOLUTION.—In 1 there are 2 halves, and in 4 halves there are as many *ones* as 2 halves are contained times in 4 halves, which are 2 times, or 2. Therefore, in 4 halves there are 2 *ones*.

2. How many 1's in 6 halves? In 8 halves? In 10 halves?

3. How many 1's in 12 fourths? In 16 fourths? In 24 thirds? In 30 thirds?

4. How many 1's in 18 sixths? In 24 sixths? In 30 fifths? In 40 fifths?

5. How many 1's in 35 sevenths? In 49 sevenths? In 56 eighths? In 64 eighths?

6. How many 1's in 11 fourths?

SOLUTION.—In 1 there are 4 fourths, and in 11 fourths there are as many 1's as 4 fourths are contained in 11 fourths, which are $2\frac{3}{4}$ times. Therefore, 11 fourths equal $2\frac{3}{4}$.

7. Reduce to mixed numbers $\frac{15}{2}$; $\frac{17}{4}$; $\frac{19}{8}$; $\frac{18}{9}$.

8. Reduce to mixed numbers $\frac{16}{8}$; $\frac{17}{5}$; $\frac{12}{5}$; $\frac{9}{4}$.

9. Reduce to mixed numbers $\frac{24}{7}$; $\frac{26}{8}$; $\frac{30}{9}$; $\frac{31}{7}$.

10. Reduce to mixed numbers $\frac{11}{6}$; $\frac{14}{6}$; $\frac{19}{10}$; $\frac{21}{10}$.

NOTE.—To reduce an improper fraction to a whole or a mixed number, divide the numerator by the denominator.

11. If a pound of corn-meal costs $3\frac{3}{4}$ cents, what will 8 pounds cost?

SOLUTION.—1. If 1 pound of corn-meal costs $3\frac{3}{4}$ cents, 8 pounds will cost 8 times $3\frac{3}{4}$ cents. 8 times 3 cents are 24 cents; 8 times $\frac{3}{4}$ cents are $\frac{24}{4}$, or 6 cents; 24 cents plus 6 cents are 30 cents. Therefore, 8 pounds of corn-meal at $3\frac{3}{4}$ cents a pound will cost 30 cents.

SOLUTION.—2. $3\frac{3}{4}$ cents equals $\frac{15}{4}$ cents. If 1 pound of corn-meal costs $\frac{15}{4}$ cents, 8 pounds will cost 8 times $\frac{15}{4}$ cents, which are $\frac{120}{4}$ cents, or 30 cents. Therefore, 8 pounds of corn-meal at $3\frac{3}{4}$ cents a pound will cost 30 cents.

12. How much will 8 pears cost at $2\frac{1}{2}$ cents each?

13. What will 6 tons of hay cost at $6\frac{1}{2}$ dollars a ton?

14. If 6 sheep cost 50 dollars, what will 1 sheep cost?

15. If there are 4 quarts in a gallon, how many gallons are there in 33 quarts?

16. There are 7 days in a week; how many weeks in 50 days?

17. How many feet in 65 inches, if there are 12 inches in 1 foot?

18. How long will it take John to walk 64 miles, at the rate of 5 miles an hour?

19. What will 1 bushel of potatoes cost, if 16 bushels cost $12\frac{4}{5}$ dollars?

20. Mr. Smith paid 33 half-dollars for some corn; how many dollars did the corn cost him?

21. At 6 cents a pound, how much sugar can you buy for $1.31?

22. If fare is 5 cents a mile, how many miles can you ride for $1.17?

23. A man saves $7\frac{1}{5}$ in 6 weeks; how much can he save in 9 weeks?

24. If 5 pairs of shoes cost $6\frac{1}{4}$, how much will 7 pairs cost?

25. How much change should I receive out of a five-dollar bill, after I pay for 6 bushels of potatoes at $\frac{5}{8}$ of a dollar a bushel?

31.

FRACTIONS TO HIGHER TERMS.

1. How many halves in 1 apple? Thirds? Fourths? Sixths?

2. How many sixths equal a half?

3. How many fourths equal a half?

4. How many sixths in $\frac{1}{2}$?

SOLUTION.—In one whole thing there are $\frac{6}{6}$, and in $\frac{1}{2}$ there is $\frac{1}{2}$ of $\frac{6}{6}$, which are $\frac{3}{6}$. Therefore, there are $\frac{3}{6}$ in $\frac{1}{2}$.

5. How many fourths in $\frac{1}{2}$? In $\frac{2}{2}$?

6. How many sixths in $\frac{1}{2}$? In $\frac{1}{3}$? In $\frac{3}{3}$? In $\frac{4}{3}$?

7. How many eighths in $\frac{1}{2}$? In $\frac{1}{4}$? In $\frac{2}{4}$? In $\frac{3}{4}$? In $\frac{5}{4}$?

8. How many tenths in $\frac{1}{2}$? In $\frac{1}{5}$? In $\frac{2}{5}$? In $\frac{3}{5}$? In $\frac{4}{5}$?

9. How many twelfths in $\frac{1}{2}$? In $\frac{1}{3}$? In $\frac{2}{3}$? In $\frac{1}{4}$? In $\frac{3}{4}$? In $\frac{2}{6}$?

10. How many twentieths in $\frac{1}{2}$? In $\frac{1}{4}$? In $\frac{3}{4}$? In $\frac{1}{5}$? In $\frac{4}{5}$?

11. Change $\frac{2}{3}$ to sixths.

SOLUTION.—$\frac{1}{3}$ equals $\frac{2}{6}$, and $\frac{2}{3}$ equals 2 times $\frac{2}{6}$, which are $\frac{4}{6}$. Hence $\frac{2}{3}$ equals $\frac{4}{6}$.

12. Change $\frac{1}{2}$, $\frac{3}{4}$ to eighths.

13. Change $\frac{1}{3}$, $\frac{1}{4}$, $\frac{3}{4}$ to twelfths.

14. Change $\frac{2}{3}$, $\frac{2}{5}$, $\frac{4}{5}$ to fifteenths.

15. Change $\frac{1}{2}$, $\frac{3}{4}$, $\frac{5}{8}$ to sixteenths.

16. Change $\frac{1}{2}$, $\frac{1}{4}$, $\frac{3}{4}$, $\frac{4}{5}$ to twentieths.

17. Change $\frac{3}{4}$ to 12ths.

Since $\frac{3}{4}$ equals $\frac{9}{12}$, by what do you multiply both the numerator and the denominator of $\frac{3}{4}$ to obtain $\frac{9}{12}$?

Since $\frac{3}{5}$ equals $\frac{9}{15}$, by what do you multiply both the numerator and the denominator of $\frac{3}{5}$ to obtain $\frac{9}{15}$?

18. By what number must we multiply both numerator and denominator of $\frac{3}{4}$ to change the fraction to 20ths?

19. By what number must we multiply both numerator and denominator of $\frac{7}{8}$ to change it to 9ths? To 12ths? To 18ths?

NOTE.—Fractions having the same denominator are said to have a *common denominator.*

20. Change $\frac{1}{3}$ to sixths; to ninths; to twelfths.
21. Change $\frac{2}{3}$ to ninths; to twelfths; to fifteenths.
22. Change $\frac{3}{4}$ to twelfths; to sixteenths; to twentieths.
23. Change $\frac{1}{2}$ to fourths; to eighths; to twelfths.
24. Change $\frac{1}{4}$ to 8ths; 12ths; 16ths.
25. Reduce $\frac{1}{4}$ and $\frac{1}{2}$ to eighths.
26. Reduce $\frac{1}{3}$ and $\frac{1}{4}$ to twelfths.
27. Reduce $\frac{1}{2}$ and $\frac{2}{3}$ to a common denominator.

SOLUTION.—A common denominator for halves and thirds is sixths; $\frac{1}{2}$ equals $\frac{3}{6}$, and $\frac{2}{3}$ equals $\frac{4}{6}$.

28. Reduce $\frac{1}{3}$ and $\frac{1}{5}$ to a common denominator.
29. Reduce $\frac{1}{3}$ and $\frac{2}{5}$ to a common denominator.
30. Reduce $\frac{2}{3}$ and $\frac{3}{5}$ to a common denominator.
31. Reduce $\frac{1}{2}$ and $\frac{1}{3}$ to a common denominator.
32. Reduce $\frac{1}{2}$ and $\frac{2}{3}$ to a common denominator.
33. Reduce $\frac{3}{4}$ and $\frac{2}{3}$ to a common denominator.
34. Reduce $\frac{3}{4}$ and $\frac{3}{4}$ to a common denominator.
35. Reduce $\frac{2}{5}$ and $\frac{3}{4}$ to a common denominator.
36. Reduce $\frac{3}{5}$ and $\frac{1}{4}$ to a common denominator.
37. Reduce $\frac{2}{5}$ and $\frac{2}{7}$ to a common denominator.
38. Reduce $\frac{1}{3}$, $\frac{1}{4}$, and $\frac{1}{5}$ to a common denominator.
39. Reduce $\frac{1}{3}$, $\frac{1}{5}$, and $\frac{1}{6}$ to a common denominator.
40. Reduce $\frac{1}{2}$, $\frac{1}{4}$, and $\frac{1}{5}$ to a common denominator.
41. Reduce $\frac{1}{5}$, $\frac{1}{6}$, and $\frac{1}{10}$ to a common denominator.
42. Reduce $\frac{2}{3}$, $\frac{3}{4}$, and $\frac{1}{6}$ to a common denominator.
43. Reduce $\frac{2}{3}$, $\frac{3}{5}$, and $\frac{5}{6}$ to a common denominator.
44. Reduce $\frac{2}{5}$, $\frac{1}{6}$, and $\frac{3}{10}$ to a common denominator.
45. If $2\frac{1}{2}$ barrels of potatoes cost \$20, what will 4 barrels cost?

46. There are 30 sheep in a field and $\frac{2}{3}$ of them jumped out; how many jumped out? How many remained in the field?

32.

FRACTIONS TO LOWER TERMS.

1. How many thirds are there in $\frac{6}{9}$?

SOLUTION.—$\frac{1}{3}$ equals $\frac{3}{9}$; hence, in $\frac{6}{9}$ there are as many thirds as $\frac{3}{9}$ is contained times in $\frac{6}{9}$, which are 2 times, or $\frac{2}{3}$. Therefore, in $\frac{6}{9}$ there are $\frac{2}{3}$.

2. How many halves in $\frac{2}{4}$; $\frac{4}{4}$; $\frac{6}{4}$; $\frac{8}{4}$?
3. How many thirds in $\frac{2}{6}$; $\frac{4}{6}$; $\frac{8}{6}$; $\frac{6}{9}$?
4. How many fourths in $\frac{6}{8}$; $\frac{9}{12}$; $\frac{12}{20}$; $\frac{10}{16}$?
5. How many sixths in $\frac{10}{12}$; $\frac{9}{18}$; $\frac{12}{24}$; $\frac{10}{30}$?
6. How many eighths in $\frac{8}{16}$; $\frac{12}{24}$; $\frac{9}{24}$; $\frac{16}{32}$?
7. How many ninths in $\frac{10}{18}$; $\frac{14}{18}$; $\frac{6}{27}$; $\frac{8}{36}$?
8. How many tenths in $\frac{10}{20}$; $\frac{18}{30}$; $\frac{8}{40}$; $\frac{25}{50}$?
9. How many twelfths in $\frac{16}{24}$; $\frac{18}{36}$; $\frac{21}{36}$; $\frac{16}{48}$?
10. How many fifteenths in $\frac{10}{30}$; $\frac{9}{45}$; $\frac{22}{30}$; $\frac{56}{60}$?
11. Reduce $\frac{6}{9}$ to thirds.
12. Since $\frac{6}{9}$ equals $\frac{2}{3}$, by what number do we divide both numerator and denominator of $\frac{6}{9}$ to obtain $\frac{2}{3}$?
13. By what number must we divide both the numerator and denominator of $\frac{6}{8}$ to obtain $\frac{3}{4}$?

NOTE.—To reduce a fraction to lower terms we divide both numerator and denominator by any number that will divide each.

14. Reduce $\frac{4}{6}$ to thirds; $\frac{12}{18}$ to thirds.
15. Reduce $\frac{6}{10}$ to fifths; $\frac{9}{15}$ to fifths.
16. Reduce $\frac{12}{16}$ to fourths; $\frac{18}{24}$ to fourths.
17. Reduce $\frac{8}{24}$ to sixths; $\frac{12}{24}$ to sixths.
18. Reduce $\frac{15}{24}$ to eighths; $\frac{20}{32}$ to eighths.
19. Reduce $\frac{27}{36}$ to twelfths; $\frac{36}{48}$ to twelfths.
20. Reduce $\frac{30}{40}$ to 20ths; $\frac{39}{60}$ to 20ths.

NOTE.—When no number will divide both the numerator and the denominator without a remainder, a fraction is then said to be in its *lowest terms.*

21. Reduce $\frac{6}{8}$ and $\frac{9}{12}$ to their lowest terms.
22. Reduce $\frac{12}{16}$ and $\frac{6}{24}$ to their lowest terms.
23. Reduce $\frac{6}{16}$ and $\frac{14}{15}$ to their lowest terms.
24. Reduce $\frac{16}{20}$ and $\frac{20}{30}$ to their lowest terms.
25. Reduce $\frac{15}{30}$ and $\frac{24}{28}$ to their lowest terms.
26. Reduce $\frac{16}{28}$ and $\frac{16}{32}$ to their lowest terms.
27. Reduce $\frac{25}{35}$ and $\frac{24}{48}$ to their lowest terms.
28. Reduce $\frac{28}{40}$ and $\frac{35}{40}$ to their lowest terms.
29. Reduce $\frac{40}{48}$ and $\frac{27}{36}$ to their lowest terms.
30. Reduce $\frac{18}{36}$ and $\frac{21}{84}$ to their lowest terms.

33.

ADDITION OF FRACTIONS.

1. What is the sum of $\frac{1}{2}$ of an apple and $\frac{1}{2}$ of an apple?
2. What is the sum of $\frac{1}{3}$ of a pear and $\frac{2}{3}$ of a pear?
3. What is the sum of $\frac{3}{4}$ of a pie and $\frac{1}{4}$ of a pie?
4. What is the sum of $\frac{2}{5}$ of an orange and $\frac{4}{5}$ of an orange?
5. What is the sum of $\frac{2}{6}$ of a dollar and $\frac{3}{6}$ of a dollar?
6. What is the sum of $\frac{2}{7}$ of a cake, $\frac{1}{7}$ of a cake, and $\frac{3}{7}$ of a cake?
7. What is the sum of $\frac{4}{6}$, $\frac{3}{6}$, and $\frac{2}{6}$?
8. What is the sum of $\frac{2}{8}$, $\frac{3}{8}$, and $\frac{4}{8}$?
9. What is the sum of $\frac{2}{9}$, $\frac{3}{9}$, and $\frac{2}{9}$?
10. What is the sum of $\frac{2}{10}$, $\frac{3}{10}$, and $\frac{4}{10}$?
11. How many fourths in $\frac{1}{2}$ and $\frac{3}{4}$?
12. How many eighths in $\frac{1}{2}$ and $\frac{2}{4}$?
13. How many tenths in $\frac{1}{2}$ and $\frac{2}{5}$?
14. How many twelfths in $\frac{1}{4}$ and $\frac{2}{6}$?
15. How many twentieths in $\frac{1}{4}$, $\frac{3}{5}$, and $\frac{3}{10}$?
16. What is the sum of $\frac{2}{3}$ and $\frac{3}{5}$?

SOLUTION.—$\frac{2}{3}$ equals $\frac{10}{15}$, and $\frac{3}{5}$ equals $\frac{9}{15}$, and $\frac{10}{15} + \frac{9}{15}$ are $\frac{19}{15}$, or $1\frac{4}{15}$.

What is the sum—

17. Of $\frac{1}{3}$ and $\frac{1}{4}$?
18. Of $\frac{1}{2}$ and $\frac{1}{4}$?
19. Of $\frac{1}{4}$ and $\frac{1}{5}$?
20. Of $\frac{1}{2}$ and $\frac{1}{6}$?
21. Of $\frac{1}{3}$ and $\frac{1}{5}$?
22. Of $\frac{2}{3}$ and $\frac{1}{4}$?
23. Of $\frac{2}{3}$ and $\frac{2}{4}$?
24. Of $\frac{3}{4}$ and $\frac{2}{5}$?
25. Of $\frac{2}{3}$ and $\frac{1}{6}$?
26. Of $\frac{3}{4}$ and $\frac{2}{6}$?
27. Of $\frac{3}{5}$ and $\frac{3}{6}$?
28. Of $\frac{3}{6}$ and $\frac{4}{5}$?
29. Of $\frac{3}{4}$ and $\frac{1}{8}$?
30. Of $\frac{5}{6}$ and $\frac{1}{4}$?
31. Of $\frac{2}{7}$ and $\frac{1}{8}$?
32. Of $\frac{3}{7}$ and $\frac{3}{5}$?
33. Of $\frac{1}{2}$, $\frac{1}{3}$, and $\frac{1}{6}$?
34. Of $\frac{1}{3}$, $\frac{1}{4}$, and $\frac{1}{5}$?
35. Of $\frac{1}{2}$, $\frac{1}{4}$, and $\frac{2}{5}$?
36. Of $\frac{2}{3}$, $\frac{1}{4}$, and $\frac{3}{5}$?
37. Of $\frac{2}{3}$, $\frac{3}{4}$, and $\frac{1}{2}$?
38. Of $\frac{2}{7}$, $\frac{1}{3}$, and $\frac{3}{4}$?
39. Of $\frac{1}{6}$, $\frac{2}{9}$, and $\frac{2}{3}$?
40. Of $\frac{2}{3}$, $\frac{3}{5}$, and $\frac{3}{10}$?

41. What is the sum of $2\frac{2}{3}$ and $2\frac{1}{2}$?

SOLUTION.—$2\frac{2}{3}$ equals $\frac{8}{3}$, and $2\frac{1}{2}$ equals $\frac{5}{2}$; $\frac{8}{3}$ equals $\frac{16}{6}$, and $\frac{5}{2}$ equals $\frac{15}{6}$; $\frac{16}{6} + \frac{15}{6}$ equals $\frac{31}{6}$, or $5\frac{1}{6}$.

NOTE.—If the teacher wishes, the whole numbers and fractions may be added separately.

What is the sum—

42. Of $2\frac{1}{3}$ and $3\frac{1}{4}$?
43. Of $3\frac{1}{4}$ and $3\frac{1}{2}$?
44. Of $3\frac{1}{2}$ and $3\frac{2}{5}$?
45. Of $3\frac{1}{5}$ and $3\frac{2}{6}$?
46. Of $6\frac{1}{2}$ and $4\frac{3}{4}$?
47. Of $7\frac{1}{3}$ and $4\frac{5}{6}$?
48. Of $5\frac{5}{6}$ and $3\frac{4}{7}$?
49. Of $8\frac{3}{5}$ and $7\frac{5}{6}$?
50. Of $9\frac{1}{3}$ and $3\frac{1}{4}$?
51. Of $10\frac{3}{4}$ and $6\frac{1}{5}$?

52. May read $\frac{1}{3}$ of a book on Monday and $\frac{1}{2}$ of it on Tuesday; how much of it did she read on both days?

53. James earned $\frac{3}{5}$ of a dollar and John $\frac{1}{3}$ of a dollar; how much did both earn?

54. A book cost $\frac{1}{2}$ of a dollar and a slate $\frac{3}{4}$ of a dollar; how much did both cost?

55. A lady, having $\frac{3}{5}$ of a barrel of flour, bought $\frac{3}{5}$ of a barrel more; how much did she have then?

56. Sarah, having $\frac{1}{2}$ of a dozen of pins, found $\frac{3}{4}$ of a dozen; how many pins did she have then?

57. A man, having $\frac{4}{5}$ of an acre of ground, bought $\frac{2}{3}$ of an acre more; how much land had he then?

58. Henry paid $\frac{3}{5}$ of a dollar for a book and $\frac{2}{5}$ of a dollar for some paper, and $\frac{3}{4}$ of a dollar for a bag; how much did all cost?

59. If $\frac{1}{2}$ of a number increased by $\frac{1}{4}$ of the number, equals 45, what is the number?

60. If $\frac{1}{2}$ of my money increased by $\frac{2}{5}$ of it, is 90 cents, how much money have I?

61. $\frac{3}{4}$ of a number increased by $\frac{1}{2}$ of the same number, equals 35; what is the number?

62. Helen's roses increased by $\frac{1}{3}$ and $\frac{1}{4}$ of them, is 57 roses; how many roses had she?

63. Samuel gave 60 dollars for a horse, and $\frac{1}{4}$ of this amount plus $\frac{2}{3}$ of it, is 5 times what I paid for the saddle; how much did I pay for the saddle?

64. If a man pays $\$3\frac{1}{2}$ for a hat and $\$8\frac{1}{4}$ for a coat, how much did he pay for both?

65. A farmer sold $3\frac{1}{2}$ tons of hay and kept $4\frac{1}{5}$ tons; how many tons did he have at first?

66. Annie had $3\frac{3}{4}$ pounds of candy and her sister gave her $2\frac{1}{5}$ pounds more; how many pounds did she have then?

67. A man walked $4\frac{1}{7}$ miles and rode $3\frac{2}{3}$ miles; how far did he travel?

68. Ruth bought at one time $5\frac{3}{5}$ yards of velvet, and at another time $3\frac{1}{2}$ yards; how much did she buy?

69. Helen studied geography for $\frac{3}{7}$ of an hour, and arithmetic for $\frac{1}{5}$ of an hour, and Latin for $2\frac{1}{2}$ hours; how long did she study?

70. If a family burns $12\frac{3}{10}$ tons of coal before Christmas and $15\frac{4}{5}$ tons after Christmas, how much do they burn during the year?

71. A string broke into two pieces, one piece measuring $3\frac{3}{4}$ yards and the other $6\frac{1}{2}$ yards; how many quarter-yards were there in the whole string?

34.

SUBTRACTION OF FRACTIONS.

1. What is the difference between $\frac{2}{3}$ of an acre and $\frac{1}{3}$ of an acre?

2. What is the difference between $\frac{4}{5}$ of an apple and $\frac{1}{5}$ of an apple?

3. What is the difference between $\frac{6}{7}$ of a cake and $\frac{2}{7}$ of a cake?

4. What is the difference between $\frac{8}{9}$ of an orange and $\frac{2}{9}$ of an orange?

5. What is the difference between $\frac{7}{10}$ of a melon and $\frac{3}{10}$ of a melon?

What is the difference—

6. Between $\frac{5}{12}$ and $\frac{1}{12}$?
7. Between $\frac{6}{14}$ and $\frac{3}{14}$?
8. Between $\frac{13}{16}$ and $\frac{6}{16}$?
9. Between $\frac{11}{18}$ and $\frac{9}{18}$?
10. Between $\frac{19}{20}$ and $\frac{4}{20}$?
11. Between $\frac{19}{25}$ and $\frac{11}{25}$?

12. What is the difference between $\frac{3}{4}$ and $\frac{1}{3}$?

SOLUTION.—$\frac{3}{4}$ equals $\frac{9}{12}$, and $\frac{1}{3}$ equals $\frac{4}{12}$; $\frac{9}{12}$ minus $\frac{4}{12}$ equals $\frac{5}{12}$. Therefore, the difference between $\frac{3}{4}$ and $\frac{1}{3}$ is $\frac{5}{12}$.

Subtract—

13. $\frac{1}{4}$ from $\frac{1}{2}$.
14. $\frac{1}{5}$ from $\frac{1}{4}$.
15. $\frac{1}{8}$ from $\frac{3}{4}$.
16. $\frac{1}{6}$ from $\frac{1}{5}$.
17. $\frac{2}{5}$ from $\frac{3}{4}$.
18. $\frac{1}{8}$ from $\frac{4}{5}$.
19. $\frac{3}{5}$ from $\frac{3}{4}$.
20. $\frac{2}{5}$ from $\frac{5}{6}$.
21. $\frac{5}{6}$ from $\frac{7}{8}$.
22. $\frac{1}{7}$ from $\frac{1}{4}$.
23. $\frac{1}{2}$ from $\frac{5}{8}$.
24. $\frac{2}{3}$ from $\frac{8}{9}$.
25. $\frac{1}{4}$ from $\frac{5}{7}$.
26. $\frac{1}{6}$ from $\frac{2}{7}$.
27. $\frac{5}{6}$ from $\frac{9}{10}$.
28. $\frac{2}{10}$ from $\frac{3}{5}$.
29. $\frac{3}{5}$ from $\frac{11}{12}$.
30. $\frac{7}{8}$ from $\frac{19}{20}$.

31. What is the difference between $4\frac{2}{3}$ and $3\frac{1}{2}$?

SOLUTION.—$4\frac{2}{3}$ equals $\frac{14}{3}$; $3\frac{1}{2}$ equals $\frac{7}{2}$; $\frac{14}{3}$ equals $\frac{28}{6}$, and $\frac{7}{2}$ equals $\frac{21}{6}$; $\frac{28}{6}$ minus $\frac{21}{6}$ equals $\frac{7}{6}$. Therefore, the difference between $4\frac{2}{3}$ and $3\frac{1}{2}$ is $\frac{7}{6}$, or $1\frac{1}{6}$.

32. What is the value of $2\frac{2}{3} - 2\frac{1}{2}$?
33. What is the value of $5\frac{1}{4} - 4\frac{1}{3}$?
34. What is the value of $6\frac{5}{6} - 4\frac{3}{4}$?
35. What is the value of $10\frac{5}{8} - 8\frac{1}{2}$?
36. What is the value of $9\frac{3}{5} - 6\frac{2}{3}$?
37. What is the value of $7\frac{1}{3} - 6\frac{1}{4}$?
38. What is the value of $18\frac{5}{7} - 10\frac{1}{3}$?
39. What is the value of $12\frac{1}{2} - 7\frac{3}{10}$?

40. $2\frac{1}{2}$ gallons of water were taken from a vessel containing $3\frac{1}{4}$ gallons; how many gallons remained in the vessel?

41. The difference between $\frac{4}{5}$ of my age and $\frac{5}{18}$ of it is 6 years; how old am I?

42. William is $6\frac{1}{5}$ years old, and Amy is $4\frac{1}{3}$ years old; what is the difference in their ages?

43. Blanche had $7\frac{1}{8}$ dollars and spent $3\frac{3}{4}$ dollars; how much money has she remaining?

44. Mr. Smith owns $9\frac{2}{3}$ acres of ground and sells $4\frac{3}{8}$ acres; how many acres has he remaining?

45. If a man walks $7\frac{2}{3}$ miles in 1 hour and his son walks $5\frac{3}{4}$ miles, how much farther does the father walk than his son?

46. Horace is $9\frac{2}{3}$ years old; in how many years will he be $10\frac{1}{2}$ years old?

47. A grocer bought $7\frac{1}{2}$ bushels of potatoes from A, and $3\frac{3}{4}$ bushels from B; how many more bushels did he buy from A than from B?

48. Mr. Smith owns two small farms, containing $8\frac{2}{5}$ acres and $10\frac{1}{2}$ acres, from which he sells to Mr. Jones $10\frac{1}{3}$ acres; how many acres does he then own?

49. A pipe delivered $6\frac{1}{8}$ gallons into a tank in one hour, and $7\frac{1}{4}$ gallons in another hour, but $4\frac{1}{2}$ gallons leaked out; how many gallons remained in the tank?

What is the value—

50. Of $\frac{1}{2} + \frac{1}{3} - \frac{1}{4}$?
51. Of $\frac{1}{4} + \frac{1}{5} - \frac{1}{8}$?
52. Of $\frac{3}{4} - \frac{2}{3} + \frac{1}{2}$?
53. Of $\frac{1}{6} + \frac{2}{3} - \frac{1}{8}$?
54. Of $\frac{3}{4} - \frac{2}{5} + \frac{1}{2}$?
55. Of $\frac{3}{10} + \frac{1}{2} - \frac{3}{5}$?
56. Of $\frac{2}{3} + \frac{3}{4} - \frac{5}{12}$?
57. Of $\frac{2}{5} + \frac{5}{6} - \frac{7}{8}$?

58. Ruth's age diminished by its $\frac{1}{8}$ is 14 years; how old is she?

59. Henry owes his store-keeper $2\frac{3}{5}$ dollars; if he hands him a five-dollar bill, how much change should he receive?

60. A boy who has 48 marbles loses $\frac{3}{8}$ of them, and then buys $\frac{3}{4}$ as many as he had at first; how many has he now?

61. A barrel of flour weighs 196 pounds, from which were sold to one man $40\frac{1}{4}$ pounds, to another $60\frac{1}{2}$ pounds, and to another $19\frac{3}{8}$ pounds; how many pounds remained in the barrel?

35.

MULTIPLICATION OF FRACTIONS.

FRACTIONS MULTIPLIED BY WHOLE NUMBERS.

1. How much is $\frac{1}{4} + \frac{1}{4}$? What are 2 times $\frac{1}{4}$?
2. How much are $\frac{2}{5} + \frac{2}{5} + \frac{2}{5}$? What are 3 times $\frac{2}{5}$?
3. How much are $\frac{3}{7} + \frac{3}{7} + \frac{3}{7} + \frac{3}{7}$?
4. How much will 3 books cost at $\frac{2}{5}$ of a dollar each?

SOLUTION.—If 1 book cost $\frac{2}{5}$ of a dollar, 6 books will cost 6 times $\frac{2}{5}$ of a dollar, which are $\frac{12}{5}$ dollars, or $2\frac{2}{5}$ dollars?

5. At $\frac{2}{9}$ of a dollar how much will 4 books cost?
6. At $\frac{1}{4}$ of a dollar each what will 10 melons cost?
7. Helen has $\frac{4}{7}$ of a yard of ribbon, and Mary has 8 times as much; how much has Mary?
8. Sarah earns $\frac{1}{8}$ of a dollar a day; how much will she earn in 10 days?
9. If a painter charges 1 dollar for $\frac{7}{8}$ of a day's work, how many days' work will 9 dollars pay for?

10. How much will 10 marbles cost at the rate of 1 marble for $\frac{3}{5}$ of a cent.

11. How many are 5 times $\frac{3}{8}$?

SOLUTION.—5 times $\frac{3}{8}$ are $\frac{15}{8}$, or $1\frac{7}{8}$.

12. What are 5 times $\frac{3}{10}$?
13. What are 6 times $\frac{4}{7}$?
14. What are 4 times $\frac{5}{6}$?
15. What are 5 times $\frac{7}{8}$?
16. What are 6 times $\frac{5}{7}$?
17. What are 8 times $\frac{5}{8}$?
18. What are 5 times $\frac{2}{7}$?
19. What are 6 times $\frac{6}{10}$?
20. How many are 4 times $\frac{2}{5}$?

SOLUTION.—4 times $\frac{1}{5}$ equals $\frac{4}{5}$, and 4 times $\frac{2}{5}$ equals 2 times $\frac{4}{5}$, which are $\frac{8}{5}$, or $2\frac{3}{5}$.

NOTE.—We multiply a fraction by a whole number when we multiply its numerator or divide its denominator by that number.

How many are—

21. 3 times $\frac{2}{5}$?
22. 4 times $\frac{4}{7}$?
23. 6 times $\frac{3}{7}$?
24. 4 times $\frac{5}{6}$?
25. 6 times $\frac{6}{7}$?
26. 7 times $\frac{3}{4}$?
27. 8 times $\frac{2}{3}$?
28. 9 times $\frac{4}{5}$?
29. 10 times $\frac{5}{7}$?
30. 11 times $\frac{6}{12}$?

31. What is the cost of 12 apples at the rate of $\frac{2}{3}$ of a cent each?

32. What will 15 pears cost at the rate of $\frac{3}{4}$ of a cent each?

33. What will 18 yards of cloth cost at the rate of $\frac{3}{5}$ of a dollar a yard?

34. Harry can walk $\frac{4}{7}$ of a mile in an hour; how far can he walk in 10 hours?

35. If a boy earns $\frac{9}{10}$ of a dollar in a day, how much can he earn in 11 days?

36. How much will 4 hats cost at $\$4\frac{1}{3}$ each?

37. If a horse eats $5\frac{3}{4}$ quarts of oats at a meal; how much will he eat in 7 meals?

38. How much will 8 inkstands cost at the rate of 2 inkstands for 15 dimes?

39. What is the cost of 9 pounds of rice at $5\frac{3}{4}$ cents a pound?

40. What is the cost of 10 tons of coal at $\$5\frac{1}{2}$ a ton?

41. What is the cost of 9 gallons of molasses at $7\frac{2}{5}$ dimes a gallon?

36.

NUMBERS MULTIPLIED BY FRACTIONS.

1. What will $\frac{1}{2}$ pound of butter cost at 18 cents a pound?

SOLUTION.—If a pound of butter cost 18 cents, $\frac{1}{2}$ of a pound will cost $\frac{1}{2}$ of 18 cents, which are 9 cents.

2. How much will $\frac{1}{4}$ of a pound of beef cost at 24 cents a pound?

3. If a vessel holds 40 gallons of vinegar, how much will $\frac{1}{8}$ of the vessel hold?

4. If a grocer puts 42 pounds of tea in 7 packages, what does he put in 1 package?

5. A girl had 60 roses and gave away $\frac{1}{6}$ of them; how many did she give away?

6. A horse cost $70 and the saddle and bridle cost $\frac{1}{7}$ as much as the horse; how much did the saddle and bridle cost?

7. What will $\frac{2}{3}$ of a pound of butter cost at 30 cents a pound?

SOLUTION.—If a pound of butter cost 30 cents, $\frac{1}{3}$ of a pound will cost $\frac{1}{3}$ of 30 cents, which are 10 cents; if $\frac{1}{3}$ of a pound cost 10 cents, $\frac{2}{3}$ of a pound will cost 2 times 10 cents, which are 20 cents. Therefore, if a pound of butter cost 30 cents, $\frac{2}{3}$ of a pound will cost 20 cents.

8. How much will $\frac{3}{4}$ of a pound of beef cost at the rate of 24 cents a pound?

9. Mary had 36 cents and spent $\frac{2}{3}$ of it; how much did she spend?

10. A boy had 60 apples and gave away $\frac{4}{5}$ of them; how many did he give away?

11. If a dozen chairs cost $80, what will $\frac{4}{5}$ of a dozen cost?

12. Mr. Smith's wedding coat cost \$84, and $\frac{3}{7}$ of that amount was the cost of the vest; how much did his vest cost?

13. 4 yards of silk cost $\frac{2}{5}$ of \$45; how much did 1 yard cost?

14. A cow cost \$90 and 2 calves cost $\frac{2}{3}$ of this amount; what did each calf cost?

15. $\frac{4}{5}$ of 20 are how many times 4?

16. $\frac{3}{4}$ of 24 are how many times 6?

17. $\frac{5}{8}$ of 40 are how many times 5?

18. $\frac{7}{8}$ of 48 are how many times 3?

19. $\frac{5}{9}$ of 45 are how many times $\frac{1}{2}$ of 10?

20. $\frac{6}{8}$ of 80 are how many times $\frac{2}{5}$ of 25?

21. What is $\frac{1}{3}$ of 6?

SOLUTION.—$\frac{1}{3}$ of 1 is $\frac{1}{3}$, and $\frac{1}{3}$ of 6 is 6 times $\frac{1}{3}$, which is $\frac{6}{3}$, or 2. Therefore, $\frac{1}{3}$ of 6 is 2.

22. What is $\frac{1}{5}$ of 5? $\frac{1}{4}$ of 5?

23. What is $\frac{1}{2}$ of 7? $\frac{1}{6}$ of 9?

24. What is $\frac{1}{5}$ of 6? $\frac{1}{7}$ of 8?

25. What is $\frac{3}{4}$ of 6? $\frac{2}{4}$ of 10?

26. What is $\frac{2}{5}$ of 3? $\frac{3}{5}$ of 4?

27. What is $\frac{2}{7}$ of 4? $\frac{4}{7}$ of 8?

28. What is $\frac{2}{7}$ of 8? $\frac{5}{7}$ of 9?

29. What is $\frac{5}{6}$ of 12? $\frac{7}{8}$ of 10?

30. What is $\frac{2}{3}$ of 15? $\frac{3}{9}$ of 15?

31. What is $\frac{3}{8}$ of 10? $\frac{4}{7}$ of 16?

32. Helen has \$7 and her brother has $\frac{2}{5}$ as much; how much has her brother?

33. If flour is worth \$5 a barrel, what will $3\frac{1}{2}$ barrels cost?

34. When potatoes are worth 60 cents per bushel, what will $4\frac{1}{2}$ bushels cost?

35. Ella bought 12 yards of velvet at $6\frac{3}{4}$ dimes a yard; how much did it cost her?

36. At $6\frac{2}{3}$ cents a pound, how much will 6 pounds of rice cost?

37. When butter is $18\frac{3}{4}$ cents a pound, what will 5 pounds cost?

38. How many miles can a man walk in 10 hours who walks $3\frac{3}{4}$ miles per hour?

39. A man starts on a journey of 100 miles; how far has he to go after he has ridden 7 hours at $7\frac{3}{4}$ miles per hour?

40. A man sold potatoes by the barrel, each barrel containing $2\frac{3}{4}$ bushels at 50 cents a bushel; how much did he get for a barrel?

41. How much will a farm of 90 acres cost at $2\frac{1}{2}$ dollars per acre?

42. How much will $4\frac{3}{4}$ gallons of syrup cost at 60 cents a gallon?

43. How much change should I receive out of a 5-dollar bill after I pay for $6\frac{3}{4}$ pounds of coffee at 40 cents a pound?

44. How much change should I receive out of a 10-dollar bill when I have paid for $9\frac{1}{3}$ bushels of wheat at 60 cents a bushel?

45. When the cost of flour is \$8 a barrel, how much is $\frac{1}{6}$ of a barrel worth?

46. If a box of oranges is worth \$16, how much is $\frac{4}{5}$ of a box worth?

47. If a horse eats a ton of hay in a month, how much will the hay cost, at \$20 a ton, to keep him $3\frac{1}{2}$ months?

48. What is the cost of $\frac{3}{4}$ of a ton of coal, when coal is worth \$9 a ton?

49. What will $\frac{5}{6}$ of a box of figs cost at 25 cents a box?

50. A man bought 12 cords of wood at $\$7\frac{1}{2}$ a cord, and $4\frac{1}{2}$ tons of coal at \$5 per ton; how much did both cost?

37.

FRACTIONS MULTIPLIED BY FRACTIONS.

1. What is $\frac{2}{3}$ of $\frac{6}{7}$?

SOLUTION.—$\frac{1}{3}$ of $\frac{6}{7}$ is $\frac{2}{7}$. If $\frac{1}{3}$ of $\frac{6}{7}$ is $\frac{2}{7}$, $\frac{2}{3}$ of $\frac{6}{7}$ are 2 times $\frac{2}{7}$, which are $\frac{4}{7}$. Therefore, $\frac{2}{3}$ of $\frac{6}{7}$ are $\frac{4}{7}$.

What is—

2. $\frac{2}{7}$ of $\frac{7}{8}$?
3. $\frac{2}{6}$ of $\frac{6}{10}$?
4. $\frac{2}{3}$ of $\frac{27}{30}$?
5. $\frac{2}{5}$ of $\frac{20}{24}$?
6. $\frac{3}{5}$ of $\frac{15}{16}$?
7. $\frac{3}{7}$ of $\frac{14}{18}$?
8. $\frac{2}{3}$ of $\frac{3}{4}$?
9. $\frac{4}{9}$ of $\frac{18}{28}$?

10. What is $\frac{2}{3}$ of $\frac{4}{6}$?

SOLUTION.—$\frac{1}{3}$ of $\frac{1}{6}$ is $\frac{1}{18}$; $\frac{1}{3}$ of $\frac{4}{6}$ is 4 times $\frac{1}{18}$, or $\frac{4}{18}$, and $\frac{2}{3}$ of $\frac{4}{6}$ are 2 times $\frac{4}{18}$, which are $\frac{8}{18}$, or $\frac{4}{9}$.

What is—

11. $\frac{2}{5}$ of $\frac{3}{4}$?
12. $\frac{2}{7}$ of $\frac{2}{3}$?
13. $\frac{3}{4}$ of $\frac{2}{5}$?
14. $\frac{3}{4}$ of $\frac{5}{6}$?
15. $\frac{5}{6}$ of $\frac{7}{10}$?
16. $\frac{3}{5}$ of $\frac{7}{9}$?

17. What is $\frac{3}{4}$ of $6\frac{1}{2}$?

SOLUTION.—$6\frac{1}{2}$ equals $\frac{13}{2}$; $\frac{1}{4}$ of $\frac{13}{2}$ is $\frac{13}{8}$, and $\frac{3}{4}$ of $\frac{13}{2}$ are 3 times $\frac{13}{8}$, which are $\frac{39}{8}$, or $4\frac{7}{8}$.

18. What is $\frac{3}{5}$ of $2\frac{1}{2}$?

19. What is $\frac{5}{6}$ of $2\frac{3}{5}$? $\frac{3}{4}$ of $3\frac{2}{5}$?

20. A boy, having $\frac{1}{6}$ of an apple, gave away $\frac{1}{2}$ of what he had; what part of the apple did he have remaining?

21. If 1 pie costs $\frac{1}{5}$ of a dime, what will $\frac{1}{4}$ of a pie cost?

22. If a pound of tea is worth $\frac{4}{5}$ of a dollar, how much is $\frac{5}{8}$ of a pound of tea worth?

23. How much will $\frac{3}{4}$ of a pound of butter cost at $\frac{8}{5}$ of a dollar a pound?

24. A boy has $\frac{3}{4}$ of a dollar and gives away $\frac{2}{3}$ of it; what part of a dollar has he remaining?

25. If Helen has $\frac{3}{4}$ of a dollar and gives away $\frac{3}{5}$ of it, what part of a dollar has she remaining?

26. What will $3\frac{1}{2}$ yards of velvet cost at $\frac{3}{4}$ of a dollar a yard?

27. William earned $\$3\frac{1}{4}$ a day; how much will he earn in $3\frac{1}{2}$ days? In $\frac{3}{4}$ of a day?

28. A grocer bought $2\frac{3}{4}$ barrels of apples at $\$2\frac{2}{5}$ a barrel; how much did he give for them?

29. A lady bought 15 yards of silk at $\$1\frac{3}{8}$ a yard; how much did she pay for the silk?

30. When potatoes are worth $\$3\frac{3}{4}$ a barrel, what is the cost of $2\frac{1}{2}$ barrels?

31. I bought $6\frac{1}{2}$ cords of wood at $4\frac{4}{5}$ dollars a cord; how much did it cost me?

32. Jane is $6\frac{2}{3}$ years old and her father is $5\frac{1}{4}$ times as old; how old is her father?

33. If 1 bushel of wheat is worth $2\frac{1}{2}$ bushels of rye, how much rye are $3\frac{3}{4}$ bushels of wheat worth?

DIVISION OF FRACTIONS.

38.

FRACTIONS DIVIDED BY WHOLE NUMBERS.

1. If 3 lots contain $\frac{3}{4}$ of an acre, what part of an acre does 1 lot contain?

2. If 4 books cost $\frac{12}{15}$ dollars, how much did each cost?

3. 7 families divide equally among them $\frac{7}{8}$ of a barrel of flour; how much does each receive?

4. If 5 handkerchiefs cost $\frac{3}{4}$ of a dollar, what will 1 cost?

SOLUTION.—If 5 handkerchiefs cost $\frac{3}{4}$ of a dollar, 1 handkerchief will cost $\frac{1}{5}$ of $\frac{3}{4}$ of a dollar, which is $\frac{3}{20}$ of a dollar.

5. If 2 pounds of tea cost $\frac{3}{5}$ of a dollar, how much does 1 pound cost?

6. If 4 boxes of figs cost $\frac{7}{10}$ of a dollar, what will 1 box cost?

7. How much will 1 pound of coffee cost if 6 pounds cost $1\frac{2}{5}$ dollars?

8. If 7 men earn $8\frac{3}{4}$ dollars, how much does 1 man earn?

9. William, having 9 quarts of berries, divided them among 7 boys; how much did each receive?

10. If \$10 is paid for 3 yards of velvet, how much is that a yard?

11. If 5 loads of wood are bought for $\$3\frac{1}{8}$, how much will 1 load cost?

12. 4 men can build $8\frac{2}{3}$ rods of wall in a day; how much does each man build?

13. 8 men earn in 1 week $\$22\frac{1}{2}$; what does each man earn?

14. If a dozen of eggs cost $\frac{3}{5}$ of a dollar, what will 1 egg cost?

15. If 6 sheep cost $\$37\frac{1}{2}$, what will 1 sheep cost?

16. If 5 barrels of flour cost $\$17\frac{1}{2}$, what will 1 barrel cost?

17. How many times is 2 contained in $\frac{4}{7}$? In $\frac{6}{7}$?

18. How many times is 5 contained in $\frac{5}{9}$? In $\frac{5}{6}$?

19. Divide $\frac{7}{12}$ by 3. $\frac{4}{9}$ by 5. $\frac{5}{8}$ by 7.

20. Divide $\frac{8}{4}$ by 6. $\frac{5}{7}$ by 7. $\frac{6}{7}$ by 11.

21. Divide $6\frac{1}{4}$ by 5. $7\frac{1}{3}$ by 4. $8\frac{2}{5}$ by 7.

22. Divide $2\frac{3}{8}$ by 3. $3\frac{2}{5}$ by 5. $5\frac{2}{3}$ by 6.

39.

NUMBERS DIVIDED BY FRACTIONS.

1. At $\frac{1}{5}$ of a dollar a pound, how many pounds of rice can be bought for \$6?

SOLUTION.—If 1 pound of rice cost $\frac{1}{5}$ of a dollar, for 6 dollars, or $\frac{30}{5}$ dollars, you can buy as many pounds as $\frac{1}{5}$ is contained times in $\frac{30}{5}$, which is 30 times, or 30 pounds.

2. How many quarts of nuts, at $\frac{2}{3}$ of a dollar a quart, can I buy for \$3?

3. If a yard of cloth costs $\frac{5}{6}$ of a dollar, how many yards can you buy for $12?

4. If a man earns $\frac{3}{4}$ of a dollar a day, how many days will it take him to earn $8?

5. How many bushels of potatoes, at $\frac{4}{5}$ of a dollar a bushel, can be bought for $10?

6. If a gallon of vinegar costs $\frac{2}{5}$ of a dollar, how many gallons can be bought for $15?

7. If a yard of muslin costs $\frac{3}{5}$ of a dime, how many yards can you buy for 12 dimes?

8. If a barrel holds $2\frac{1}{2}$ bushels of apples, how many barrels will 15 bushels fill?

9. If it requires $\frac{5}{8}$ of a yard of satin to make a necktie, how many neckties can you make from 12 yards of satin?

10. A jug holds $1\frac{1}{4}$ gallons; how many jugs can be filled from 10 gallons?

11. If 1 man can do a piece of work in $6\frac{2}{3}$ days, how long will it require 4 men to do it?

12. A boy shared 14 peaches with his companions: if he gave each companion $3\frac{1}{2}$ peaches, how many companions had he?

13. How many pounds of cheese, at $7\frac{1}{2}$ cents, can you buy for 60 cents?

14. How many books, at $\frac{5}{6}$ of a dollar each, can you buy for $6?

15. Divide 3 by $\frac{3}{5}$?

SOLUTION.—3 divided by 1 is 3, and 3 divided by $\frac{1}{5}$ is 5 times 3, or 15; 3 divided by $\frac{3}{5}$ is $\frac{1}{3}$ of 15, which is 5. Therefore, 3 divided by $\frac{3}{5}$ is 5.

16. Divide 4 by $\frac{2}{5}$; 6 by $\frac{3}{4}$; 7 by $\frac{4}{5}$.

17. Divide 7 by $\frac{2}{3}$; 8 by $\frac{3}{7}$; 9 by $\frac{4}{5}$.

18. Divide 5 by $\frac{5}{8}$; 7 by $\frac{2}{5}$; 6 by $\frac{5}{7}$.

40.

FRACTIONS DIVIDED BY FRACTIONS.

1. How many times is $\frac{3}{4}$ contained in $\frac{6}{4}$?
2. How many times is $\frac{2}{8}$ contained in $\frac{8}{8}$? In $\frac{10}{8}$?
3. How many times is $\frac{1}{4}$ contained in 4? In 8?
4. How many times is $\frac{5}{6}$ contained in $2\frac{1}{2}$? In $4\frac{1}{2}$?
5. If 1 yard of cloth cost $\frac{1}{5}$ of a dollar, how many yards can you buy for $\frac{4}{5}$ of a dollar?

SOLUTION.—If 1 yard of cloth cost $\frac{1}{5}$ of a dollar, for $\frac{4}{5}$ of a dollar you can buy as many yards as $\frac{1}{5}$ is contained times in $\frac{4}{5}$, which is 4 times, or 4 yards.

6. If a box of nuts costs $\frac{3}{4}$ of a dollar, how many boxes can be bought for $\$7\frac{1}{2}$?
7. A yard of tape costs $\frac{4}{5}$ of a dime; how many yards can be bought for \$1?
8. At $\frac{1}{6}$ of a dollar each, how many books can I buy for \$3?
9. If 1 turkey costs $\$1\frac{1}{5}$, how many turkeys can be bought for $\$7\frac{1}{5}$?
10. I paid $\$1\frac{1}{2}$ for a yard of velvet; how much could I buy for $\frac{1}{2}$ of a dollar?
11. If 2 sheep can be bought for \$10, how many sheep can be bought for 30 half-dollars?
12. If $2\frac{1}{2}$ barrels of apples cost \$15, how many barrels can be bought for \$18?
13. How many times is $\frac{2}{3}$ contained in $\frac{3}{5}$?

SOLUTION.—Since $\frac{2}{3}$ equals $\frac{10}{15}$, and $\frac{3}{5}$ equals $\frac{9}{15}$, $\frac{10}{15}$ is contained into $\frac{9}{15}$ as many times as 10 is contained in 9, which is $\frac{9}{10}$ times. Therefore, $\frac{2}{3}$ is contained in $\frac{3}{5}$, $\frac{9}{10}$ times.

14. How many times is $\frac{3}{4}$ contained in $\frac{3}{5}$? In $\frac{3}{6}$?
15. How many times is $\frac{3}{7}$ contained in $\frac{4}{6}$? In $\frac{4}{7}$?
16. How many times is $\frac{2}{3}$ contained in $\frac{5}{8}$? In $\frac{7}{8}$?

17. How many times is $\frac{4}{7}$ contained in $\frac{7}{8}$? In $\frac{7}{8}$?

18. How many times is $\frac{4}{5}$ contained in $\frac{5}{6}$? In $\frac{9}{10}$?

19. How many times is $\frac{3}{5}$ contained in $1\frac{1}{2}$? In $2\frac{3}{5}$?

NOTE.—To divide a fraction by a fraction we invert the divisor and multiply. Thus, $\frac{1}{2}$ divided by $\frac{3}{4}$ equals $\frac{1}{2}$ multiplied by $\frac{4}{3}$, which is $\frac{2}{3}$.

20. Divide $\frac{4}{5}$ by $\frac{2}{3}$; $\frac{2}{7}$ by $\frac{8}{4}$.

21. Divide $\frac{3}{5}$ by $\frac{1}{4}$; $\frac{2}{6}$ by $\frac{1}{8}$.

22. Divide $\frac{4}{5}$ by $\frac{2}{8}$; $\frac{2}{7}$ by $\frac{5}{6}$.

23. Divide $\frac{5}{6}$ by $\frac{3}{4}$; $\frac{3}{4}$ by $\frac{2}{7}$.

24. Divide $\frac{7}{8}$ by $\frac{3}{8}$; $\frac{3}{7}$ by $\frac{4}{5}$.

25. Divide $2\frac{1}{2}$ by $\frac{3}{7}$; $3\frac{1}{4}$ by $\frac{5}{6}$.

26. Divide $3\frac{3}{4}$ by $1\frac{1}{2}$; $4\frac{3}{5}$ by $2\frac{1}{4}$.

27. At $\$2\frac{2}{3}$ a pair, how many pairs of shoes can you buy for $\$13\frac{1}{3}$?

28. If a field can be plowed by 1 man in $9\frac{1}{3}$ days, how long will it take 4 men to plow it?

29. How many bushels of apples can be bought for \$33, at $\$1\frac{3}{8}$ a bushel?

30. A man walked 11 miles in $4\frac{2}{5}$ hours; what was the rate per hour?

31. Mr. A. sold a horse for \$176, which was $1\frac{3}{5}$ times what he cost; what did he cost?

32. When you can buy eggs at the rate of 18 for 45 cents, how much is that a dozen?

33. How many dozens of eggs, at $\frac{2}{5}$ of a dollar a dozen, will pay for 12 bushels of potatoes at the rate of $\frac{3}{4}$ of a dollar a bushel?

34. If I pay as much for a turkey as for 7 chickens, how much will a turkey cost when 2 chickens are worth $4\frac{2}{3}$ dimes?

35. A farmer sold 4 bushels of potatoes at $\frac{3}{5}$ of a dollar a bushel, for which he took in exchange some wheat at $\frac{3}{4}$ of a dollar per bushel; how many bushels did he receive?

41.

COMPOUND FRACTIONS.

A compound fraction is a fraction of a fraction; as, $\frac{2}{3}$ of $\frac{3}{4}$; $\frac{1}{2}$ of $\frac{1}{3}$ of $\frac{3}{4}$; etc.

1. What is $\frac{1}{2}$ of $\frac{1}{4}$?

SOLUTION.—$\frac{1}{4}$ equals $\frac{2}{8}$, and $\frac{1}{2}$ of $\frac{1}{4}$ is $\frac{1}{2}$ of $\frac{2}{8}$, which is $\frac{1}{8}$. Therefore, $\frac{1}{2}$ of $\frac{1}{4}$ is $\frac{1}{8}$.

2. What is $\frac{1}{2}$ of $\frac{1}{3}$? $\frac{1}{2}$ of $\frac{1}{5}$? $\frac{1}{2}$ of $\frac{1}{6}$?
3. What is $\frac{1}{3}$ of $\frac{1}{5}$? $\frac{1}{3}$ of $\frac{1}{6}$? $\frac{1}{3}$ of $\frac{1}{7}$?
4. What is $\frac{1}{4}$ of $\frac{1}{5}$? $\frac{1}{4}$ of $\frac{1}{6}$? $\frac{1}{4}$ of $\frac{1}{8}$?
5. What is $\frac{1}{5}$ of $\frac{1}{6}$? $\frac{1}{5}$ of $\frac{1}{7}$? $\frac{1}{5}$ of $\frac{1}{9}$?
6. John had $\frac{1}{5}$ of a dollar and spent $\frac{1}{2}$ of it; how much did he spend?
7. Kate had $\frac{1}{4}$ of a melon and ate $\frac{1}{3}$ of it; how much did she eat? How much had she left?
8. From a barrel of vinegar $\frac{1}{2}$ of $\frac{1}{3}$ leaked out; how much of the barrel leaked out? What part of the whole barrel is full?
9. A man gave his brother $\frac{1}{2}$ of $\frac{1}{5}$ of a dollar; how much did he receive?
10. A boy earned $\frac{3}{4}$ of a dollar and gave his sister $\frac{1}{2}$ of it; how much did he give his sister?
11. What is $\frac{2}{5}$ of $\frac{3}{4}$?

SOLUTION.—$\frac{1}{5}$ of $\frac{1}{4}$ is $\frac{1}{20}$; $\frac{1}{5}$ of $\frac{3}{4}$ is 3 times $\frac{1}{20}$, which is $\frac{3}{20}$; and $\frac{2}{5}$ is 2 times $\frac{3}{20}$, which is $\frac{6}{20}$, or $\frac{3}{10}$. Therefore, $\frac{2}{5}$ of $\frac{3}{4}$ is $\frac{3}{10}$.

12. What is $\frac{3}{4}$ of $\frac{2}{3}$?
13. What is $\frac{2}{5}$ of $\frac{5}{6}$?
14. What is $\frac{4}{5}$ of $\frac{7}{8}$?
15. What is $\frac{3}{4}$ of $\frac{5}{6}$?
16. What is $\frac{4}{5}$ of $\frac{6}{7}$?
17. What is $\frac{5}{6}$ of $\frac{7}{8}$?
18. What is $\frac{5}{6}$ of $\frac{8}{9}$?
19. What is $\frac{7}{8}$ of $\frac{9}{10}$?
20. Frank had $\frac{3}{4}$ of a pie and gave his brother $\frac{2}{3}$ of it; how much did he give his brother?
21. Having $\frac{3}{4}$ of a bushel of apples, I gave my sister $\frac{3}{5}$ of them; what part of a bushel did I give my sister?

22. Mr. Mitchel, owning $\frac{2}{5}$ of the stock of the bank, sold $\frac{2}{3}$ of it; how much did he sell?

23. If $\frac{1}{2}$ of $\frac{3}{4}$ of a barrel of molasses leaks, how much leaks away?

24. Helen bought a dress for 6 dollars, which was $\frac{1}{2}$ of $\frac{3}{8}$ of all her money; how much money had she?

25. A lot cost \$150, and the back taxes were $\frac{2}{5}$ of $\frac{4}{6}$ of this amount; what were the back taxes?

26. After spending $\frac{2}{3}$ of $\frac{3}{4}$ of my money I had 40 cents left; how much money had I at first?

27. If my age be increased by $\frac{2}{5}$ of $\frac{3}{4}$, I will be 12 years older; what is my age?

42.

COMPLEX FRACTIONS.

A complex fraction is one whose numerator or denominator, or both, are a fraction or a mixed number.

1. Change to a simple fraction $\frac{\frac{4}{5}}{5\frac{1}{3}}$.

SOLUTION.—This expression means that $\frac{4}{5}$ is to be divided by $5\frac{1}{3}$, or $\frac{16}{3}$. Then, since $\frac{4}{5}$ equals $\frac{12}{15}$, and $\frac{16}{3}$ equals $\frac{80}{15}$, $\frac{4}{5}$ divided by $5\frac{1}{3}$ equals 12 divided by 80, which is $\frac{12}{80}$, or $\frac{3}{20}$.

What is the value—

2. Of $\frac{\frac{1}{2}}{\frac{1}{4}}$?

3. Of $\frac{\frac{2}{3}}{\frac{3}{4}}$?

4. Of $\frac{\frac{4}{5}}{\frac{2}{3}}$?

5. Of $\frac{\frac{3}{5}}{\frac{5}{6}}$?

6. Of $\frac{\frac{1}{2} \text{ of } \frac{1}{3}}{\frac{1}{2} \text{ of } \frac{1}{4}}$?

7. Of $\frac{\frac{1}{3} \text{ of } \frac{3}{4}}{\frac{1}{4} \text{ of } \frac{4}{5}}$?

8. Of $\frac{\frac{1}{2} \text{ of } 6\frac{1}{2}}{1\frac{5}{8}}$?

9. Of $\frac{\frac{1}{2} \text{ of } \frac{1}{2} \text{ of } \frac{1}{8}}{\frac{1}{2} \text{ of } \frac{1}{2} \text{ of } \frac{1}{6}}$?

10. George earns $\frac{2}{3}$ of $\frac{3}{4}$ of a dollar a day; how long will it take him to earn $\$16\frac{1}{2}$?

11. If $6\frac{1}{2}$ oranges cost $8\frac{2}{3}$ dimes, how much will $\frac{1}{2}$ of $\frac{5}{6}$ of a dozen cost?

12. What will $\frac{1}{4}$ of $\frac{4}{7}$ of a cord of wood cost at $14 a cord?

RELATION OF NUMBERS.

43.

INTEGERS TO INTEGERS.

1. If 4 apples cost 11 cents, what will 8 apples cost?

SOLUTION.—If 4 apples cost 11 cents, 8 apples, which are 2 times 4 apples, will cost 2 times 11 cents, or 22 cents.

2. If 3 oranges cost 7 cents, how much will 9 oranges cost?

3. If 5 books cost 12 cents, how much will 15 books cost?

4. If 7 caps cost $20, what will 14 caps cost?

5. 6 are how many times 1?

SOLUTION.—6 are as many times 1 as 1 is contained in 6, or 6 times 1.

6. 8 are how many times 2? 4?

7. 12 are how many times 2? 3? 4? 6?

8. 18 are how many times 2? 3? 6? 9?

9. What is the relation of 6 to 2?

SOLUTION.—6 is 3 times 2.

10. What is the relation of 8 to 2? Of 12 to 4? Of 15 to 3?

11. What is the relation of 14 to 7? Of 15 to 5? Of 18 to 6?

12. What is the relation of 12 to 6? Of 24 to 8? Of 27 to 9?

13. What is the relation of 32 to 4? Of 30 to 3?

14. What is the relation of 30 to 6? Of 36 to 9? Of 36 to 6?

15. What is the relation of 40 to 10? Of 60 to 12? Of 60 to 10?

16. If 12 pencils cost 10 cents, what will 36 pencils cost?

17. If 6 combs cost 20 cents, what will 18 combs cost at the same rate?

18. What is the cost of 21 oranges, if 7 oranges cost 15 cents?

19. How much will 30 primers cost at the rate of 6 primers for 21 cents?

20. What will 5 cows cost if 10 cows cost $300?

21. If $18 will buy a dozen of geese, how many geese will $6 buy?

44.

FRACTIONS TO INTEGERS.

1. What part of 5 is $\frac{2}{3}$?

SOLUTION.—1 is $\frac{1}{5}$ of 5, and $\frac{1}{3}$ is $\frac{1}{5}$ of $\frac{1}{5}$ of 5, which is $\frac{1}{15}$ of 5, and $\frac{2}{3}$ is 2 times $\frac{1}{15}$, or $\frac{2}{15}$ of 5. Therefore, $\frac{2}{3}$ is $\frac{2}{15}$ of 5.

2. What part of 4 is $\frac{2}{5}$? Of 5 is $\frac{4}{5}$?
3. What part of 4 is $\frac{4}{6}$? Of 6 is $\frac{5}{8}$?
4. What part of 7 is $\frac{5}{6}$? Of 6 is $\frac{3}{7}$?
5. What part of 8 is $\frac{2}{3}$? Of 9 is $\frac{3}{7}$?
6. What part of 5 is $\frac{3}{5}$ of $\frac{5}{6}$? Of 4 is $\frac{2}{5}$ of $\frac{3}{2}$?
7. What is the relation of $\frac{2}{5}$ to 16?
8. What is the relation of $\frac{5}{6}$ to 18?
9. What is the relation of $\frac{3}{7}$ to 20?
10. What is the relation of $5\frac{1}{3}$ to 16?
11. What is the relation of $6\frac{2}{3}$ to 20?
12. What is the relation of $12\frac{1}{2}$ to 100?

45.

INTEGERS TO FRACTIONS.

1. What is the relation of 6 to $\frac{2}{5}$?

SOLUTION.—$\frac{1}{5}$ is $\frac{1}{2}$ of $\frac{2}{5}$, $\frac{5}{5}$, or 1, are 5 times $\frac{1}{2}$ of $\frac{2}{5}$, or $\frac{5}{2}$ of $\frac{2}{5}$. If 1 is $\frac{5}{2}$ of $\frac{2}{5}$, 6 is 6 times $\frac{5}{2}$ of $\frac{2}{5}$, or $\frac{30}{2}$, or 15 times $\frac{2}{5}$. Therefore, 6 is 15 times $\frac{2}{5}$.

What is the relation—

2. Of 6 to $\frac{4}{5}$?	6. Of 10 to $\frac{6}{7}$?	10. Of $3\frac{1}{2}$ to $\frac{3}{4}$?
3. Of 8 to $\frac{2}{3}$?	7. Of 12 to $\frac{3}{5}$?	11. Of $4\frac{1}{4}$ to $\frac{3}{5}$?
4. Of 10 to $\frac{3}{7}$?	8. Of 15 to $\frac{4}{7}$?	12. Of 20 to $6\frac{2}{3}$?
5. Of 9 to $\frac{2}{5}$?	9. Of 15 to $\frac{5}{9}$?	13. Of 26 to $8\frac{2}{3}$?

46.

FRACTIONS TO FRACTIONS.

1. What part of $\frac{3}{7}$ is $\frac{2}{3}$?

SOLUTION.—1. $\frac{1}{7}$ is $\frac{1}{3}$ of $\frac{3}{7}$, and $\frac{7}{7}$, or *one*, is 7 times $\frac{1}{3}$, or $\frac{7}{3}$ of $\frac{3}{7}$. If 1 is $\frac{7}{3}$ of $\frac{3}{7}$, $\frac{1}{3}$ is $\frac{1}{7}$ of $\frac{7}{3}$ of $\frac{3}{7}$, or $\frac{1}{7}$ of $\frac{3}{7}$, and $\frac{2}{3}$ is 2 times $\frac{1}{7}$, which is $\frac{14}{9}$ of $\frac{3}{7}$. Therefore, $\frac{2}{3}$ is $\frac{14}{9}$ of $\frac{3}{7}$.

SOLUTION.—2. $\frac{3}{7}$ equals $\frac{9}{21}$, and $\frac{2}{3}$ equals $\frac{14}{21}$; hence $\frac{14}{21}$ are $\frac{14}{9}$ of $\frac{9}{21}$. Therefore, $\frac{2}{3}$ are $\frac{14}{9}$ of $\frac{3}{7}$.

What part—

2. Of $\frac{1}{2}$ is $\frac{1}{4}$?	6. Of $\frac{5}{6}$ is $\frac{3}{5}$?	10. Of $\frac{7}{8}$ is $\frac{5}{6}$?
3. Of $\frac{1}{4}$ is $\frac{1}{2}$?	7. Of $\frac{4}{5}$ is $\frac{2}{3}$?	11. Of $5\frac{1}{4}$ is $\frac{3}{7}$?
4. Of $\frac{2}{3}$ is $\frac{3}{4}$?	8. Of $\frac{5}{8}$ is $\frac{3}{7}$?	12. Of $8\frac{1}{3}$ is $\frac{2}{3}$?
5. Of $\frac{3}{4}$ is $\frac{2}{3}$?	9. Of $\frac{2}{5}$ is $\frac{2}{3}$?	13. Of $16\frac{1}{2}$ is $8\frac{1}{4}$?

14. What is the relation of $7\frac{1}{4}$ to 29?

15. What is the relation of $36\frac{1}{2}$ to $9\frac{1}{8}$?

ANALYSIS.

47.

INTEGERS WITH INTEGERS.

1. If 5 pitchers cost \$3, what will 7 pitchers cost?

SOLUTION.—If 5 pitchers cost \$3, 1 pitcher will cost $\frac{1}{5}$ of \$3, which are $\frac{3}{5}$ dollars, and 7 pitchers will cost 7 times $\frac{3}{5}$ dollars, which are $\frac{21}{5}$ dollars, or $4\frac{1}{5}$ dollars.

2. If 7 inkstands cost \$5, what will 9 inkstands cost?

3. If 4 bunches of grapes cost 48 cents, what will 3 bunches cost at the same rate?

4. What will 20 pairs of shoes cost if 5 pairs cost $25?

5. How far will a man travel in 40 days if he travels 30 miles in 10 days?

6. If 6 yards of calico cost 45 cents, how much will 12 yards cost at the same rate?

7. If 10 bushels of potatoes are worth $6, what are 4 bushels worth?

8. If 5 men can build 10 rods of wall in a week, how many rods can 50 men build in the same time?

9. If 12 peaches cost 13 cents, what will 36 peaches cost?

10. If 5 sheep cost $28, how many could be bought for $56?

11. If 7 quarts of milk cost 30 cents, what will 3 quarts cost?

12. What is the cost of 9 pigs, if 3 pigs cost $38?

13. What is the cost of 15 cows, if 3 cows cost $60?

14. If 20 books cost $6, how much will 40 books cost?

15. How much will 4 apples cost, if 20 apples cost 30 cents?

16. How much will 9 sheep cost, if 36 sheep cost $48?

17. If 8 men can build a boat in 10 days, how long will it take 2 men to build it?

SOLUTION.—If 8 men can build a boat in 10 days, it will take 1 man 8 times 10 days, which are 80 days, to build it, and 2 men can build it in $\frac{1}{2}$ of 80 days, which are 40 days. Therefore, etc.

18. $16 is $\frac{4}{5}$ of what Charles earns in 10 days; how much will he earn in 20 days?

19. $20 is $\frac{2}{3}$ of the amount required to buy 2 suits of clothes; how many suits can be bought for $60?

20. If 4 men can do a piece of work in 16 days, how long will it require 12 men to do it?

21. How long will it take 1 man to do a piece of work, if 8 men can do the work in 3 days?

22. If 9 men can mow a field of grass in 18 days, how long will it take 5 men to mow it?

23. \$30 is \$5 more than $\frac{5}{6}$ of 4 times what Horace paid for a chain; what did he pay for the chain?

24. \$60 is \$10 more than $\frac{5}{6}$ of 3 times what George paid for a watch; how much did the watch cost?

48.

FRACTIONS WITH INTEGERS.

1. If $\frac{2}{3}$ of a ton of coal cost \$4, what will 1 ton cost?

SOLUTION.—If $\frac{2}{3}$ of a ton of coal cost \$4, $\frac{1}{3}$ of a ton of coal will cost $\frac{1}{2}$ of \$4, which are \$2, and $\frac{3}{3}$, or 1 ton, will cost 3 times \$2, which are \$6. Therefore, if $\frac{2}{3}$ of a ton of coal cost \$4, 1 ton will cost \$6.

2. If $\frac{2}{3}$ of a bushel of wheat cost 40 cents, what is the price per bushel?

3. If $\frac{4}{7}$ of a pound of coffee cost 20 cents, what will 1 pound cost?

4. How much do I weigh, if $\frac{4}{5}$ of my weight is 40 pounds?

5. How tall am I, if $\frac{3}{4}$ of my height is 48 inches?

6. \$42 is $\frac{6}{7}$ of what a man paid for a cow; how much did the cow cost?

7. \$36 is \$4 less than $\frac{8}{9}$ of the cost of a horse; what was the cost of the horse?

8. I bought a lot for \$110, which is $1\frac{1}{12}$ of what I sold it for; how much do I gain?

9. If $\frac{4}{5}$ of a cord of wood cost \$3.60, how much is that a cord?

10. There are 8 pear trees in an orchard, which is $\frac{2}{5}$ of the number of apple trees; how many apple trees are there?

11. 18 books are $\frac{2}{3}$ of the number in my library; how many books in my library?

12. Mary is 12 years old, and in 8 years more her age will be $\frac{2}{3}$ of her mother's age now; how old is her mother now? How old will her mother be then?

13. 8 is $\frac{1}{4}$ of what number?
14. 9 is $\frac{3}{4}$ of what number?
15. 12 is $\frac{3}{4}$ of what number?
16. 20 is $\frac{5}{6}$ of what number?
17. 18 is $\frac{2}{3}$ of what number?
18. 21 is $\frac{7}{9}$ of what number?
19. 25 is $\frac{5}{8}$ of what number?
20. 16 is $\frac{4}{5}$ of how many times 5?
21. 18 is $\frac{3}{4}$ of how many times 8?
22. 25 is $\frac{5}{6}$ of how many times 4?
23. 18 is $\frac{3}{5}$ of how many times 6?
24. 14 is $\frac{1}{2}$ of $\frac{2}{3}$ of what number?
25. 30 is $\frac{1}{4}$ of $\frac{3}{5}$ of what number?
26. 33 is $\frac{3}{5}$ of $\frac{5}{6}$ of what number?
27. $\frac{2}{3}$ of 15 is $\frac{5}{7}$ of what number?
28. $\frac{5}{6}$ of 24 is $\frac{2}{3}$ of what number?
29. 36 is $\frac{4}{5}$ of how many times $\frac{3}{5}$ of 15?
30. 60 is $\frac{5}{6}$ of how many times $\frac{3}{4}$ of 48?
31. A calf cost \$16, which is $\frac{4}{7}$ of the cost of the cow; how much did the cow cost?
32. A harness cost \$40, which is $\frac{2}{3}$ of $\frac{3}{4}$ of the cost of the carriage; what is the cost of the carriage?
33. A carriage cost \$80, which is $\frac{4}{5}$ of $\frac{5}{8}$ of the cost of the horse; what is the cost of the horse?
34. A vest cost \$12, which is \$4 less than $\frac{4}{7}$ of $\frac{7}{8}$ of the cost of the coat; what was the cost of the coat?
35. A saddle cost \$8, and 5 times the cost of the saddle is $\frac{5}{8}$ of $\frac{2}{3}$ of the cost of the horse; what was the cost of the horse?
36. Mr. Brown paid \$200 for a horse, and $\frac{3}{8}$ of this is $\frac{3}{5}$ of the cost of the harness, and the sleigh cost twice as much as the harness; what was the cost of each?

49.

INTEGERS WITH FRACTIONS.

1. If 10 pounds of sugar cost 40 cents, how much will $\frac{3}{4}$ of a pound cost?

SOLUTION.—If 10 pounds of sugar cost 40 cents, 1 pound of sugar will cost $\frac{1}{10}$ of 40 cents, which are 4 cents. If 1 pound of sugar cost 4 cents, $\frac{1}{4}$ of a pound will cost $\frac{1}{4}$ of 4 cents, which is 1 cent, and $\frac{3}{4}$ of a pound will cost 3 times 1 cent, which are 3 cents. Therefore, if 10 pounds of sugar cost 40 cents, $\frac{3}{4}$ of a pound will cost 3 cents.

2. If 5 yards of lace cost 60 cents, what will $\frac{2}{3}$ of a yard cost?

3. Horace earns \$1.60 in 2 days; how much does he earn in $\frac{1}{5}$ of a day?

4. How much does $3\frac{1}{2}$ pounds of candy cost, if 4 pounds cost \$2.40?

5. If 10 gallons of molasses cost \$8, what will $4\frac{1}{2}$ gallons cost at the same rate?

6. What will $5\frac{3}{4}$ acres of land cost, if 9 acres cost \$540?

7. If 4 pounds of coffee cost \$1.80, what will $1\frac{2}{3}$ pounds cost?

8. If 2 dozens of eggs cost 64 cents, what will $5\frac{1}{2}$ dozens cost?

9. What must I pay for $5\frac{2}{3}$ cords of wood at the rate of 15 cords for \$90?

10. How much will $6\frac{3}{4}$ tons of coal cost, if 3 tons cost \$24?

11. If George earned \$80 in 10 weeks, how much could he earn in $3\frac{1}{2}$ weeks?

12. If 10 bushels of wheat cost \$8, what will $7\frac{3}{4}$ bushels cost?

13. If a tug-boat burns 16 tons of coal in 2 days, how much does it burn in $3\frac{3}{4}$ days?

14. If a horse cost \$160 and a cow $\frac{3}{8}$ as much, what does the cow cost?

15. A cow cost \$28; if she had cost $\frac{3}{4}$ of this amount more, how much would she have cost?

16. Henry sold some sheep for \$20; if he had received $\frac{4}{5}$ of this amount more, what would he have sold them for?

17. Harry is now 10 years old; if he were $2\frac{1}{2}$ times as old, how many years old would he then be?

18. A farmer sold $\frac{4}{5}$ of his sheep and had 5 sheep remaining; how many sheep had he at first?

19. Mrs. Smith sold $\frac{1}{3}$ of her ducks and had 40 ducks remaining; how many ducks had she at first?

20. How much must I pay for $\frac{2}{3}$ of 9 yards of carpet, if 15 yards cost \$35?

50.

FRACTIONS WITH FRACTIONS.

1. If $\frac{3}{5}$ of a cord of wood cost \$3.24, what will $\frac{2}{3}$ of a cord cost?

SOLUTION.—If $\frac{3}{5}$ of a cord of wood cost \$3.24, $\frac{1}{5}$ of a cord will cost $\frac{1}{3}$ of \$3.24, which is \$1.08, and $\frac{5}{5}$, or a whole cord of wood, will cost 5 times \$1.08, which is \$5.40. If 1 cord cost \$5.40, $\frac{1}{3}$ of a cord will cost $\frac{1}{3}$ of \$5.40, which is \$1.80, and $\frac{2}{3}$ will cost 2 times \$1.80, which is \$3.60. Therefore, if $\frac{3}{5}$ of a cord of wood costs \$3.24, $\frac{2}{3}$ of a cord will cost \$3.60.

2. If $\frac{1}{2}$ of a ton of coal cost \$3.50, how much will $\frac{3}{7}$ of a ton cost?

3. If 2 barrels of potatoes cost \$16, what will $\frac{5}{8}$ of a barrel cost?

4. If $3\frac{1}{3}$ pounds of meat cost 30 cents, what will $4\frac{1}{3}$ pounds cost?

5. If $\frac{3}{4}$ of my money is \$36, how much is $\frac{5}{6}$ of it?

6. $\frac{3}{8}$ of Mr. Smith's age is 24 years; how many years is $\frac{3}{16}$ of his age?

7. How many hens, at $5\frac{1}{2}$ dimes each, can be bought for 8 pounds of butter at $2\frac{3}{4}$ dimes a pound?

8. A boy earns \$9 in 4 days; how much will he earn in $\frac{2}{3}$ of a day?

9. If $\frac{1}{2}$ of a dozen of oranges cost 20 cents, how much will $2\frac{1}{2}$ dozens cost?

10. If $3\frac{1}{2}$ dozens of eggs cost 49 cents, how much will $2\frac{3}{7}$ dozens cost?

11. A farmer exchanged 7 tons of hay, at \$12 a ton, for sheep at $\$4\frac{1}{5}$ apiece; how many sheep did he receive?

12. If $2\frac{3}{7}$ pounds of coffee cost 60 cents, how much will $3\frac{1}{3}$ pounds cost?

13. How much will $4\frac{1}{4}$ pounds of flour cost, if $2\frac{3}{8}$ pounds cost 16 cents?

14. A farmer sold $3\frac{1}{3}$ bushels of corn for 80 cents; how much would he get for $2\frac{3}{4}$ bushels?

15. \$30 is $\frac{3}{4}$ of what Mr. Jones paid for a cow; how much would he pay for 2 cows?

16. $\frac{2}{5}$ of the distance from New York City to Trenton is 40 miles. If a man drives 12 miles an hour, what part of the whole distance from New York to Trenton will he travel in $2\frac{1}{2}$ hours?

17. If $\frac{3}{10}$ of a barrel of cider cost $\$1\frac{1}{2}$, what will $3\frac{4}{5}$ barrels cost?

51.

DIFFERENCE AND A FRACTION.

1. A man spent $\frac{2}{5}$ of his money for a cow and had \$30 remaining; how much had he at first?

SOLUTION.—If a man spent $\frac{2}{5}$ of his money for a cow, he had remaining the difference between $\frac{5}{5}$ and $\frac{2}{5}$, which is $\frac{3}{5}$ of his money. Since he had \$30 remaining, \$30 must equal $\frac{3}{5}$ of his money. If \$30 is $\frac{3}{5}$ of his money, $\frac{1}{5}$ of his money is $\frac{1}{3}$ of \$30, or \$15, and $\frac{5}{5}$ of his money will be 5 times \$15, or \$75. Therefore, if a man spent $\frac{2}{5}$ of his money for a cow and had \$30 remaining, he had at first \$75.

2. Mrs. Smith spent $\frac{3}{4}$ of her money for groceries and had 40 cents remaining; how much money had she?

3. What number is that from which, if its $\frac{1}{3}$ be taken, will equal 20?

4. A boy, being asked his age, replied that his age being diminished by its $\frac{1}{4}$ equals 12 years; how old was he?

5. In a game a boy lost $\frac{3}{7}$ of his marbles and had 12 remaining; how many had he at first?

6. A man had a certain number of sheep in a field and $\frac{5}{6}$ of them jumped out, when he found that only 10 remained in the field; how many sheep had he?

7. A farmer sold $\frac{2}{5}$ of his cows and had 20 remaining; how many cows had he at first?

8. William's money, diminished by its $\frac{1}{4}$, equals 24 cents; how much money had he?

9. Helen gave $\frac{2}{7}$ of her money for a box of candy and had 60 cents left; how much money had she?

10. Sarah gave $\frac{1}{2}$ of her money for silk and $\frac{1}{8}$ for thread, and had 12 cents remaining; how much money had she at first?

11. Horace's money, diminished by its $\frac{1}{2}$ and $\frac{1}{4}$ equals 20 cents; how much money had he?

12. A farmer sold $\frac{1}{4}$ of his potatoes to one man and $\frac{2}{3}$ to another, and had 40 bushels remaining; how many had he at first?

13. Mr. Brown sold $\frac{1}{3}$ of his butter at one store and $\frac{1}{2}$ of $\frac{4}{7}$ of his butter at another, and had 32 pounds remaining; how much had he at first?

14. A boy spent $\frac{1}{2}$ of $\frac{3}{5}$ of his money and had 70 cents remaining; how much money had he at first?

15. Margaret's age, diminished by $\frac{1}{3}$ of $\frac{3}{5}$ of her age, is 16 years; how old is she?

16. $\frac{1}{2}$ of Mrs. Brown's poultry are chickens, $\frac{1}{4}$ ducks, and $\frac{1}{5}$ geese, the remainder are 20 turkeys; how many of each kind has she? How many altogether?

17. Harvey spent $\frac{3}{4}$ of his money, and his brother gave him $\frac{1}{2}$ as much as he had at first, when he found he had 60 cents; how much money had he at first?

18. George spent $\frac{2}{5}$ of his money and then borrowed $\frac{1}{2}$ as much as he spent, when he found he had 80 cents; how much had he at first?

19. A man sold $\frac{3}{4}$ of his sheep and then bought $\frac{2}{3}$ as many as he sold, and found he had 30 sheep; how many had he at first?

20. $\frac{1}{3}$ of my money being increased by its $\frac{1}{5}$ and $\frac{1}{6}$ is \$420; how much money had I?

21. A lady being asked her age replied that $\frac{1}{4}$ of her age being increased by $\frac{1}{2}$ of $\frac{3}{4}$ of her age equalled 25 years; how old was she?

22. A gentleman spent $\frac{1}{2}$ of $\frac{5}{7}$ of his income to keep his family; if he saves \$800, what is his income?

23. A watch cost \$60, and this is $\frac{2}{3}$ of $\frac{3}{4}$ the cost of both watch and chain together; how much did the chain cost?

24. A man, having spent $\frac{1}{3}$, $\frac{1}{4}$, and $\frac{1}{6}$ his money, then found \$10, when he had \$35; how much money had he at first?

25. A dog, having killed $\frac{1}{3}$ of $\frac{3}{7}$ of a man's sheep, and 10 more, there remained in the field 38 sheep; how many sheep were in the field at first?

26. $\frac{2}{3}$ of 24 is how many thirds of 12?

27. $\frac{5}{6}$ of 12 is how many fourths of 20?

28. $\frac{3}{4}$ of 32 is how many sixths of 48?

29. $\frac{3}{7}$ of 63 is how many sevenths of 21?

30. $\frac{5}{8}$ of 48 is how many eighths of 80?

31. $\frac{8}{8}$ of 64 is how many ninths of 36?

32. $\frac{4}{9}$ of 54 is how many ninths of 27?

33. $\frac{7}{10}$ of 90 is how many tenths of 70?

34. $\frac{5}{6}$ of 60 is $\frac{2}{3}$ of how many times 3?

35. $\frac{3}{4}$ of 72 is $\frac{1}{2}$ of how many times 9?

36. $\frac{7}{8}$ of 48 is $\frac{3}{7}$ of how many times 14?

37. $\frac{8}{9}$ of 72 is $\frac{2}{3}$ of how many times 24?
38. $\frac{7}{9}$ of 81 is $\frac{3}{4}$ of how many times $\frac{2}{3}$ of 18?
39. $\frac{4}{5}$ of $\frac{5}{7}$ of 49 is what part of 56?
40. $\frac{3}{5}$ of $\frac{5}{8}$ of 80 is what part of $\frac{3}{4}$ of 80?

52.

PROBLEMS FOR REVIEW.

1. James had $\frac{3}{5}$ of a dollar, and spent $\frac{1}{4}$ of a dollar; how much had he remaining?
2. A man, having $\frac{2}{3}$ of a barrel of flour, bought $\frac{3}{4}$ of a barrel; how much had he then?
3. Helen, having a certain sum of money, found $\frac{1}{2}$ of a dollar, and then had $\$1\frac{3}{4}$; how many dollars had she at first?
4. Mary's number of roses, increased by $\frac{1}{2}$ of her roses, equals 33 roses; how many roses had she?
5. John, having $\frac{3}{8}$ of a certain sum of money, found $\frac{1}{4}$ of the same sum, and then had \$20; what was the sum?
6. A gave \$45 for a watch, and $\frac{2}{3}$ of $\frac{1}{6}$ of this amount for a chain; how much did he give for the chain?
7. Paid \$30 for a cow, and $\frac{2}{3}$ of this amount is $2\frac{1}{2}$ times what the calf cost; how much did the calf cost?
8. If my money be increased by its $\frac{1}{2}$ and $\frac{1}{3}$, the sum will equal \$99, how much money have I?
9. Twice my age, being increased by $\frac{1}{2}$ of $\frac{2}{3}$ of my age, the sum will be 42 years; what is my age?
10. Bought a coat for $\$10\frac{1}{2}$ and a pair of shoes for $\$5\frac{3}{4}$; how much change would I get from 2 ten-dollar bills?
11. If 6 men can do a piece of work in 10 days, how long will it take 5 men to do the same?
12. If 6 men can perform a piece of work in 18 days, how many men will be required to do it in 9 days?
13. A man sold a cow for \$40, which was $\frac{1}{3}$ less than she cost him; how much did she cost him?

14. A man sold a horse for $80, which was $\frac{1}{4}$ more than he cost him; how much did he cost him?

15. William gathered $5\frac{3}{4}$ bushels of chestnuts and Harry $6\frac{3}{8}$ bushels; how many did both gather?

16. If my age be increased by its $\frac{1}{3}$ and $\frac{1}{4}$, it will equal 57 years; how old am I?

17. If my age be increased by its $\frac{1}{3}$ and $\frac{1}{4}$, I will be 21 years older; how old am I now?

18. Helen's age, being increased by the difference between $\frac{3}{4}$ and $\frac{2}{3}$, will equal 26 years; how old is she?

19. Helen's age, being diminished by the sum of $\frac{1}{4}$ and $\frac{1}{5}$, will equal 22 years; how old is she?

20. A horse and sleigh cost $180; what is the cost of each, if the sleigh cost $\frac{1}{2}$ as much as the horse?

21. A man paid $120 for a horse and saddle. If the saddle cost $\frac{1}{5}$ as much as the horse, what did each cost?

22. A man paid $84 for a watch and chain. If $\frac{1}{2}$ the cost of the chain equalled $\frac{1}{4}$ the cost of the watch, what was the cost of each?

23. Mr. Smith paid $96 for a watch and chain; what is the cost of each, provided $\frac{2}{3}$ of the cost of the chain equalled $\frac{2}{5}$ the cost of the watch?

24. A man and his son earned $18 in a week; how much did each earn if the father earned twice as much as the son?

25. Frank has 3 times as many apples as Fred, and they together have 24; how many has each?

26. A real-estate agent bought 2 houses for $2700. For one he paid twice as much as for the other; how much did each cost?

27. A horse and carriage cost $175, and $\frac{3}{4}$ the cost of the horse, plus $20, is $95; what is the cost of each?

28. What number diminished by $\frac{3}{5}$ of itself and 8 equals 24?

29. A fishing-pole 12 feet long is $\frac{3}{5}$ as long as the line minus 4 feet; how long is the line?

30. If $\frac{3}{4}$ of a man's age and 10 years more is 34 years, what is his age?

31. A man determined to walk from Philadelphia to Chicago, a distance of 800 miles. If he travelled $\frac{1}{2}$ the distance in January, $\frac{1}{4}$ in February, and the remainder in March, how many miles did he travel in March?

32. When hens are selling for $\frac{2}{5}$ of a dollar each, and ducks for $\frac{3}{4}$ of a dollar each; how much more will 2 pairs of ducks cost than 2 pairs of chickens?

33. If twice my weight be increased by $\frac{1}{4}$ my weight and 60 pounds, it will equal 240 pounds; what is my weight?

34. Harry's age is 16 years. If 4 years be added to his age, the sum will be $\frac{4}{5}$ of his father's age; how old is his father?

35. A pole is 63 feet high in the air, mud, and water. $\frac{5}{6}$ of $\frac{6}{7}$ of it is in the air, $\frac{1}{2}$ of $\frac{2}{7}$ is in the water, and the remainder in the mud; how many feet are in the mud?

36. In a battle $\frac{2}{7}$ of an army were killed, $\frac{2}{3}$ were taken prisoners, and the remainder—100 men—escaped; how many men were in the army?

37. If I were 40 years old, $\frac{1}{4}$ of my age would be $\frac{1}{5}$ of my brother's age; how old is my brother?

38. Amy spent $\frac{3}{5}$ of her money and then earns $\frac{1}{2}$ as much as she has left; if she has then \$1.20, how much had she at first?

39. \$300 is $\frac{1}{2}$ of $\frac{4}{5}$ of the cost of a certain number of horses at \$75 each; how many horses were there?

40. A man bought a lot for \$2400. $\frac{7}{8}$ of $2\frac{1}{8}$ times the cost of the lot is $\frac{7}{10}$ of the cost of the house he built upon it; how much did the house cost?

41. How many barrels of flour, at $\$5\frac{1}{4}$ a barrel, can I get in payment of 96 bushels of wheat at $\frac{7}{8}$ of a dollar a bushel?

42. The sum of 6 equal fractions is $5\frac{1}{7}$; what part of $5\frac{1}{7}$ is the sum of 5 of these parts?

43. If apples can be bought at the rate of 5 for 3 cents, what part of a dollar would 40 apples cost?

44. If a passenger train runs from Philadelphia to Harrisburg in $3\frac{3}{4}$ hours, how many hours will it take a train which runs only $\frac{2}{3}$ as fast?

45. If a sailboat sails $10\frac{1}{2}$ miles in $2\frac{1}{3}$ hours, what is the rate per hour?

46. If Harry can walk $6\frac{2}{3}$ miles an hour, and William can ride 20 miles an hour on his bicycle, what part of an hour must William ride to go as far as Harry can walk in 1 hour?

47. One-half of a cord of wood at \$8 a cord will pay for what part of a ton of coal at $\$7\frac{1}{2}$ a ton?

48. If $\frac{1}{2}$ of a number is 5 greater than $\frac{1}{3}$ of the number, what is the number?

49. By what number must $8\frac{3}{4}$ be divided to give $1\frac{3}{4}$ as a quotient?

50. If $\frac{1}{4}$ of a string $\frac{5}{6}$ of a yard long is cut off, what part of a yard is left?

51. A man agrees to work 10 hours for a day's work; what part of a day's wages should he receive for working $3\frac{1}{2}$ hours?

52. If a man can plow $\frac{1}{10}$ of a field in $\frac{1}{4}$ of a day, in how many days can he plow the field?

53. The sum of two numbers is 36, and the smaller is $\frac{4}{5}$ of the larger; what are the numbers?

54. A man, owning $\frac{3}{4}$ of a cargo of flour, sells $\frac{2}{3}$ of his share for \$6000; what was the value of the whole cargo?

55. In a certain class $\frac{2}{5}$ of the pupils are girls; if there are in the class 8 more girls than boys, how many pupils are in the class?

56. A boy, having spent $\frac{1}{3}$ of his money for a slate and $\frac{1}{4}$ of it for a book, found that 30 cents was $\frac{1}{2}$ of what remained; how much money had he at first?

57. What is the height of a tree, if 60 feet equals the height diminished by 20 feet?

58. A man, owning a farm, sold $\frac{1}{8}$ of it, and, after buying 40 acres, then had 100 acres; how much had he at first?

59. One-fourth more than the number of roses on a bush are 36 roses; how many roses are there on the bush?

60. One-third less than the number of pencils in a box are 20 pencils; how many are there in the box?

61. The cost of a horse is $\frac{4}{7}$ of the cost of a carriage, and the carriage cost $42 more than the horse; what is the cost of each?

62. If I sell a horse for $\frac{3}{5}$ the cost, and lose $60, how much would I have gained if I had sold him for $155?

63. My age increased by $\frac{2}{3}$ of $2\frac{1}{4}$ times my age is 70 years; how old am I?

64. An apple cost $\frac{2}{3}$ as much as a pear, and a dozen of each cost 50 cents; what was the cost of each?

DENOMINATE NUMBERS.

A **Denominate Number** is a number whose unit is named; as 3 quarts, 5 gallons, 6 bushels, etc.

When numbers have the same unit they are said to be in the same denomination; as 3 feet, 8 feet, 12 feet.

A **Compound Denominate Number** consists of denominations of the same nature; as 2 hours, 20 minutes, 30 seconds.

Denominate Numbers consist of 8 classes, namely: 1, value; 2, time; 3, length; 4, weight; 5, capacity; 6, surface; 7, volume; 8, circular.

A **Measure** is a unit by which quantity is estimated.

MEASURES OF VALUE.

Money is the unit used to measure the value of things.

NOTE.—See page 45 for United States Money.

ENGLISH OR STERLING MONEY.

English or **Sterling** money is the currency used in Great Britain.

TABLE.

4 farthings (qr.)	= 1 pence,	d.
12 pence	= 1 shilling,	s.
20 shillings	= 1 pound,	£.
21 shillings	= 1 guinea,	G.

53.

1. How many farthings in 4 pence? In 5 pence? In 6 pence? In 8 d.? In 10 d.?
2. How many pence in 12 farthings? In 16 farthings? In 20 farthings? In 40 farthings? In 2 farthings?
3. How many pence in 3 shillings? In 4 s.? In 10 s.? In 12 s.?
4. How many shillings in 24 pence? In 36 d.? In 48 d.?
5. How many shillings in 2 £? In 3 £? In 4 £? In 5 £?
6. How many pounds in 20 shillings? In 40 s.? In 60 s.?
7. What part of a pound is 10 s.? Is 15 s.?
8. What part of 3 £ is 6 pence? Is 9 pence?
9. What part of 20 pence is $\frac{5}{6}$ of a shilling?
10. How many pence in 5 s. 6 d.? In 6 s. 5 d.?
11. How many shillings in 4 £ 4 s.? In 10 £ 6 s.?
12. How many shillings in 2 G.? In 4 G.?
13. What part of a guinea is $\frac{3}{4}$ of a pound?
14. What part of a pound is $\frac{2}{3}$ of a guinea?
15. What part of 30 shillings is $\frac{3}{4}$ of a pound?

MEASURES OF TIME.

Time Measure is used in measuring a portion of time or duration.

TABLE.

60 seconds (sec.)	= 1 minute, min.
60 minutes	= 1 hour, hr.
24 hours	= 1 day, da.
7 days	= 1 week, wk.
365 days	= 1 year, yr.
366 days	= 1 leap-year.
12 calendar months	= 1 year.
100 years	= 1 century.

NOTES.—1. Thirty days are considered a month, and 12 months a year in all business transactions.

2. April, June, September, and November each has 30 days. February has 28, except in leap year, when it has 29 days. The other months have 31 days each.

3. Every year that can be divided by 4, except centennial years, and every centennial year that can be divided by 400, are leap years. The figures representing centennial years end in two ciphers.

54.

1. How many seconds in 5 minutes? In 10 min.? In 15 min.?

2. How many minutes in 2 hours? In 3 hours? In 4 hours?

3. How many minutes in 120 seconds? In 180 sec.? In 30 sec.?

4. How many seconds in a $\frac{1}{2}$ minute? In $\frac{3}{4}$ of a minute? In $1\frac{1}{2}$ minutes?

5. How many hours in 120 minutes? In 180 min.? In 90 min.?

6. How many hours in 2 days? In 3 days? In 4 days?

7. How many hours in 120 minutes? In 180 min.? In 300 min.?

8. How many days in 3 weeks? In 8 weeks? In 10 weeks?

9. How many days in 72 hours? In 96 hours? In 120 hours?

10. If a man works 10 hr. a day and sleeps 8 hr., how many hours will be left for other things?

11. If a man works 9 hr. a day, which is the better wages, 20 cents an hour, or $1.50 a day?

12. Give the names of the months which have 30 days. Those having 31 days. Tell how many days February has.

LONG MEASURE.

Long Measure is used in measuring distances.

TABLE.

12 inches (in.)	= 1 foot, ft.
3 feet	= 1 yard, yd.
5½ yards, or 16½ feet	= 1 rod, rd.
320 rods, or 5280 feet	= 1 mile, mi.

55.

1. How many inches in 3 feet? In 4 feet? In 5 feet?

2. How many feet in 36 inches? In 48 inches? In 60 inches?

3. How many feet in 2 yards? In 3 yards? In 8 yards?

4. How many yards in 30 feet? In 36 feet? In 48 feet?

5. How many yards in 2 rods? In 3 rods? In 10 rods?

6. How many rods in 33 yards? In 44 yd.? In 55 yd.?

7. How many rods in 1 mile? In 2 miles? In 3 miles?

8. How many miles in 640 rods? In 960 rods? In 1280 rods?

9. How many feet in 5 yards? In 5½ yards?

10. How many inches in 2 yards? In 3 yards?

11. How many yards in 72 inches? In 108 in.? In 144 in.?

12. How many inches in 2 feet 6 inches? In 3 ft. 4 in.?

13. How many feet in 33 inches? In 50 in.? In 65 in.?

14. How many rods in $\frac{1}{2}$ of a mile? In $\frac{1}{4}$ of a mile?

15. How many inches in $4\frac{1}{2}$ feet? In $2\frac{1}{2}$ yards?

16. What part of 2 yards is 2 feet? Is 4 feet?

17. What part of a foot is 4 inches? Is 6 in.? Is 9 in.?

18. What part of a yard is 2 feet? Is $1\frac{1}{2}$ ft.? Is 12 in.?

19. What part of a rod is 10 yards? Is 32 yd.?

20. If the top of a table measures 5 feet one way and 4 feet the other way, how many yards are there around it?

21. At a dollar a yard, what will be the cost of 5 strips of carpet, each strip 15 feet long?

MEASURES OF WEIGHT.

AVOIRDUPOIS WEIGHT.

Avoirdupois Weight is used in weighing all articles excepting gold, silver, jewels, and some drugs.

TABLE.

16 ounces (oz.)	= 1 pound,	lb.
100 pounds	= 1 hundredweight,	cwt.
20 hundredweight, or 2000 pounds	= 1 ton,	T.

NOTES.—1. The ton used in some States contains 2240 pounds, and is called a *long ton*.

2. The avoirdupois pound contains 7000 grains.

3. The following measures are also used:

196 lbs. of flour = 1 barrel, bbl.
200 lbs. of beef or pork = 1 barrel.

56.

1. How many ounces in 5 pounds? In 6 lb.? In 10 lb.?
2. How many ounces in $2\frac{1}{2}$ lb.? In $3\frac{1}{2}$ lb.? In $4\frac{1}{2}$ lb.?
3. How many pounds in 32 ounces? In 48 oz.? In 64 oz.?
4. How many pounds in 40 oz.? In 56 oz.? In 72 oz.?
5. How many pounds in 2 tons? In 4 tons?
6. How many tons in 4000 lb.? In 8000 lb.?
7. How many pounds in $2\frac{1}{2}$ tons? In $4\frac{3}{4}$ tons?
8. What will $2\frac{1}{2}$ pounds of butter cost at $\frac{5}{4}$ of a cent an ounce?
9. What will 2 tons 15 cwt. of hay cost at $12 a ton?
10. A farmer sold 3 tons 5 cwt. of hay at 50 cents a cwt. how much did he receive for it?

TROY WEIGHT.

Troy Weight is used in weighing gold, silver, gems, and precious stones.

TABLE.

24 grains (gr.)	= 1 pennyweight,	pwt.
20 pennyweights	= 1 ounce,	oz.
12 ounces	= 1 pound,	lb.

NOTE.—The Troy pound contains 5760 grains.

57.

1. How many grains in 2 pwt.? In 3 pwt.?
2. How many pennyweights in 48 gr.? In 72 gr.? In 96 gr.?
3. How many pennyweights in 3 oz.? In 4 oz.? In 5 oz.?
4. How many ounces in 40 pwt.? In 60 pwt.? In 72 pwt.?
5. How many ounces in 2 lb.? In 3 lb.? In 5 lb.?
6. How many pounds in 24 oz.? In 30 oz.? In 36 oz.?
7. How many ounces in 4 lb. 4 oz.? In 6 lb. 3 oz.?

8. How many more grains in a pound of iron than in a pound of gold?

9. How many pennyweights in 4 oz. 8 pwt.?

10. How many table-spoons, weighing 3 oz. each, can be made from 4 lb. of silver?

11. If silver is worth 2 cents a pennyweight, how much will I pay for a pound?

APOTHECARIES' WEIGHT.

Apothecaries' Weight is used in prescribing medicines.

TABLE.

20 grains (gr.) = 1 scruple, ℈.
3 scruples = 1 dram, ʒ.
8 drams = 1 ounce, ℥.
12 ounces = 1 pound, ℔.

NOTES.—1. A pound contains 5760 Troy grains.

2. Medicines are bought by avoirdupois weight and sold by apothecaries' weight.

58.

1. How many gr. in 4 ℈? In 5 ℈? In 6 ℈?
2. How many scruples in 3 ʒ? In 4 ʒ? In 5 ʒ?
3. How many ounces in 3 ℔? In 4 ℔? In 8 ℔?
4. How many drams in 60 ℈? In 90 ℈? In 120 ℈?
5. How many drams in 120 gr.? In 180 gr.? In 3 ℔?
6. If 10 gr. of quinine cost 20 cents, what will 5 ℥ cost?
7. If 5 gr. of quinine cost 10 cents, what will 10 ℈ cost?
8. If $\frac{2}{3}$ of 6 scruples of medicine cost 16 cents, what will $\frac{3}{4}$ of 2 ounces cost?
9. How many doses, of 10 grains each, can be taken from 1 ounce of quinine?
10. How many doses, of 5 grains each, are there in 3 ʒ?
11. How many grains are there in 3 ℈ and 15 gr.?
12. How many scruples are there in 4 ʒ and 2 ℈?

MEASURES OF CAPACITY.

LIQUID MEASURE.

Liquid Measure is used for measuring nearly all kinds of liquids.

TABLE.

4 gills (gi.) = 1 pint, pt.
2 pints = 1 quart, qt.
4 quarts = 1 gallon, gal.

NOTES.—1. A liquid gallon contains 231 cubic inches.

2. A barrel contains 31½ gallons, and a hogshead contains 63 gallons.

59.

1. How many gills in 5 pints? In 6 pt.? In 8½ pt.?
2. How many pints in 8 gills? In 16 gi.? In 36 gi.?
3. How many pints in 2 quarts? In 8 qt.? In 10½ qt.?
4. How many quarts in 8 pints? In 10 pt.? In 12 pt.?
5. How many quarts in 2 gallons? In 5 gal.? In 10½ gal.?
6. How many gallons in 16 quarts? In 24 qt.? In 30 qt.?
7. If a quart of molasses is worth 10 cents, how much are 2 gallons worth?
8. If a pint of milk cost 4 cents, what will ½ of a gallon cost?
9. How much will a pint of coal-oil cost, at 20 cents a gallon?
10. How much will 5 gallons of vinegar cost, at 3 cents a pint?
11. Helen paid $1 for a pint of cologne; how much would a gallon cost at the same rate?
12. How much will 4 gal. 1 pt. of milk cost at 3 cents a quart?

DRY MEASURE.

Dry Measure is used in measuring grain, fruit, vegetables, etc.

TABLE.

2 pints (pt.) = 1 quart, qt.
8 quarts = 1 peck, pk.
4 pecks = 1 bushel, bu.

NOTE.—The unit in dry measure is the *bushel*, and it contains 2150.42 cubic inches.

60.

1. How many quarts in 3 pecks? In 4 pk.? In 5 pk.?
2. How many pecks in 16 quarts? In 24 qt.? In 40 qt.?
3. How many quarts in $2\frac{1}{2}$ pk.? In $3\frac{1}{4}$ pk.? In $4\frac{3}{4}$ pk.?
4. How many pecks in 20 qt.? In 38 qt.? In 48 qt.?
5. How many bushels in 16 pk.? In 20 pk.? In 32 pk.?
6. How many quarts in 2 pk. 4 qt.? In 3 pk. 6 qt.?
7. How many quarts in 1 bu. 2 pk.? In 1 bu. 3 pk.?
8. How many quarts in 1 bu., 1 pk., 1 qt.?
9. How much will $2\frac{1}{2}$ bu. of oats cost at 10 cents a peck?
10. How much will 1 bu., 1 pk., 2 qt. of corn cost at 3 cents a quart?
11. At 20 cents a peck, how many bushels of apples can be bought for $4?
12. If oats cost 15 cents a half-peck, how much is that a bushel?
13. When apples are selling at 15 cents a half-peck, how much are they worth a bushel?
14. When potatoes are selling at 20 cents a half-peck, how much is a barrel worth which contains $2\frac{1}{2}$ bushels?
15. What will 2 bushels of clover seed cost at 10 cents a quart?

MEASURES OF SURFACE.

SQUARE MEASURE.

Surface or Square Measure is used in measuring surfaces, such as land, boards, glass, etc.

The area of a rectangular surface is equal to the product of the numbers representing its length and breadth.

TABLE.

144 square inches (sq. in.)	= 1 square foot,	sq. ft.
9 square feet	= 1 square yard,	sq. yd.
30¼ square yards	= 1 square rod,	sq. rd.
160 square rods	= 1 acre,	A.
640 acres	= 1 square mile,	sq. mi.

61.

1. How many square inches in 2 sq. ft.? In ½ a sq. ft.?
2. How many square feet in 288 sq. in.? In 432 sq. in.?
3. How many square feet in 3 sq. yd.? In 5 sq. yd.?
4. How many square yards in 18 sq. ft.? In 45 sq. ft.?
5. How many square yards in 2 sq. rd.? In 3 sq. rd.?
6. How many square rods in 121 sq. yd.? In 242 sq. yd.?
7. How many square rods in 2 acres? In 3 acres? In a ½ A.? In a ¼ A.?
8. How many acres in 480 sq. rd.? In 800 sq. rd.? In 80 sq. rd.?
9. How many acres in 2 sq. mi.? In 3 sq. mi.?
10. How many acres in ½ of a sq. mi.? ¾ of a sq. mi.? ¼ of a sq. mi.?
11. How many square feet in a piece of glass 2 feet wide and 3 feet long?
12. How many square yards in a piece of canvas 2 yards wide and 10 yards long?

13. How many acres in a piece of ground 20 rods wide and 40 rods long?

14. How much will it cost to paint the floor of a room 11 feet long and 8 feet wide, at 10 cents a square foot?

15. What is the difference between 2 feet square and 2 square feet? 4 feet square and 4 square feet?

MEASURES OF VOLUME.

CUBIC MEASURE.

Cubic Measure is used in measuring solids and the contents of solids.

The volume of a solid is equal to the product of the three numbers representing its length, breadth, and thickness.

TABLE.

1728 cubic inches (cu. in.)	= 1 cubic foot,	cu. ft.
27 cubic feet	= 1 cubic yard,	cu. yd.
16 cubic feet	= 1 cord foot,	cd. ft.
8 cord feet or 128 cu. ft.	= 1 cord of wood,	C.

NOTES.—1. In cellar digging and excavating a cubic yard of earth is called a *load*.

2. In masonry $24\frac{3}{4}$ cubic feet are called a *perch*.

3. In lumbering a pile of wood 4 feet wide, 4 feet high, and 8 feet long is called a *cord*.

62.

1. How many cubic inches in 2 cu. ft.? In 3 cu. ft.?
2. How many cubic feet in 3456 cu. in.? In 5184 cu. in.?
3. How many cubic feet in 2 cu. yd.? In 3 cu. yd.?
4. How many cubic yards in 54 cu. ft.? In 108 cu. ft.?
5. How many cubic feet in 4 perch of stone?
6. How many perch of stone in $49\frac{1}{2}$ cubic feet?
7. In a 2-inch cube how many cubic inches?
8. In a 4-inch cube how many cubic inches?

9. How many cord feet in 32 cubic feet?

10. How many cubic feet in 2 cords? In 3 cords?

11. How many cords in 256 cu. ft.? In 384 cu. ft.?

12. What is the difference between a 2-inch cube and 2 cubic inches? A 4-inch cube and 4 cubic inches?

13. How many cubic inches in a piece of marble 6 inches long, 4 inches wide, and 2 inches thick?

14. How many cubic feet in a pile of wood 8 feet long, 4 feet wide, and 4 feet high?

15. How many cords of wood in a pile 16 feet long, 4 feet wide, and 8 feet high?

16. What is the cost of a piece of timber 10 feet long, 3 feet wide, and 2 feet thick, at 10 cents a cubic foot?

17. How many loads of clay in a ditch 900 feet long, 2 feet wide, and 3 feet deep?

18. How many cubic half-inches in a cubic inch? How many cubic quarter-inches in a cubic inch?

MEASURES OF ANGLES.

ANGULAR MEASURE.

Angular Measure is used in measuring angles and arcs of circles. It is sometimes called *circular measure.*

TABLE.

60 seconds ($''$) = 1 minute, $'$.
60 minutes = 1 degree, $^\circ$.
30 degrees = 1 sign, S.
360 degrees = 1 circle, C.

63.

1. How many degrees in the circumference of a circle? In $\frac{1}{2}$ of the circumference? In $\frac{3}{4}$ of the circumference?

2. How many seconds in 3 minutes? In 4′? In 5′?

3. How many minutes in 180 seconds? In 240″?
4. How many minutes in 2 degrees? In $2\frac{1}{2}°$? In 4°?
5. How many degrees in 120 minutes? In 240′? In 80′?
6. How many degrees in the circumference of a wheel? Of a watch? Of a silver dollar? Of a gold dollar?

Miscellaneous Tables.

NUMBERS.	STATIONER.
TABLE.	TABLE.
12 units = 1 dozen.	24 sheets = 1 quire.
12 dozen = 1 gross.	20 quires = 1 ream.
12 gross = 1 great gross.	480 sheets = 1 ream.
20 units = 1 score.	10 reams = 1 bale.

64.

1. How many units in 3 dozen? In 4 doz.? In $5\frac{1}{2}$ doz.?
2. How many units in 2 gross? In 3 gross? In $\frac{1}{2}$ gross?
3. How many units in 1 great gross? In 4 score?
4. How many sheets of paper in 2 quires? In $2\frac{1}{2}$ quires?
5. How many reams in 60 quires? In 100 quires?
6. How many bales in 20 reams? In 40 reams?
7. How many sheets of paper in 2 reams and 2 quires?
8. What fractional part of a ream are 120 sheets of paper?

PRACTICAL MEASUREMENTS.

I. To find the area of rectangles.

Figures shaped like slates, blackboards, etc., are rectangles. To find their area, multiply length by width.

1. How many sq. ft. in a floor 15 ft. long and 10 ft. wide?
2. How many sq. in. in a pane of glass 12 in. long and 8 in. wide?
3. A rectangular mirror has an area of 800 sq. in.; if it is 20 in. wide, how long is it?

4. How many sq. ft. in the surface of a blackboard 9 yd. long and 4 ft. wide?

5. A city lot containing 2500 sq. ft. is 125 ft. long, what is its width?

II. To find the cost of painting, plastering, and paving.

1. At 10 cents a sq. ft., what would it cost to paint the floor of a room 12 ft. long and 8 ft. wide?

2. What would be the cost of painting the floor and ceiling of a room 15 long and 10 ft. wide, at 8 cents a sq. ft.

3. How much would it cost to plaster the bottom and sides of a cubical cistern 9 ft. square and 9 ft. deep, at 30 cents a sq. yd.?

4. What will be the expense of paving a sidewalk 5 ft. wide and 40 ft. long, at 25 cents a sq. ft.?

5. What would it cost to pave a sidewalk 216 ft. long and 10 ft. wide, at $2 per sq. yd.?

III. To find the cost of carpeting and papering.

Carpets are necessarily made a little too wide and must be *turned under*, consequently in obtaining the cost of carpeting, the number of *strips* must be found.

1. How many yards of carpet, 1 yard wide, will be required to carpet a floor 17 ft. wide and 20 ft. long,—strips running lengthwise?

2. What will be the cost of carpeting a floor 14 ft. wide and 30 ft. long, with carpet 1 yd. wide, if the strips run lengthwise and the carpet cost $1.50 a yd.?

3. How many rolls of paper 8 yd. long and 18 in. wide will be required to paper the ceiling of a room 18 ft. long and 15 ft. wide?

Wall-paper is bought by the roll, and in estimating the amount of paper required, a part of a roll is considered a whole roll. A roll is 8 yd. long and 18 in. wide, unless otherwise stated.

4. What would be the expense of papering the walls and ceiling of a reception-room 15 ft. long, 12 ft. wide, and 10 ft.

high, at $2.50 per roll for paper and putting it on, making no deduction for doors or windows?

IV. To find the cost of brick and stone-work.

A *perch* of stone-work is 16½ ft. long, 1½ ft. wide, and 1 ft. thick, or 24¾ cu. ft. It is customary in many places to consider the *cubic foot* the unit, instead of the perch.

1. How many cu. ft. in a wall 20 ft. long, 2 ft. thick, and 4 ft. high?

2. How much would it cost to build a wall 3 ft. high, 2 ft. thick, and 30 ft. long, at 50 cents a cu. ft.?

3. At $3 a perch, what would be the expense of building a wall 3 ft. high, 2 ft. thick, and 33 ft. long?

V. To find the quantity and cost of wood.

A cord of wood is a pile 8 ft. long, 4 ft. high, and 4 ft. wide, and contains 128 cu. ft.

1. How many cords of wood in a pile 8 ft. long, 4 ft. wide, and 8 ft. high?

2. How many cords in a pile of wood 4 ft. wide, 4 ft. high, and 16 ft. long?

3. What would be the cost of a pile of wood 4 ft. wide, 4 ft. high, and 12 ft. long, at $6 a cord?

4. How many cords of wood can be put in a shed 16 ft. long, 8 ft. wide, and 4 ft. high?

VI. To find the quantity and cost of lumber.

In measuring lumber, boards 1 in. or less in thickness are estimated by the sq. ft. of surface. If more than 1 in. thick, multiply the length in feet by the breadth in feet, and this product by the thickness in inches.

1. How many feet are there in a board 12 ft. long and 1½ ft. wide?

2. How many feet are there in a board 16 ft. long and 18 in. wide?

3. How much will be the cost of a board 20 ft. long and 9 in. wide, at 30 cents per foot?

4. What will be the cost of 10 planks, each 16 ft. long, 18 in. wide, and 2 in. thick, at 20 cents per foot?

VII. To find the approximate capacity of bins, etc.

A bushel is nearly $1\frac{1}{4}$ cu. ft.; therefore, $\frac{4}{5}$ of the number of cu. ft. is nearly the number of bushels.

1. A box. 3 ft. long, 2 ft. wide, and $2\frac{1}{2}$ ft. high, contains how many cu. ft.?

2. About how many bushels of wheat are there in a bin 6 ft. long, 5 ft. wide, and 4 ft. high?

3. About how many bushels of grain will a bin hold that is 10 ft. long, 6 ft. wide, and 4 ft. high?

4. I wish to make a bin 5 ft. wide and 5 ft. high that will hold 200 bushels of corn; about how long must I make it?

VIII. To find the approximate capacity of cisterns, etc.

A cubic foot of liquid contains nearly $7\frac{1}{2}$ gallons; therefore, multiplying the number of cubic feet by $7\frac{1}{2}$ will give nearly the number of gallons.

1. About how many gallons in a trough 3 ft. wide, 4 ft. long, and 2 ft. high?

2. About how many gallons in a tank 4 ft. wide, 6 ft. long, and 10 ft. deep?

3. A tank 6 ft. square and 5 ft. deep will hold about how many gallons?

4. I wish to make a tank 4 ft. wide by 5 ft. long that will hold 1500 gallons of vinegar; about how deep must I make it?

IX. To find approximately the contents of a mow or stack.

In a well-settled stack, or mow, a ton of fine hay is about 450 cu. ft. A ton of clover hay is about 550 cu. ft.

1. About how many tons of fine hay can be packed in a mow 20 ft. long, 18 ft. wide, and 10 ft. deep?

2. About how many tons of clover hay can be packed in a mow 20 ft. long, 15 ft. wide, and 22 ft. deep?

3. About what is the value of a stack of clover hay 12 ft. high, 10 ft. wide, and 55 ft. long, at $10 per ton?

LONGITUDE AND TIME.

Longitude is distance east or west of a *Prime Meridian.* A meridian is a line passing around the earth through the poles.

A **Prime Meridian** is any meridian used, from which longitude is reckoned.

The earth revolves on its axis from west to east in 24 hours; hence, the sun appears to pass around the earth in 24 hours. Since there are 360 degrees in every circle, any place on the surface of the earth passes through 360 degrees every 24 hours.

In one hour it will pass through $\frac{1}{24}$ of 360°, or 15°; in one minute it will pass through $\frac{1}{60}$ of 15°, or 15′; in one second it will pass through $\frac{1}{60}$ of 15′, or 15″.

TABLE.

15″ of longitude = 1 second of time.
15′ of longitude = 1 minute of time.
15° of longitude = 1 hour of time.

65.

1. Over how many degrees of the surface of the earth does the sun pass in 24 hours? In 18 hr.? In 12 hr.?

2. Over how many degrees does the sun pass in 1 hr.? In 6 hr.? In 15 hr.?

3. Over how many degrees does the sun pass in half an hour? In $\frac{1}{3}$ of an hr.? In $\frac{1}{5}$ of an hr.?

4. How many degrees of longitude equal 2 hr. of time? 3 hr. of time? 4 hr. of time? 5 hr. of time?

5. A city, situated 5 degrees west of a prime meridian, and another 15 degrees west of the same meridian, will be how many degrees apart?

6. A city, situated 5° east of a prime meridian, and another 10° west of the same meridian, will be how many degrees apart?

7. If one city is situated 10° east of a prime meridian, and another 20° west of a prime meridian, how far apart are they?

8. Berlin is 10° east longitude, and Philadelphia 75° west longitude; how many degrees are these cities apart?

9. Philadelphia is 75° west longitude, and Chicago is 87° west longitude; how far are they apart?

10. When it is 4 o'clock at Chicago, what time is it 30° east? 30° west?

11. When it is 12 o'clock at Cleveland, how many degrees west will it be 10 o'clock, A. M.? 2 o'clock, P. M.?

NOTE.—A. M. means before noon, P. M. means afternoon, and M. means noon.

12. Brussels is 5° east longitude, and Columbus 85° west longitude; how many degrees are these cities apart? What is the difference in time between these cities?

13. Berlin is 15° east longitude, and Philadelphia is 75° west longitude; what is the difference in time between these cities?

14. The difference in time between Paris and Chicago is 5 hr.; what is the difference in longitude?

15. The difference in time between Lisbon and Boston is 4 hr.; what is the difference in longitude?

16. The longitude of Philadelphia is 75° west, and of St. Louis 90° west; what is the difference in time? When it is 12 o'clock noon at Philadelphia, what time is it at St. Louis?

17. Boston is 70° west longitude, and Bismarck is 100° west longitude When it is 10 o'clock, A. M., at Bismarck, what time is it at Boston?

18. Vienna is 15° east longitude, and Cape Sable is 60° west longitude. When it is 4 o'clock, P. M., at Cape Sable, what time is it at Vienna?

19. How far east or west of Philadelphia must a man travel that his watch may be 2 hours slow? 2 hours fast?

66.

REVIEW PROBLEMS.

1. If 2 quarts of oil cost 16 cents, what will 1 gallon cost?

2. If 5 quarts of molasses cost 60 cents, what will 1 quart cost?

3. How much will 1 pint of molasses cost, if a quart cost 12 cents?

4. What will 1 pint of vinegar cost, if 2 quarts cost 20 cents?

5. If 3 quarts and 1 pint of vinegar cost 35 cents, what will 1 pint cost?

6. If 2 gallons of milk cost 32 cents, what will 1 quart cost?

7. If 2 gallons of oil cost 48 cents, how much will 1 pint cost?

8. If a pint of molasses costs 5 cents, how much will a barrel cost?

9. What will a pane of glass 12 inches long and 10 inches wide cost, at 2 cents a square inch?

10. What will 2 yd. 2 ft. of muslin cost, at 6 cents a yard?

11. What is the cost of 10 square yards of oilcloth, at 50 cents a square yard?

12. What must I pay for 5 yd. 2 ft. of wire, at 2 cents a foot?

13. How much will a board 12 ft. long and 2 feet wide cost, at 4 cents a square foot?

14. How much must I pay for a piece of tin 5 yards long and 2 feet wide, at 5 cents a square foot?

15. What will a piece of leather 2 yd. 1 ft. long and 2 ft. wide cost, at 50 cents a square foot?

16. If a square yard of tin costs 90 cents, how much will a piece of tin cost which is 3 yd. 2 ft. long and 3 ft. wide?

17. If a dozen of eggs are worth 24 cents, how much will 2 dozen and 8 eggs cost?

18. At 50 cents a hundredweight, how much will a ton of hay cost?

19. How much will 2 tons 10 cwt. of hay cost, at $12 a ton?

20. If a boy buys peanuts at $3 a bushel, and sells them at 10 cents a pint, how much does he make on a bushel?

21. At 24 cents a dozen, what will 15 oranges cost?

22. How much will 7 quarts of timothy seed cost, at $6.40 a bushel?

23. How many pint bottles will 5 gal. 3 qt. 1 pt. of milk fill?

24. Sold a box containing $2\frac{1}{2}$ bushels of chestnuts for $8; how much was that a quart?

25. A boy picked 5 bu. 3 pk. of blackberries; how many quart boxes did he fill?

26. If potatoes are selling for 64 cents a bushel, how much are they worth a half-peck?

27. When apples are selling for 10 cents a half-peck, how much is that a bushel?

28. A hatter buys a box containing 1 dozen hats for $25, and sells them at $3 each; how much does he gain on the box?

29. What part of a year are 4 months and 1 week?

30. How much will 2 tons of hay cost at 50 cents a hundredweight?

31. My grandfather is "four score years and ten"; how many years old is he?

32. If flour costs $1.50 a cwt., what will 30 pounds cost?

33. A ream of paper costs $2.40; what will a quire cost? How much will 12 sheets cost?

34. If a gross of buttons costs $2.88; how much will 20 buttons cost?

35. What is the difference in time of sunset between two cities which are 60° of longitude apart?

PERCENTAGE.

Percentage is the name given to operations in arithmetic in which the unit of measure is 100.

Per Cent. is a Latin term, and means *by the hundred.* This sign % stands for per cent.

The **Base** is the number on which percentage is reckoned.

The **Rate** is the number of hundredths taken on every unit in the base.

The **Percentage** is the quantity obtained by taking a certain per cent. of the base.

NOTES.—1. The base + the percentage is called the *amount.*

2. The base − the percentage is called the *difference.*

67.

1. What part of a number is 50% of it?

SOLUTION.—50% of a number is $\frac{50}{100}$ of it, or $\frac{1}{2}$. Therefore, 50% of a number is $\frac{1}{2}$ of it.

What part of a number—

2. Is 75% of it?
3. Is 25% of it?
4. Is 10% of it?
5. Is 5% of it?
6. Is 30% of it?
7. Is 40% of it?
8. Is 60% of it?
9. Is 80% of it?

What part of a number—

10. Is 8% of it?
11. Is 12% of it?
12. Is 14% of it?
13. Is 15% of it?
14. Is 20% of it?
15. Is 28% of it?
16. Is 45% of it?
17. Is 85% of it?

What part of a number—

18. Is $6\frac{1}{4}$% of it?
19. Is $12\frac{1}{2}$% of it?
20. Is $16\frac{2}{3}$% of it?
21. Is $37\frac{1}{2}$% of it?
22. Is $62\frac{1}{2}$% of it?
23. Is $66\frac{2}{3}$% of it?
24. Is $33\frac{1}{3}$% of it?
25. Is $87\frac{1}{2}$% of it?

What per cent. of a number—

26. Is $\frac{1}{2}$ of it?
27. Is $\frac{1}{4}$ of it?
28. Is $\frac{1}{3}$ of it?
29. Is $\frac{1}{6}$ of it?
30. Is $\frac{3}{4}$ of it?
31. Is $\frac{1}{8}$ of it?
32. Is $\frac{3}{8}$ of it?
33. Is $\frac{2}{3}$ of it?
34. Is $\frac{5}{8}$ of it?
35. Is $\frac{9}{10}$ of it?

36. What per cent. of a number is $\frac{1}{5}$ of it?

SOLUTION.—$\frac{1}{5} = \frac{20}{100}$, or 20%.

37. What part of a number is 40% of it?

SOLUTION.—$40\% = \frac{40}{100}$, or $\frac{2}{5}$ of it.

NOTE—The teacher should see to it that the pupil is able to give readily the per cent. corresponding to any fraction, or the fraction corresponding to any per cent., before going on with the following examples.

68.

To Find the Percentage.

1. What is 20% of 50 yards of muslin?

SOLUTION.—$20\% = \frac{20}{100}$, or $\frac{1}{5}$; and $\frac{1}{5}$ of 50 yards of muslin is 10 yards. Therefore, 20% of 50 yards of muslin is 10 yards.

What is—

2. 5% of 40?
3. 10% of 50?
4. 15% of 60?
5. 20% of 80?
6. 25% of 72?
7. 30% of 80?
8. $37\frac{1}{2}\%$ of 80?
9. $33\frac{1}{3}\%$ of 66?
10. 60% of 60?
11. 75% of 84?

What is—

12. 25% of 48 hens?
13. 10% of 40 sleighs?
14. 5% of \$80?
15. $12\frac{1}{2}\%$ of \$64?
16. Horace had \$80 and spent 50% of it; how much did he spend?

17. A farmer paid $50 for a store-wagon and sold it at a loss of 20%; how much did he get for it?

18. Mr. Smith bought a cow for $30 and sold her at a loss of 10%; what did he get for her?

19. Harry bought a set of harness for $20 and sold it at a gain of 25%; what was the gain?

20. A man earned $500 a year and his rent amounted to 20% of it; what was his rent?

21. Mr. B sold 30% of 500 bushels of wheat; how much wheat did he sell?

22. Miss Jones bought carpet to the amount of $80; but, because she was a teacher, was allowed 10% off the bill; how much did she pay?

23. In an orchard of 200 trees, 30% of them are pear, 60% are apple, and the remainder plum; how many trees of each kind are there?

24. A miller bought 10 barrels of flour for $40 and sold them at a gain of 25%; what did he get for each barrel?

25. 10% of $160 is $\frac{1}{4}$ of what I paid for a watch; if I sell the watch at a gain of 10%, what do I get for it?

69.

To Find the Rate.

1. A man bought a watch for $20 and sold it for $25; what was the gain per cent.?

SOLUTION.—If a watch cost $20, and he sold it for $25, he gained the difference between $20 and $25, which are $5. If he gained $5 on $20, he must have gained $\frac{5}{20}$, or $\frac{1}{4}$ of the cost, or 25%. Therefore, etc.

What per cent.—

2. Of 20 is 4? Is 5? Is 10? Is 15?

3. Of 30 is 6? Is 10? Is 15? Is 20?

4. Of 50 is 10? Is 20? Is 30? Is 40?

5. Of 60 sheep are 30 sheep?

6. Of 80 apples are 60 apples?
7. Of 75 oranges are 25 oranges?
8. Of 90 men are 30 men?
9. Of 36 peaches are 9 peaches?
10. Of 18 buttons are 12 buttons?
11. Of 24 books are 18 books?
12. Of 48 hens are 32 hens?
13. Of 60 boys are 20 boys?
14. Of 30 girls are 9 girls?
15. Of 65 horses are 13 horses?
16. Of 84 cows are 21 cows?
17. Of 64 birds are 40 birds?
18. What per cent. of a five-dollar bill are $3?
19. What per cent. of $2 are 50 cents?
20. What per cent. of a gallon of vinegar is a quart?
21. What per cent. of a bushel is a peck?
22. What per cent. of a dollar is $\frac{3}{5}$ of it?
23. I had 80 books in my library and loaned 16 to friends; what per cent. did I loan?
24. Mr. B bought a cow for $80 and sold her for $60; what was the loss per cent.?
25. Mr. C bought a horse for $150 and sold him for $\frac{2}{3}$ of the amount; what was the loss per cent.?
26. Frank bought a dozen of oranges for 36 cents and sold them for 4 cents apiece; what did he gain per cent.?
27. From a can of oil containing 20 gallons 2 vessels are filled, one containing $8\frac{1}{2}$ gallons and the other $6\frac{1}{2}$ gallons; what per cent. was taken out?
28. Henry sold a lot for $100 and thereby lost $25; what per cent. did he lose?
29. A man sold a cow for $55 and thereby cleared $\frac{1}{5}$ of this amount; what per cent. did he gain?
30. A man sold a cow for $60 and thereby cleared $\frac{1}{4}$ of this amount; what per cent. did he gain?

70.

To Find the Base.

1. A tailor sold a coat for $30 and thereby gained 20%; what was the cost of the coat?

SOLUTION.—If by selling the coat for $30 he gained 20%, he must have gained $\frac{20}{100}$, or $\frac{1}{5}$ of the cost; $\frac{5}{5}$ of the cost plus $\frac{1}{5}$ of the cost, or the gain, is $\frac{6}{5}$ the cost, or $30. If $\frac{6}{5}$ the cost is $30, $\frac{1}{5}$ of the cost is $\frac{1}{6}$ of $30, which is $5; and $\frac{5}{5}$, or the cost, will be 5 times $5, or $25. Therefore, etc.

2. Thomas sold a calf for $14, which is at a gain of 40%; what did the calf cost?

3. William sold a cow for $46 and thereby gained 15%; what did the cow cost?

4. A man gained $12 on a lot of poultry, which was a gain of 6%; what did the poultry cost?

5. $50 is 10% of Mary's money; how much money has Mary?

6. Harry lost at a game of marbles 20 of his number, which was a loss of 5%; how many marbles did he have at first?

7. If by selling a horse for $165, I gain 37½%, what did the horse cost me?

8. My income, after deducting expenses, is $600; if my expenses are 33⅓% of my income, what is my income?

9. A man lost 60% on a bicycle by selling it for $40; what did the bicycle cost?

10. If by selling a horse at a gain of 25%, I make $35, what did the horse cost me?

11. A man sold 2 carriages for $120 each; on one he gained 25%, and on the other he lost 25%; did he gain or lose, and how much?

12. A man sold 2 watches for $25 each: on one he gained 25%, and on the other he lost 16⅔%; did he gain or lose, and how much?

13. Henry sold a horse for $135 and thereby gained 12½%; what would he have gained per cent. if he had sold him for $250?

14. A man sold a horse and harness for $150, receiving twice as much for the horse as for the harness: on the harness he lost 16⅔%, and on the horse he gained 25%; did he gain or lose by the transaction, and how much?

71.

Problems for Review.

1. 50 is 25% of what number?

SOLUTION.—If 50 is 25% of some number, 1% of that number is $\frac{1}{25}$ of 50, which is 2, and 100%, or the number, will be 100 times 2, or 200. Therefore, 50 is 25% of 200.

2. 30 is 6% of what?
3. 40 is 20% of what?
4. 60 is 10% of what?
5. 75 is 25% of what?
6. 80 is 40% of what?
7. 90 is 30% of what?
8. 65 is 13% of what?
9. 45 is 15% of what?

10. 7½ bushels of potatoes are 12½% of how many bushels?

11. 16½ quarts of oil are 16⅔% of how many quarts?

12. 24 gallons of vinegar are 37½% of how many gallons of vinegar?

13. What number increased by 25% of itself equals 35?

14. What number increased by 20% of itself equals 36?

15. A man sold a horse for $240 and thereby gained 20%; what did the horse cost?

16. A man sold a horse for $240 and thereby lost 11⅓%; what did the horse cost?

17. If there is a loss of 33⅓% when silk is sold for $6 a yard, what did the silk cost?

18. A man plowed 62½% of a field containing 24 acres; how many acres did he plow?

19. What number is 150% of 20?

20. $\frac{5}{4}$ of a number is what per cent. of the number?

21. 125% of a number is what fraction of the number?

22. 12 is $\frac{3}{4}$ of what number? 75% of what number?

23. 20 is $\frac{4}{5}$ of what number? 80% of what number?

24. 40 is $\frac{2}{3}$ of what number? $66\frac{2}{3}$% of what number?

25. 49 is $\frac{7}{8}$ of what number? $87\frac{1}{2}$% of what number?

26. Henry had \$50 and William 4 times as much: William then gave 40% of his money to Henry, and afterward borrowed 30% of what Henry then had; how much money had each then?

27. What must I ask for a bicycle which cost \$60, so that after falling 25% I may still gain 25%?

28. What must I ask for a horse which cost \$80, so that after falling $11\frac{1}{9}$% I may still gain 20%?

29. Mr. Shallcross sold a boat for \$250 and thereby cleared $\frac{1}{5}$ of this amount; what per cent. would he have gained if he had sold it for \$260?

30. What must I ask for a library which cost me \$600, that I may make a discount of 20% and 25% off to the agent, and still gain 50%?

72.

PROFIT AND LOSS.

1. Bought a knife for 40 cents and sold it at a gain of 20%; what did I get for it?

SOLUTION.—If I gained 20%, I gained $\frac{1}{5}$ of the cost. $\frac{1}{5}$ of 40 cents is 8 cents. If the knife cost 40 cents and I sell it at a gain of 8 cents, I receive for it 40 cents plus 8 cents, or 48 cents.

2. A sewing machine cost \$60; for how much must I sell it to gain 25%?

3. For what must I sell hay bought at \$15 a ton, so as to gain $33\frac{1}{3}$%?

4. For how much must I sell goods that cost \$12 a yard, so as to gain $66\frac{2}{3}$%?

5. If I pay $40 for a sleigh and sell it at a gain of 50%, how much do I get for it?

6. I buy tea for 80 cents per pound and sell it at a loss of 25%; what do I get for it per pound?

7. A man weighed 200 pounds, but through sickness his weight decreased 12½%; how much did he weigh then?

8. A coal dealer bought coal at $3 a ton and retailed it at an advance of 66⅔%; what did he sell it for?

9. A man buys a carriage for $160 and sells it at a loss of 25%; what does he sell it for?

10. For how much apiece must I sell eggs which cost 30 cents a dozen, so as to gain 20%?

73.

1. A man buys a watch for $40 and sells it for $60; what is the gain per cent.?

SOLUTION.—If the watch is bought for $40 and sold for $60, the gain is the difference between $60 and $40, which are $20. If he gained $20 on $40, he gained $\frac{20}{40}$, or $\frac{1}{2}$ of the cost, or 50%.

2. A lady buys a shawl for $30 and sells it for $45; what is the gain per cent.?

3. Mr. B buys a cow for $50 and sells her for $60; what per cent. does he gain?

4. A farmer buys sheep at $4 a head and sells them for $6 a head; what does he gain per cent.?

5. Bought a carriage for $160 and sold it for $120; what was the loss per cent.?

6. A man buys lead pencils at 12 cents a dozen and sells them at 1½ cents apiece; what per cent. does he gain?

7. A storekeeper bought some calico at 10 cents a yard and sold it at 8 cents a yard; what did he lose per cent.?

8. Mr. James bought 50 shares of electric light stock at $10 a share and sold them at a gain of 10%; what did he get for them?

9. Wilson bought a horse for $150 and sold him for $\frac{9}{10}$ of this amount; what per cent. did he lose?

10. How much must a piano costing $200 be marked, so that the seller may drop 25% and still make 20% profit?

74.

1. A man sold a watch for $15 more than the cost and thereby gained 20%; what was the cost of the watch?

SOLUTION.—A gain of 20% is $\frac{1}{5}$ of the cost; since $15 is his gain, $15 must equal $\frac{1}{5}$ of the cost; $\frac{5}{5}$ of the cost is 5 times $15, which are $75.

2. A lady sold a knife for 10 cents less than the cost and thereby lost 10%; what did the knife cost her?

3. A farmer sold a horse for $20 less than it cost and thereby lost $12\frac{1}{2}$%; what did the horse cost him?

4. Mr. Brown sold his watch for $20 more than it cost and thereby gained $33\frac{1}{3}$%; what was the cost of the watch?

5. A lady sold a piano for $30 more than it cost and thereby gained $16\frac{2}{3}$%; what did the piano cost her?

6. A boy at school lost 15 cents, which was 10% of his money; how much money had he?

7. If I lose 20 cents by selling a knife at 20% below cost, what is the cost of the knife?

8. A man lost 40 cents by selling a book 25% below cost; what did the book cost?

9. A farmer's crop of potatoes this year was 75 bushels more than last year, which is an increase of 25%; what was his crop last year?

10. A farmer sold a cow for $15 less than the cost and thereby lost 20%: he then bought another for $60 and sold her at a gain of 20%; did he gain or lose, and how much?

11. Harry won 20 marbles from his playmate, which was 10% of what he had at first; how many marbles has he now?

75.

1. Mr. Jones sold a cow for \$36 and thereby gained 20%; what did the cow cost him?

SOLUTION.—If he gained 20%, $\frac{1}{5}$ of the cost equals the gain, and $\frac{5}{5}$ the cost, plus $\frac{1}{5}$ of the cost, which is the gain, is $\frac{6}{5}$ of the cost, or the selling price, or \$36. If $\frac{6}{5}$ of the cost of the cow is \$36, $\frac{1}{5}$ the cost is $\frac{1}{6}$ of \$36, which are \$6, and $\frac{5}{5}$, or the whole cost, is 5 times \$6, or \$30.

2. A merchant sold a case of goods for \$90, thereby gaining $12\frac{1}{2}\%$; what did the goods cost?

3. A boy sold his bicycle for \$60 and by so doing lost $16\frac{2}{3}\%$; how much did his bicycle cost?

4. Sold a lot for \$124 and thereby gained $33\frac{1}{3}\%$; what did the lot cost?

5. A farmer sold a horse for \$124 and by so doing lost $33\frac{1}{3}\%$; what did the horse cost him?

6. A picture-dealer sold two pictures for \$24 each: on one he gained 20%, and on the other he lost 20%; how much did each cost?

7. By selling oranges at 4 cents apiece I gain $33\frac{1}{3}\%$; what did they cost a dozen?

8. By selling a horse at a gain of \$15 a farmer gains 10%; what should he have sold him for to gain 20%?

9. A tailor sells coats for \$21 and at this price gains $16\frac{2}{3}\%$; how much must he sell them for to gain twice that per cent.?

10. A drover bought 50 sheep at \$5 a head, and 20% of them died; for how much each must he sell the remainder to gain 20% on the flock?

11. By selling meat at 18 cents a pound a grocer gains $12\frac{1}{2}\%$; what did the meat cost per pound?

12. William sold his watch for \$30 and by so doing lost $33\frac{1}{3}\%$; what did the watch cost?

76.

BROKERAGE AND COMMISSION.

Brokerage is a percentage paid to a broker for buying or selling stocks, etc.

Commission is a percentage paid to an agent for the transaction of business.

I.—1. An agent collects a bill of \$300 on a commission of 2%; what is his commission?

2. A collector receives 3% for collecting a bill of \$800; what is his commission?

3. An attorney collects a bad debt of \$400 on a commission of 2%; if he settles with the debtor for 75%, what is his commission?

4. A broker bought for Mr. Evans 10 shares of Penna. R. R. stock (\$50) at par, brokerage $\frac{1}{2}\%$; what is the amount of the brokerage?

NOTE.—*Par* means face value.

5. Mr. Brown bought through a broker 50 shares of New York Central (\$100) at par, brokerage $\frac{1}{4}\%$; what was the brokerage?

II.—1. An agent charges \$6 for collecting a bill of \$300; what is his rate of commission?

SOLUTION.—If the agent charges \$6 for collecting \$300, for collecting \$1 he would charge $\frac{6}{300}$ of \$6, or $\frac{6}{300} = \frac{1}{50}$, which equals 2%.

2. A collector collects a bill of \$800 for \$16; what rate of commission does he charge?

3. A dealer in real estate receives \$50 commission for selling a house for \$2500; what is the rate of commission?

4. An attorney received \$60 for collecting a bill of \$4500; if he was obliged to take off $11\frac{1}{9}\%$ in settlement with the debtor, what was his rate of commission?

NOTE.—Agents get commission on what they collect only.

5. A commission merchant sold 1000 barrels of apples at $4 a barrel; what was his commission at 2%?

III.—1. An attorney receives $20 for collecting a bill on a commission of 2%; what amount does he collect?

SOLUTION.—If he receives $20 for collecting a bill at 2%, then $20 must be 2%, or $\frac{2}{100}$, or $\frac{1}{50}$ of the amount collected; and $\frac{50}{50}$ will be 50 times $20, which are $1000. Therefore, etc.

2. A collector charges $60 for collecting rents; if his rate is 5%, what amount of rent does he collect?

3. An agent charges $40 for selling goods at a commission of 4%; what amount of goods does he sell?

4. An auctioneer receives $80 as his commission for a sale of goods; if his rate is 10%, what amount of goods does he sell?

5. A farmer took a certain amount of grain to the mill and brought back the meal of 27 bushels; if the miller's toll is 10%, how many bushels did he take to the mill?

IV.—1. If an agent's rate of commission is 5%, how many dollars worth of goods will he buy for me if I send him $420?

SOLUTION.—His commission is $\frac{5}{100}$, or $\frac{1}{20}$ of the amount invested. $\frac{20}{20}$ of the amount invested plus $\frac{1}{20}$ of the amount invested, which is his commission, equals $\frac{21}{20}$, or $420. If $\frac{21}{20}$ of the amount invested is $420, $\frac{20}{20}$ of the amount invested will be $400. Therefore, etc.

2. I order my agent in Chicago to buy apples for me; if his commission for buying is 4% and I send him $780, how many dollars worth of apples does he buy?

3. I order my agent in New York to buy shoes for me and send him $510; if his commission is 2%, how many pairs of shoes will he buy me at $1.25 a pair?

4. A merchant sent his agent $2020 to invest in wheat; if his commission is 1%, how many bushels will he buy at 50 cents a bushel?

5. An agent's commission for collecting a bad debt is 10%; if he collects all of $400 for me, how much of it will I get?

NOTE.—An agent gets commission on what he invests only.

77.

INSURANCE.

Insurance is a guarantee against loss by fire, storm, etc.

Premium is the money paid to secure the guarantee, and is a certain per cent. of the sum insured.

A **Policy** is a written contract between the company and the insured.

1. What is the cost for insuring a house for $5000 at 2%?

SOLUTION.—At 2%, $\frac{2}{100}$, or $\frac{1}{50}$ of the amount insured, equals the cost or premium; $\frac{1}{50}$ of $5000 is $100. Therefore, etc.

2. What is the cost for insuring a barn for $2000 at $1\frac{1}{2}$%?

3. Mr. Jones has his store insured for $4000 at 2%; what was the premium?

4. If I pay $50 for insuring the contents of a store for $5000, what is the rate?

5. Mr. Jones paid $50 for insuring $2500 worth of goods; what was the rate?

6. Mr. Wood paid $10 for insuring the contents of his stable at 2%; for how much had he his property insured?

7. A man paid $50 for insuring his store at 2%; for how much had he his store insured?

8. A premium on a house at $\frac{3}{4}$% is $30; for how much is the house insured?

9. I pay a premium of $84 for insuring my house, worth $4800, for $\frac{7}{8}$ of its value; what is the rate?

10. Paid \$50 for insuring a store, worth \$4000, for $62\frac{1}{2}\%$ of its value; what was the rate of insurance?

11. A man's furniture was insured for $\frac{3}{5}$ of its value at 2%; what was the value of the furniture, if the premium was \$24?

12. A man's barn was insured for $\frac{3}{4}$ of its value at 4%; what was the value of the barn, if the premium was \$63?

78.

STOCKS.

NOTES.—1. The par value of stocks is understood to be \$100 a share, unless otherwise stated.

2. Stock is at a premium when it sells for more than its face value; at a discount when it sells for less than its face value.

I.—1. When stock is at a premium of 10%, what is the value of a 50-dollar share? Of a 100-dollar share?

2. When stock is at a discount of 10%, what is the value of a 50-dollar share? Of a 100-dollar share?

3. What is the cost of 5 shares of electric light stock at 10% premium?

4. What is the cost of 10 shares of P. R. R. stock at 20% premium?

5. What is the cost of 20 shares of Traction stock at 10% discount?

6. What will 30 shares of railway stock cost at 20% discount?

II.—1. If I buy stock for 90 and sell it at 95, and by so doing make \$200, how many shares do I buy?

SOLUTION.—If I buy stock at \$90 and sell it at \$95, I gain \$5 on each share. If I gain \$200, I will have to have as many shares as \$5 are contained times in \$200, which are 40 times, or 40 shares.

2. A man buys stock at 95 and sells it at 90, thereby losing \$40; how many shares had he?

3. Mr. Brown bought stock at 110 and sold it at 125, thereby gaining $750; how many shares had he?

4. Mr. Smith buys stock at $5 above par and sells it at $5 below par, and by so doing loses $100; how many shares did he hold?

79.

III.—1. A company declares a dividend of 5%; what is Mr. Smith's dividend if he owns 20 shares?

2. A railroad declares a dividend of 5%; what is a stockholder's dividend who has 40 shares?

3. A creamery declares a dividend of 10%; what is Mr. Jones's dividend if he has 30 shares?

4. Mr. Brown owns 80 shares of railroad stock; if the company declares a dividend of 5%, and pays it in stock, how many shares will he then own?

5. I own 50 shares in a stocking-factory; if the company declares a stock dividend of 10%, how many shares will I then own?

NOTE.—A dividend is a sum of money paid to the stockholders out of the profits of the company. It is a percentage of the par value of the stock.

IV.—1. If a company declares a dividend of 5% and Mr. Brown receives $450, how many shares does he own?

SOLUTION.—If the dividend is 5%, the income from 1 share is $5. Mr. B.'s income is $450; he must own as many shares as $5 are contained in $450, which are 90 times, or 90 shares.

2. A lady received $80 as her share of a 5% bank dividend; how many shares did she own?

3. A bank declares a dividend of 10%; how many shares does the stockholder own who receives $50?

4. A railroad company declares a dividend of 5%, which is paid in stock; if I receive 5 shares of stock, how much stock did I own before I received the dividend?

V.—1. 20 shares of bank stock yield an income of \$100; what is the rate of dividend declared by the bank?

SOLUTION.—20 shares equal \$2000: if \$2000 gain \$100, \$1 will gain $\frac{100}{2000}$, or $\frac{1}{20}$, or 5%.

2. 50 shares of stock yield an income of \$25; what is the rate of income?

3. \$9000 worth of stock earns an income of \$225; what is the rate of dividend declared?

4. 10 shares of bank stock give another share dividend; what is the rate of the stock dividend?

VI.—1. How many shares of stock at 20% premium can I buy for \$600?

SOLUTION.—Stock is worth, at 20% premium, \$120 a share; and for \$600 I buy as many shares as 120 is contained in 600, which is 5 times, or 5 shares.

2. When stock is selling at 10% discount, how many shares can I buy for \$540?

3. Reading R. R. stock sells at 20% discount; how much can I buy for \$2000?

4. At 25% premium, how much stock may be bought for \$3750?

INTEREST.

Interest is a certain percentage charged for the use of money. It is always a certain rate per cent. on the principal for each year and fraction thereof.

The **Principal** is the sum for the use of which interest is charged.

Rate of Interest is the rate per cent. on 1 dollar for a year.

The **Amount** is the sum of the principal and interest.

80.

GENERAL METHOD.

1. What is the interest on \$50 for 1 year at 6%?

SOLUTION.—At 6%, $\frac{6}{100}$, or $\frac{3}{50}$ of the principal, equals the interest; $\frac{3}{50}$ of \$50 are \$3. Therefore, etc.

2. What is the interest on \$100 for 1 yr. at 6%?
3. What is the interest on \$200 for 1 yr. at 4%?
4. What is the interest on \$80 for 1 yr. at 5%?
5. What is the interest on \$300 for 1 yr. at 7%?
6. What is the interest on \$120 for 1 yr. at $8\frac{1}{3}$%?
7. What is the interest on \$160 for 1 yr. at $12\frac{1}{2}$%?
8. What is the interest on \$500 for 1 yr. at 20%?
9. What is the interest on \$138 for 1 yr. at $16\frac{2}{3}$%?
10. What is the interest on \$50.50 for 1 yr. at 6%?
11. What is the interest on \$300 for 2 yr. at 6%?

SOLUTION.—At 6%, $\frac{6}{100}$, or $\frac{3}{50}$ of the principal equals the interest for 1 year, and for 2 years, 2 times $\frac{3}{50}$, or $\frac{6}{50}$ of the principal equals the interest; $\frac{6}{50}$ of \$300 are \$36. Therefore, etc.

What is the interest—

12. Of \$125 for 3 yr. at 6%?
13. Of \$300 for 5 yr. at 5%?
14. Of \$350 for 4 yr. at 7%?
15. Of \$150 for 3 yr. at 5%?
16. Of \$250 for 2 yr. at 8%?
17. Of \$800 for $6\frac{1}{2}$ yr. at 6%?
18. Of \$600 for $4\frac{1}{2}$ yr. at 5%?
19. Of \$900 for 5 yr. at 6%?
20. Of \$700 for $5\frac{1}{2}$ yr. at 6%?
21. Of \$500 for $3\frac{1}{2}$ yr. at 4%?
22. Of \$900 for $2\frac{3}{4}$ yr. at 8%?
23. Of \$600 for 7 yr. at 5%?
24. Of \$300 for $5\frac{2}{3}$ yr. at 9%?

81.

1. What is the interest on \$200 for 2 yr. 6 mo. at 6%?

SOLUTION.—2 years 6 months equal $2\frac{1}{2}$ years. At 6% $\frac{6}{100}$ of the principal equals the interest for 1 year, and for $2\frac{1}{2}$ years, $2\frac{1}{2}$ times $\frac{6}{100}$, which are $\frac{15}{100}$, or $\frac{3}{20}$ of the principal equals the interest; $\frac{3}{20}$ of \$200 are \$30. Therefore, etc.

What is the interest—

2. Of \$250 for 2 yr. 3 mo. at 6%?
3. Of \$350 for 3 yr. 4 mo. at 6%?
4. Of \$400 for 4 yr. 2 mo. at 8%?
5. Of \$500 for 5 yr. 8 mo. at 4%?
6. Of \$400 for 4 yr. 6 mo. at 5%?
7. Of \$550 for 2 yr. 8 mo. at 6%?
8. Of \$460 for 5 yr. 9 mo. at 10%?
9. Of \$600 for 6 yr. 9 mo. at 4%?
10. Of \$750 for 2 yr. 10 mo. at 12%?
11. Of \$400 for 7 yr. 2 mo. at 4%?
12. What is the interest of \$200 for 2 yr. 6 mo. 18 da. at 5%?

SOLUTION.—18 days equal $\frac{18}{30}$, or $\frac{3}{5}$ of a month; 6 months and 18 days equal $6\frac{3}{5}$ months, or $\frac{33}{5}$ months; 1 month equals $\frac{1}{12}$ of a year, and $\frac{1}{5}$ of a month equals $\frac{1}{5}$ of $\frac{1}{12}$ of a year, or $\frac{1}{60}$ of a year, and $\frac{33}{5}$ months equals 33 times $\frac{1}{60}$, which are $\frac{33}{60}$, or $\frac{11}{20}$ of a year, which added to 2 years equals $2\frac{11}{20}$ years. If the interest for \$1 for 1 year is 5%, for $2\frac{11}{20}$ years it is $2\frac{11}{20} \times 5\%$, or $12\frac{3}{4}\%$; $12\frac{3}{4}\%$ of 200 are \$25.50. Therefore, etc.

13. What is the interest of \$400 for 2 yr. 4 mo. 15 da. at 6%?

NOTE.—In computations in interest, 30 days constitute a month; 360 days a year.

What is the interest—

14. Of \$400 for 4 yr. 7 mo. 6 da. at 6%?
15. Of \$300 for 2 yr. 6 mo. 12 da. at 4%?
16. Of \$500 for 3 yr. 2 mo. 20 da. at 5%?
17. Of \$600 for 1 yr. 4 mo. 18 da. at 8%?

18. Of $200 for 2 yr. 7 mo. 24 da. at 9%?

19. What is the amount of $50 for 2 yr. at 6%?

SOLUTION.—For 2 years at 6% $\frac{12}{100}$, or $\frac{3}{25}$ of the principal equals the interest; $\frac{3}{25}$ of $50 is $6, which added to $50, the principal, is $56, which is the amount.

20. What is the amount of $100 for 3 yr. at 5%?

21. What is the amount of $200 for 4 yr. at 8%?

22. What is the amount of $300 for 5 yr. at 10%?

23. What is the amount of $250 for 2 yr. 4 mo. at 6%?

24. What is the amount of $300 for 4 yr. 4 mo. at 9%?

25. What is the amount of $400 for 6 yr. 6 mo. at 8%?

26. What is the amount of $100 for 3 yr. 6 mo. 18 da. at 5%?

27. What is the amount of $200 for 4 yr. 2 mo. 12 da. at 6%?

28. In a savings bank a man has deposited $400, which is $\frac{2}{3}$ of what his brother has; if it draws 4% interest, what amount will each have in the bank in 1 year?

29. My wife and I together have $2500 in bank; if $\frac{2}{3}$ of my money equals my wife's, and the bank pays 6%, what amount of money will each have in the bank in 2 years?

30. If the amount of $2000 for 3 yr. 4 mo. at 6% be divided between Mr. A and his sister so that $\frac{1}{6}$ of A's money equals $\frac{1}{2}$ of his sister's, how much money will each have?

PROBLEMS IN INTEREST.

82.

To Find the Rate.

1. At what per cent. will $100 gain $12 in 2 yr.?

SOLUTION.—The interest on $100 for 1 year at 1% is $1, and for 2 years it is 2 times $1, which are $2. If the interest on $100 for 2 years is $2 at 1%, to yield an interest of $12 it will require as many per cent. as $2 are contained in $12, which are 6 times, or 6%.

2. At what per cent. will \$200 gain \$30 in 3 yr.?
3. At what per cent. will \$300 gain \$72 in 4 yr.?
4. At what per cent. will \$250 gain \$40 in 2 yr.?
5. At what per cent. will \$350 gain \$42 in 3 yr.?
6. At what per cent. will \$150 gain \$60 in 5 yr.?
7. At what per cent. will \$500 gain \$140 in 4 yr.?
8. At what per cent. will \$200 gain \$55 in $2\frac{1}{2}$ yr.?
9. At what per cent. will \$100 amount to \$120 in 4 yr.?
10. At what per cent. will \$300 amount to \$354 in 3 yr.?
11. At what per cent. will \$500 amount to \$670 in 4 yr. 3 mo.?
12. At what per cent. will \$800 amount to \$1600 in 6 yr. 3 mo.?
13. At what per cent. will \$400 amount to \$800 in 2 yr. 6 mo.?
14. At what per cent. will a principal double itself in 10 yr.?

NOTE.—At 1% a principal gains $\frac{1}{10}$ of itself in 10 yr.; and to gain $\frac{10}{10}$ of itself it will require as many per cent. as $\frac{1}{10}$ is contained in $\frac{10}{10}$, which are 10 times, or 10%.

15. At what per cent. will a principal treble itself in 10 yr.?
16. At what per cent. will a principal gain 3 times itself in 10 yr.?
17. At what per cent. will a principal quadruple itself in 5 yr.? In 10 yr.?
18. The amount of a certain principal for 6 yr. at a certain per cent. is \$680, and for 10 yr. it is \$800; what are the rate and the principal?
19. The amount of a certain principal for 4 yr. at a certain per cent. is \$480, and for 8 yr. it is \$560; what are the rate and the principal?

83.

To Find the Principal.

1. What principal will in 6 yr. at 6% give $72 interest?

SOLUTION.—$1 in 6 years at 6% will give 36 cents interest; and to give $72 interest it will require as many dollars as 36 cents are contained times in $72, which are 200 times, or $200.

2. What principal will in 5 yr. at 6% give $60 interest?

3. What principal will in 4 yr. at 5% give $40 interest?

4. What principal will in 6 yr. at 7% give $84 interest?

5. What principal will in 8 yr. at 4% give $96 interest?

6. What principal will in 4 yr. 6 mo. at 6% give $81 interest?

7. What principal will in 6 yr. 9 mo. at 8% give $108 interest?

8. What principal will in 8 yr. 3 mo. at 4% give $132 interest?

9. I wish to put money enough out at interest at 5% to pay the rent of my house which is $50 per month; how much money must I have on interest?

10. How much money has a man at interest at 6%, if with his income he can buy 4 shares of railway stock at 10% discount?

11. The interest of a sum of money for 4 years at 5% is $160 more than its interest for 2 years at 6%; what is the sum?

12. The money paid for a horse and sleigh will in 2 years 6 months at 6% give $36 interest; what is the cost of each if $\frac{2}{3}$ the cost of the horse equals $\frac{4}{5}$ the cost of the sleigh?

13. How much money must be put on interest for 2 years at 6% to yield the same interest as $400 for 3 years at 9%?

14. Mr. Jones bought a house, for which he paid one half in cash and borrowed the remainder at 6%; required the cost of the house, if his annual interest is $180.

84.

To Find the Time.

1. In what time will \$100 at 5% give \$45 interest?

SOLUTION.—The interest of \$100 for 1 year at 5% is \$5; hence, to give \$45 will require as many years as \$5 are contained times in \$45, which are 9 times, or 9 years.

2. In what time will \$100 at 6% give \$36 interest?
3. In what time will \$200 at 6% give \$48 interest?
4. In what time will \$400 at 5% give \$80 interest?
5. In what time will \$200 at 8% give \$64 interest?
6. In what time will \$300 at 7% give \$84 interest?
7. In what time will \$200 at 10% give \$140 interest?
8. In what time will \$60 at 5% give \$30 interest?
9. In what time will \$50 at 6% give \$15 interest?
10. In what time will \$150 at 4% give \$24 interest?
11. In what time will \$400 at 5% give \$90 interest?
12. In what time will \$200 at 6% give \$30 interest?
13. In what time will \$250 at 6% give \$35 interest?
14. In what time will \$200 at 4% amount to \$240?
15. In what time will \$400 at 6% amount to \$496?
16. In what time will \$500 at 10% amount to \$1000?
17. In what time will any principal double itself at 10%?

NOTE.—At 10% a principal will gain $\frac{1}{10}$ of itself in 1 year, and to gain $\frac{1}{10}$ of itself it will require 10 years.

18. In what time will any principal double itself at 5%? At 15%? At 20%? At 25%?
19. In what time will any principal treble itself at 5%? At 10%? At 20%?
20. In what time will any principal quadruple itself at 5%? At 10%? At 20%?
21. The amount of a principal for a certain time at 6% is \$472, and for the same time at 10% is \$520; required the principal and time?

85.

Interest by Sixty Days.

A short method of computing interest is by moving the decimal point two places to the left; this gives the interest for 60 days at 6%. Thus, the interest of $200 for 60 days at 6% is $2.00; for $400 is $4.00; for $650 is $6.50.

Since the interest at 6% for 2 months, or 60 days, is 1%, $\frac{1}{100}$ of the principal equals the interest, and when the interest for 60 days is obtained, we take aliquot parts or multiples of this interest for the interest for any number of days.

What is the interest—

1. Of $300 for 60 da. at 6%?
2. Of $360 for 60 da. at 6%?
3. Of $720 for 60 da. at 6%?
4. Of $530 for 60 da. at 6%?
5. Of $784 for 60 da. at 6%?
6. Of $200 for 30 da. at 6%?
7. Of $300 for 90 da. at 6%?
8. Of $400 for 120 da. at 6%?
9. Of $240 for 45 da. at 6%?
10. Of $360 for 75 da. at 6%?

What is the interest—

11. Of $200 for 63 days at 6%?

SOLUTION.—The interest of $200 for 60 days at 6% is $2.00; for 63 days it is $2.00 plus $\frac{1}{20}$ of $2.00, which are $2.10; since $\frac{1}{20}$ of 60 days is 3 days.

12. Of $300 for 93 days at 6%?
13. Of $400 for 123 days at 6%?
14. Of $600 for 33 days at 6%?
15. Of $800 for 63 days at 6%?
16. What is the interest of $100 for 63 days at 6%?
17. What is the interest of $200 for 63 days at 8%?
18. What is the interest of $360 for 93 days at 9%?
19. What is the interest of $400 for 63 days at 7%?
20. What is the interest of $800 for 33 days at 5%?

86.

PRESENT WORTH.

The **Present Worth** of a debt, payable in the future without interest, is such a sum, which, being put at interest for the time, at the legal rate, will amount to the debt.

True Discount is the difference between the *debt* and the *present worth.*

1. What sum of money put at interest for 3 years at 5% will amount to $345?

SOLUTION.—At 5% for 3 years $1 will amount to $1.15, and to amount to $345 it will require as many dollars to be put at interest as $1.15 are contained times in $345, which are 300 times, or $300.

2. What principal put at interest for 4 years at 5% will amount to $480?

3. What is the present worth of $500 due 5 years hence at 5%?

4. What is the present worth of $560 due 3 years 6 months hence at 8%?

5. What is the present worth of $360 due 9 months hence at 8%?

6. What is the present worth of $442 due 18 months hence at 7%?

7. What is the true discount of $480 due 4 years hence at 5%?

8. What is the true discount of $500 due 5 years hence at 5%?

9. The amount of money required to pay a note which had been on interest for 5 years 6 months at 6% was $665; what was the face of the note?

10. Mr. Linn bought $5100 worth of paper on a credit of 4 months, but on receipt of the paper preferred to pay cash; what sum in cash will pay the debt, money being worth 6%?

87.

BANK DISCOUNT.

Bank Discount is a charge made by a bank for the payment of a note before it becomes due.

It is interest on the face of the note for the time the note has to run.

NOTE.—In some States interest is taken for three days more than the time specified in the note, and these days are known as "days of grace."

The *proceeds* is the difference between the discount and the face of the note.

1. What is the bank discount for \$320 for 60 days at 6%?

SUGGESTION.—Bank discount is the same as simple interest; hence, the bank discount of \$320 for 60 days is \$3.20.

What is the bank discount—

2. Of \$200 for 60 da. at 6%?
3. Of \$250 for 60 da. at 6%?
4. Of \$220 for 90 da. at 6%?
5. Of \$500 for 90 da. at 5%?
6. Of \$600 for 45 da. at 8%?
7. Of \$480 for 30 da. at 7%?
8. Of \$360 for 60 da. at 5%?
9. Of \$800 for 45 da. at 6%?
10. Of \$700 for 60 da. at 6%?
11. Of \$800 for 90 da. at 9%?
12. Of \$450 for 60 da. at 5%?
13. Of \$150 for 45 da. at 6%?
14. Of \$800 for 75 da. at 6%?
15. Of \$160 for 90 da. at 5%?
16. Of \$1200 for 60 da. at 7%?
17. Of \$125 for 60 da. at 6%?

18. What is the proceeds of a 90-day note for \$200, discounted at 6%?

19. What are the proceeds and discount of a 60-day note for \$300, discounted at 5%?

20. Find the face of a 60-day note which, when discounted at a bank at 6%, will yield \$198.

21. Find the face of a note which, when discounted at a bank for 90 days at 5%, will yield \$790.

22. A bank bought a 90-day note for \$60 less than its face; what was its face value if discounted at 6%?

88.

TRADE DISCOUNT.

Trade Discount is an allowance, or a deduction made from the amount of a bill of goods, and is usually estimated at a certain per cent. off the list-price. The discount varies according to the market. Frequently two or more successive discounts are given, and in such a case, the *first* discount is made from the list-price; the *second* from what remains, and so on. Thus, when 10 and 5 off are specified from a bill of \$50, 10% is taken off first, leaving \$45, and then 5% from the \$45, leaving \$40.50. If a further discount is allowed, it is deducted from \$40.50.

1. What is due on a bill of \$50 from which is deducted a discount of 20 and 10?

SOLUTION.—20% of \$50 is \$10; \$50 minus \$10 is \$40; 10% of \$40 is \$4; \$40 minus \$4 is \$36, or the net amount of the bill.

NOTE.—By the *net price* is meant the amount paid after all the discounts are taken off.

2. What is the net price of a bill of goods sold at \$100, subject to a discount of 20 and 10 off?

3. What is the net price of a bill of goods amounting to \$500, subject to a discount of 25 and 10 off?

4. The list-price of goods is \$2.50; what is the net price if the discount is 20 and 5 off?

5. A merchant marked a sofa at \$100 and gave a discount of 20 and 5; how much did he receive for it?

6. The net price of a bill of goods, subject to a discount of 10%, is \$81; what was the list-price?

7. A man bought a bill of goods amounting to \$100, and the merchant's discount was 20 and 10 off, but the purchaser prevailed on him to take 30 off; how much did he gain by the operation?

8. A wholesale grocer sold to a retailer a bill of \$240, and offered a single discount of 25%, or 20 and 5 off; which would be the better for the purchaser, and how much?

PROPORTION.

89.

SIMPLE PROPORTION.

1. Horace and William divided some oranges, for which they paid 36 cents: Horace took 16 oranges and William 8; how much should each pay?

SOLUTION.—Since Horace took 16 oranges and William 8, they together had 24 oranges. If the cost of 24 oranges is 36 cents, the cost of 1 orange is $1\frac{1}{2}$ cents, and of 16 oranges 24 cents; of 8 oranges, 12 cents. Therefore, etc.

2. Horace and William bought 24 apples for 18 cents: Horace paid 15 cents and William paid 3 cents; how many apples should each receive?

3. John and Francis paid 30 cents for 45 peaches: John paid 24 cents and Francis 6 cents; how many peaches should each receive?

4. Two farmers hire a pasture for \$60: the first pastures 20 horses and the second 10 horses; what part of the bill should each pay?

5. Two farmers hire a pasture for \$30, on which they pasture 10 horses: the first pays \$18 and the second \$12; how many horses did each pasture?

6. Frank and John hire a horse and carriage for 25 days at the rate of \$2 a day: Frank used it 18 days and John 7 days; what should each pay?

7. A and B agree to plow a field for \$60: A plows 12 days and B 8 days; how much money should each receive?

8. George and Thomas hire a horse and carriage for 20 days for \$50: George paid \$30 and Thomas \$20; for how many days did each pay?

9. Three men, A, B, and C, agree to plow a field for \$90: A works 8 days, B 6 days, and C 4 days; how much should each receive?

10. Three men, A, B, and C, agree to build a boat for $180: A sent 4 men 5 days, B 6 men 5 days, and C 5 men 8 days; how much does A, B, and C each receive?

11. A, B, and C hire a pasture for $140: A puts in 3 cows for 4 weeks, B 6 cows for 3 weeks, and C 5 cows for 8 weeks; how much should each pay?

12. Two men, A and B, hire a pasture for $40: A puts in 5 cows for 4 weeks and B puts in 20 horses for 2 weeks; what is each man's share of the expense, if the pasture of a cow equals that of 2 horses?

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13. Four times a number, increased by 5, equals 45; what is the number?

SOLUTION.—Since 4 times a number, increased by 5, are 45, then 4 times the number, *not* increased by 5, must equal 45 less 5, or 40. If 4 times the number is 40, once the number is $\frac{1}{4}$ of 40, or 10. Therefore, etc.

14. Two times a number increased by 6 equals 26; what is the number?

15. What number is that which being doubled and increased by 12 equals 42?

16. Frank, after earning twice as much money as he had, and finding $16, had $76; how much money had he at first?

17. Two-thirds of Harry's money being increased by $12 equals $34; how much money had he?

18. Three-fourths of Amy's money being diminished by $10 is $14; how much money had she?

19. If 20 be added to 4 times a number, we shall have 120; what is the number?

20. A watch and chain cost $150, and $\frac{4}{5}$ of their cost is $20 less than twice the cost of the chain; what is the cost of each?

21. Walter found $\frac{3}{4}$ as much money as he had, and then had \$70; how much did he have at first?

SOLUTION.—$\frac{4}{4}$, the money he had at first, plus $\frac{3}{4}$, the money he found, equals $\frac{7}{4}$ of his money, or \$70. If \$70 is $\frac{7}{4}$ of his money, he must have had \$40 at first.

22. Mary spent $\frac{3}{4}$ of her money for a dress, and then had \$20; how much money had she at first?

23. At a game of marbles a boy won $\frac{4}{15}$ as many as he had at first, and then had 57 marbles; how many had he at first?

24. My age, if increased by $\frac{1}{3}$ of $\frac{2}{5}$ of my age, would be 51 years; how old am I?

25. My age and that of my brother together equal 70 years; what is the age of each, if $\frac{7}{8}$ of my brother's age is $\frac{7}{6}$ of my age?

26. One-half the length of a pole is in the air, $\frac{1}{3}$ in the water, and the remainder, which is 15 feet, is in the mud; how long is the pole?

27. A boy spent $\frac{5}{8}$ of his money and then lost $\frac{2}{5}$ as much as he spent, and then had 20 cents remaining; how much had he at first?

28. If 3 times my weight be diminished by $\frac{2}{5}$ of my weight and 60 pounds, it will equal 180 pounds; what is my weight?

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29. Divide \$120 between A, B, and C, so that their shares will be to each other as 3, 4, and 5.

SOLUTION.—As the shares are to be to each other as 3, 4, and 5, we divide \$120 into 3 + 4 + 5, or 12 equal shares; one of these shares will be $\frac{3}{12}$ of \$120, or \$30; another will be $\frac{4}{12}$ of \$120, and another will be $\frac{5}{12}$ of \$120.

30. Divide 54 cents between 3 boys, so that their shares will be to each other as 2, 3, and 4.

31. A lady had 200 ducks, which she divided among her daughters in such a way that their respective numbers were to each other as 2, 3, and 5; how many did each get?

32. In a school of 65 pupils there are 6 girls to every 7 boys; how many of each sex are there?

33. In a field there are 40 cows and calves, and the cows are to the calves as 5 to 3; how many are there of each?

34. Divide 44 apples between Wilson and his sister, so that their respective numbers may be to each other as $\frac{1}{3}$ and $\frac{1}{5}$.

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35. My age and my daughter's age together are 60 years; what is the age of each if my age is 3 times my daughter's?

SOLUTION.—Since my age is 3 times my daughter's, 3 times my daughter's age equals my age; once my daughter's age added to 3 times my daughter's age, or my age, or both, equals 4 times my daughter's, or 60 years. Hence my daughter's age will be the $\frac{1}{4}$ of 60 years, which are 15 years, and my age will be 45 years.

36. Two boys have 50 cents; how much has each, if one has 10 cents more than the other?

37. Margaret and Amy gathered 60 daisies; how many did each gather, if Margaret gathered twice as many as Amy?

38. Horace has 12 cents more than William, and they together have 72 cents; how many has each?

39. The sum of 2 numbers is 90, and their difference is 10; what are the numbers?

40. Mary has 7 oranges more than George, and they together have 27 oranges; how many has each?

41. A watch cost \$30 more than the chain, and they together cost \$70; what was the cost of each?

42. Three times George's age increased by 10 years equals his father's age, and the sum of their ages is 90 years; how old is each?

43. Helen has 8 cents more than $\frac{1}{2}$ as many as Mabel, and they together have 68 cents; how many cents has each?

44. Two farmers bought 2 pigs for \$26. When they reached home, they agreed that one pig was worth \$1 more than the other; what is the price of each pig?

90.

COMPOUND PROPORTION.

1. If 6 horses eat 36 bushels of oats in 3 days, how much will 9 horses eat in 4 days?

SOLUTION.—If 6 horses eat 36 bushels in 3 days, 1 horse will eat $\frac{1}{6}$ of 36 bushels, or 6 bushels in 3 days; and in 1 day 1 horse will eat $\frac{1}{3}$ of 6 bushels, or 2 bushels. If 1 horse eats 2 bushels in 1 day, in 4 days he will eat 4 times 2 bushels, which are 8 bushels; and 9 horses will eat in 4 days 9 times 8 bushels, which are 72 bushels. Therefore, etc.

2. If 4 men can earn $32 in 8 days, how many dollars can 6 men earn in 12 days?

3. How long will 12 loaves of bread last 6 persons, if 24 loaves last 3 persons 8 days?

4. How long will 3 barrels of flour last 8 persons, if 4 persons eat 4 barrels in 40 weeks?

5. If 8 men can build 6 rods of wall in 12 weeks, how many men can build 20 rods in 8 weeks?

6. If 6 persons spend $72 in 4 days, how much will 5 persons spend in 5 days?

7. If 8 men spend $80 in 5 days, how many men would it require to spend $56 in 4 days?

8. If 12 boys can pick 72 boxes of strawberries in 3 days, how many days would it require 5 boys to pick 60 boxes?

PARTNERSHIP.

91.

1. Mr. Smith and Mr. Brown form a partnership: Mr. Smith puts in $600 and Mr. Brown $900; if they gain $500, what is each one's share of the gain?

SOLUTION.—Since the capital of both equals $1500, Mr. Smith puts in $\frac{600}{1500}$, or $\frac{2}{5}$ of it, and Mr. Brown $\frac{900}{1500}$, or $\frac{3}{5}$ of it, and are entitled respectively to $\frac{2}{5}$ and $\frac{3}{5}$ of the gain. Mr. Smith's gain is $200; and Mr. Brown's $300.

2. A and B form a partnership to engage in the coal business: A puts in \$1000 and B \$2000; they gain \$900; what is each one's share of the gain?

3. M and N own a house which rents for \$600 a year: M paid \$2000 as his share of the cost of the house, and N paid \$4000; how much of the rent should each receive?

4. C and D enter into partnership with a capital of \$6000: C's share of the gain is \$700 and D's is \$500; what is the capital of each?

5. A, B, and C went into partnership, and they gain in 1 year \$700: A puts in \$800, B puts in \$400, and C's gain is \$100; what was C's capital and A's and B's gain?

6. Three persons enter into partnership with \$1200: A puts in $\frac{1}{2}$, B $\frac{1}{3}$, and C the remainder, and they gain \$2400; what sum belongs to each?

7. Three boys agree to share 120 marbles, Thomas taking $\frac{1}{2}$, Henry $\frac{1}{4}$, and George $\frac{1}{12}$: but upon each taking these parts they find there are some left; how many marbles should each receive?

8. Two men, A and B, in partnership, gain \$600: B owns $\frac{2}{3}$ of the stock lacking \$200 and gains \$300; how much stock has each?

9. Two men, A and B, pay \$180 for the pasturage of some cattle: A turns in 10 cows for 20 weeks and B turns in 14 cows for 20 weeks; how much of the bill should each pay?

10. B and C engage in partnership: B puts in 5 times as much capital as C and they gain \$1200; what is each one's share of the gain?

11. M and N form a partnership: M puts in $\frac{2}{3}$ as much capital as N, and they gain \$2500; what is each one's share of the gain?

12. A, B, and C engage in partnership: A put in \$400 for 3 months, B put in \$500 for 6 months, and C put in \$600 for 8 months, and they gain \$300; what is each one's share of the gain?

INVOLUTION AND EVOLUTION.

92.

INVOLUTION.

A **Power** of a number is the product obtained in using the number several times as a factor.

Involution is the process of finding any power of a number.

The **First Power** of a number is the number itself.

The **Second Power**, or square of a number, is the product obtained in using the number *twice* as a factor, as $3 \times 3 = 9$.

The **Third Power**, or cube of a number, is the product obtained in using the number *three times* as a factor, as $3 \times 3 \times 3 = 27$, and so on.

1. Find the square of 2; 3; 4; 5.
2. Find the square of 6; 7; 8; 9.
3. Find the square of 10; 11; 12; 20.
4. Find the square of 1; $\frac{1}{2}$; $\frac{1}{3}$; $\frac{1}{4}$.
5. Find the cube of 2; 3; 4; 5.
6. Find the cube of 10; 20; 30; 40.
7. Find the cube of $\frac{1}{2}$; $\frac{1}{3}$; $\frac{1}{4}$; $\frac{2}{3}$.

93.

EVOLUTION.

The **Root** of a number is *one* of its *equal* factors. Roots are of several degrees, as *second*, *third*, etc.

Evolution is the process of finding any root of a number.

The **Square Root** of a number is one of its *two* equal factors, as the square root of 25 is 5, because 5 used twice as a factor is 25.

The **Cube Root** of a number is one of its *three* equal factors, as the cube root of 27 is 3, because 3 used 3 times as a factor is 27.

1. Find the square root of 4; 9; 16; 25; 36.

2. Find the square root of 49; 64; 81; 100; 132; 144.
3. Find the square root of 1; $\frac{1}{4}$; $\frac{1}{9}$; $\frac{1}{16}$; $\frac{1}{25}$.
4. Find the square root of $\frac{4}{9}$; $\frac{9}{16}$; $\frac{16}{25}$; $\frac{25}{36}$.
5. Find the cube root of 8; 27; 64; 125; 1000.
6. Find the cube root of $\frac{8}{27}$; $\frac{27}{64}$; $\frac{64}{125}$; $\frac{125}{1000}$.
7. The square of twice a number is 36; what is the number?
8. The square of twice a number is 64; what is the number?
9. The square of three times a number is 144; what is the number?
10. Two-thirds of the square of a number is 96; what is the number?
11. The square of $\frac{2}{3}$ of a number is 64; what is the number?
12. Three-fourths of the cube of a number is 48; what is the number?
13. The cube of $\frac{3}{4}$ of a number is 216; what is the number?
14. The square of a number divided by the number equals 6; what is the number?
15. Thirty-eight is 6 more than $\frac{1}{2}$ the cube of a number; what is the number?
16. The cube of a number divided by the number equals 64; what is the number?
17. The square of a number divided by $\frac{1}{4}$ the number equals 32; what is the number?
18. The cube of a number divided by the square of the number is 5; what is the number?
19. The difference between the square of half the number and the square of twice the number is 60; what is the number?
20. The square of a number divided by $\frac{2}{3}$ of the number is 9; what is the number?

94.

FIRST STEPS IN ALGEBRA.

1. PROBLEM.—A man bought a horse and carriage for $400, and the horse cost three times as much as the carriage; how much did each cost him?

SOLUTION BY ARITHMETIC.

A certain amount = the cost of the carriage.
Then 3 times that amount = the cost of the horse.
And 4 times that amount = the cost of both, or $400.
If 4 times that amount = $400.
The amount = $100, or the cost of the carriage.
And 3 times the amount = $300, or the cost of the horse.

The above solution may be very much shortened and simplified by using some letter, as x, to represent the expression—"*A certain amount*," and hence, by such a device, we arrive at the following:

SOLUTION BY ALGEBRA.

Let x = cost of the carriage.
Then $3x$ = cost of the horse.
And $4x$ = cost of both, or $400.
Therefore x = $100, cost of the carriage.
And $3x$ = $300, cost of the horse.

The pupil will observe that the above algebraic solution is very much like the arithmetical solution, and differs from it only in the using of a letter to represent a certain number or quantity. Thus, in the example above, x is used to represent the cost of the carriage, and $3x$ to represent the cost of the horse.

2. Read $a + b$; $a + 4$; $a - b$; $a \div b$.

3. Write the sum of a and b; the difference between a and b.

4. Write a increased by 4. $a + 4$, ans.

5. Write a diminished by 4. $a - 4$, ans.

6. Write a increased by b.

7. Write a diminished by b.

8. Three times a is written $3\,a$. Write 3 times b; 3 times c; 4 times x.

9. Tell what is meant by $\frac{20}{4}$; $\frac{a}{3}$; $\frac{b}{5}$.

10. Tell what is meant by $\frac{a}{b}$; $\frac{b}{c}$; $\frac{c}{x}$.

11. Read the equations $8 + 2 = 10$; $4 + 9 = 12 + 1$; $18 = 10 + 8$; $x = 12 - 2$.

12. If $a = 6$, $b = 5$, $c = 3$, and $d = 7$, find the value x in $3x = 2a + 5b - 2d + c$.

13. Find the value of $\frac{4a}{2c} + 3d$.

Find the number that x stands for if—

14. $2x = 10$.
15. $4x = 12$.
16. $5x = 20$.
17. $6x = 30$.
18. $2x + x = 36$.
19. $3x + 4x = 42$.
20. $8x - 2x = 48$.
21. $10x - 4x = 28 - 4$.
22. $9x - 10 = 7x$.
23. $\frac{x}{4} = 6$.
24. $\frac{3x}{5} = 3$.
25. $2x + \frac{x}{2} = 25$.
26. $\frac{3x}{4} + \frac{2x}{8} = 10$.
27. $\frac{3x}{5} - \frac{x}{5} = 20 - 4$.
28. $3x - 22 = 78 - 2x$.
29. $7x - 19 = 5x + 7$.
30. $5(x - 2) = 3x + 4$.

31. If $2x + 10 = 3x$, find the value of x.

32. If $2x + 3x - 6 = 4x + 2$, find the value of x.

33. If $x + 5x - 2x + 8 = 3x + 10$, find the value of x.

34. If $\frac{x}{2} + \frac{2x}{3} - \frac{3x}{4} = 5$, find the value of x.

35. If $x - 5 = \frac{2x}{3} + 4$, find the value of x.

36. If $x + 5 = \frac{1}{2}(x + 40)$, find the value of x.

37. If three times William's age equals 45 years, what is William's age?

Explanation.	Operation.
Let x equal William's age. Then $3x$ will equal 3 times William's age, or 45 years; and x will equal $\frac{1}{3}$ of 45 years, or 15 years.	Let $x =$ William's age. Then $3x = 45$ years. And $x = 15$ years, or William's age.

38. Horace has 4 times as much money as Harry, and they together have \$60; how many dollars has each?

Explanation.	Operation.
Let x equal Harry's money. Then $4x$ will equal Horace's money, and $5x$ will equal the money of both, or \$60; then x equals $\frac{1}{5}$ of \$60, or \$12, or Harry's money; and $4x$ equals \$48, or Horace's money.	Let $x =$ Harry's money. Then $4x =$ Horace's money. And $5x =$ \$60. Whence $x =$ \$12. And $4x =$ \$48.

39. Frank's money, increased by 3 times his money, equals \$40; how much money has he?

40. Samuel's age, increased by 12 years, equals 42 years; how old is he?

41. A man is 3 times as old as his son, and the sum of their ages is 40 years; what is the age of each?

42. Helen's age, increased by 30 years, equals 6 times her age; how old is she?

43. Horace spent $\frac{2}{3}$ of his money for a bicycle and had 20 dollars remaining; how much money had he at first?

EXPLANATION.	OPERATION.
Let x equal Horace's money. Then $\frac{2}{3}x$ will equal $\frac{2}{3}$ of his money, and x minus $\frac{2}{3}x$ equals 20 dollars, or $\frac{1}{3}x$ equals 20 dollars. Then $\frac{3}{3}x$, or x, will equal 3 times 20 dollars, which are 60 dollars. Hence, Horace's money was 60 dollars.	Let x = Horace's money. Then $x - \frac{2}{3}x = 20$ dollars, or, $\frac{1}{3}x = 20$ dollars. And $x = 60$ dollars, Horace's money.

44. Harry's money diminished by \$12 equals \$28; how much money has Harry?

45. Frank's money increased by \$10 equals \$40; how much money has Frank?

46. William's money increased by \$60 equals three times his money; how much money has William?

47. Twice Margaret's money increased by \$16 equals four times her money; how much money has she?

48. Horace has \$10 more than Amy, and together they have \$50; how much money has each?

49. Samuel's money increased by its $\frac{3}{4}$ and \$9 more, will equal \$30; how much money has he?

50. My father's age is five times my age, and the difference between our ages is 44 years; what is the age of each?

51. Four times Charles' age, plus 12 years, equals six times his age, plus 4 years; how old is he?

52. Twice a number, plus 10, equals four times the number, minus 6; what is the number?

53. Three times my money, minus 10 dollars, equals 6 times my money, minus 40 dollars; how much money have I?

54. What number is that whose double and half added together give 35?

NOTE.—Solve by algebra some of the problems in lesson 89.

ADVANCED COURSE.

NOTE.—The solution of the most difficult problem is given in each lesson of this course.

PROBLEMS IN ANALYSIS.

95.

1. If $3\frac{1}{2}$ times John's age are 84 years more than $3\frac{1}{2}$ times Peter's age, and $\frac{2}{3}$ of Henry's equal $\frac{8}{15}$ of John's age, and $\frac{2}{3}$ of Peter's age equal $\frac{1}{2}$ of Henry's age, how old is each?

SOLUTION.—Since Henry's age is directly compared with each of the other two, we can measure the others by it. If $\frac{2}{3}$ of Peter's age = $\frac{1}{2}$ of Henry's age, $\frac{1}{3}$ of Peter's age = $\frac{1}{2}$ of $\frac{1}{2}$ of Henry's age, which is $\frac{1}{4}$ of Henry's age, and $\frac{3}{3}$ of Peter's age = 3 times $\frac{1}{4}$ of Henry's age, which is $\frac{3}{4}$ of Henry's age. If $\frac{8}{15}$ of John's age = $\frac{2}{3}$ of Henry's age, $\frac{1}{15}$ of John's age = $\frac{1}{8}$ of $\frac{2}{3}$ of Henry's age, which is $\frac{1}{12}$ of Henry's age, and $\frac{15}{15}$ of John's age = 15 times $\frac{1}{12}$ of Henry's age, which are $\frac{15}{12}$, or $\frac{5}{4}$ of Henry's age. $3\frac{1}{2}$, or $\frac{7}{2}$ times John's age = $\frac{7}{2}$ times $\frac{5}{4}$, which are $\frac{35}{8}$ of Henry's age; and $3\frac{1}{2}$, or $\frac{7}{2}$ times Peter's age = $\frac{7}{2}$ times $\frac{3}{4}$, which are $\frac{21}{8}$ of Henry's age. Hence, $\frac{35}{8} = \frac{21}{8} = \frac{14}{8}$, or $\frac{7}{4}$ of Henry's age = 84 years; $\frac{1}{4}$ of Henry's age = 12 years, and $\frac{4}{4}$ of his age = 48 years. Since $\frac{1}{2}$ of 48 years, or 24 years, = $\frac{2}{3}$ of Peter's age, Peter's age = 36 years; and $\frac{3}{3}$ of 48 years, or 32 years, = $\frac{8}{15}$ of John's age, John's age = 60 years. Therefore, etc.

2. If $\frac{9}{11}$ of an acre of ground cost \$27, what will $\frac{2}{3}$ of an acre cost?

3. If $\frac{3}{4}$ of a gallon of oil cost $\frac{5}{6}$ of a dollar, what is the cost of 1 gallon?

4. If 1 quart of milk cost $\frac{5}{6}$ of a dime, what will $\frac{6}{11}$ of a quart cost?

5. If $\frac{1}{8}$ of a farm is worth $\frac{3}{7}$ of a store, $\frac{3}{5}$ of the farm is worth what part of the store?

6. If $2\frac{1}{2}$ times A's money equals B's money, A's money equals what part of B's money?

7. If $3\frac{2}{5}$ times the value of John's horse equal $\frac{4}{7}$ of the value of Henry's horse, John's horse equals what part of the value of Henry's horse?

8. If $5\frac{1}{4}$ times A's weight equal $2\frac{2}{3}$ times B's weight, $\frac{3}{4}$ of A's weight equal what part of B's weight?

9. If $\frac{2}{3}$ of an acre is worth $\frac{5}{6}$ of the value of a horse, and $\frac{3}{4}$ of the value of the horse is worth $\frac{2}{5}$ of the value of a watch, $\frac{3}{5}$ of the value of the watch equal what part of the value of an acre?

10. A has $\frac{3}{4}$ as many dollars as B has, and C has $\frac{2}{3}$ as many as A has; how many dollars has each, if A has $9 more than C?

11. If $2\frac{1}{2}$ times A's weight is 50 pounds more than $2\frac{1}{2}$ times B's weight, and $\frac{1}{2}$ of C's weight equals $\frac{2}{5}$ of B's weight, and $\frac{2}{5}$ of C's weight equal $\frac{4}{15}$ of A's weight, *what is* the weight of each?

12. A can do a piece of work in $\frac{2}{3}$ of a day, B in $\frac{3}{4}$ of a day, and C in $\frac{5}{6}$ of a day; what time can they do it working together?

RECIPROCAL PROBLEMS.

96.

1. A and B can do a piece of work in 4 days, A and C in 6 days, and B and C in 5 days; how long will it take each to do the work, and how long will it take the three, working together, to do it?

SOLUTION.—A and B can do $\frac{1}{4}$ of the work in 1 day, A and C can do $\frac{1}{6}$ of it in 1 day, and B and C can do $\frac{1}{5}$ of it in 1 day; hence, $\frac{1}{4} + \frac{1}{6} + \frac{1}{5}$ of the work, or $\frac{37}{60}$ of it = what the three can do in 2 days; in 1 day they will do $\frac{1}{2}$ of $\frac{37}{60}$, which is $\frac{37}{120}$ of the work. If in 1 day they can

do $\frac{37}{120}$ of the work, to do $\frac{120}{120}$, or all of the work, it will take as many days as $\frac{37}{120}$ are contained times in $\frac{120}{120}$, which are $3\frac{9}{37}$ times, or $3\frac{9}{37}$ days. In 1 day the three can do $\frac{37}{120}$, and A and B can do $\frac{1}{4}$, or $\frac{30}{120}$, hence C must do $\frac{37}{120} - \frac{30}{120}$, which are $\frac{7}{120}$ in 1 day, and to do all the work it will take him $17\frac{1}{7}$ days. $\frac{37}{120} - \frac{20}{120} = \frac{17}{120}$, or the part B can do in 1 day, and $\frac{37}{120} - \frac{24}{120} = \frac{13}{120}$, or the part A can do in 1 day. Therefore, etc.

2. If A can build a wall in 6 days, and B can build the same wall in 8 days, how long would it take both working together to build the wall, and what part of the pay should each receive?

3. John and Henry working together can dig a trench in 9 days. If John alone can dig the trench in 12 days, how long would it take Henry alone to dig it?

4. Peter can build a fence in 6 days; how long will it take Peter and James to build the fence, if James works twice as fast as Peter?

5. A tank supplying three pipes can be emptied in 8 hours if all are left open, or in 15 hours if only the first is open, or in 12 hours if the first and second only are open. In how many hours will the second and third each empty the tank?

6. If 6 men or 8 boys can do a job in 12 days, how long will it take 8 men and 6 boys to do the same job?

7. A can do a job worth $120 in 40 days, B can do the same job in 60 days. If they work together, how long will it take them to do the job, and how much should each receive?

8. One pipe can fill a cistern in 8 hours, a second pipe can fill it in 10 hours, a third pipe can fill it in 12 hours. If all fill together, how long will it take to fill the cistern, and what part will each pipe fill?

9. A and B can build a shed in 15 days, A and C can build it in 12 days, and B and C can build it in 10 days; how long will it take all three working together to build the shed? How long will it take each alone to build it? What part does each do when the three build it together?

10. E, F, and G take a job for \$60. If E and F can do it in 15 days, and F and G can do it in 20 days and E and G can do it in 12 days, how long will it take each alone to do the job, and what should each receive if all work together until the job is done?

11. If A, B, and C together can mow a field in 4 days, how long will it take each alone to mow the field, if A works twice as fast as B, and B works twice as fast as C? If the job is worth \$21, how much should each receive if all do the work together?

PROPORTION PROBLEMS.

97.

NOTE.—In machinery, power is transmitted by means of cog-wheels, belts, and shafts. All pulleys on the same shaft rotate in the same time. Circumferences are in the same ratio as their diameters.

1. A pulley 4 inches in diameter and a pulley 6 inches in diameter are on the same shaft. The 6 inch pulley is driven by an 8 inch pulley by a belt; and the 4 inch pulley drives a 3 inch pulley by a belt. How many rotations will each pulley make while the 3 inch pulley gains 7 rotations on the 8 inch pulley?

SOLUTION.—One rotation of the 8 inch pulley will give the 6 inch pulley $1\frac{1}{3}$ rotations, which gives the 4 inch pulley $1\frac{1}{3}$ rotations. One rotation of the 4 inch pulley gives the 3 inch pulley $1\frac{1}{3}$ rotations. Therefore, $\frac{1}{3}$ rotations of the 4 inch pulley gives the 3 inch pulley $\frac{4}{3} \times \frac{4}{3}$ rotations $= \frac{16}{9}$. Hence, one rotation of the 8 inch pulley gives the 3 inch pulley $\frac{16}{9}$, or $1\frac{7}{9}$ rotations, and the 3 inch pulley gains $\frac{7}{9}$ of a rotation at every rotation of the 8 inch pulley; but to gain 7 rotations the 8 inch pulley must rotate as often as $\frac{7}{9}$ is contained times into 7 rotations, or 9 rotations. Therefore, the 8 inch pulley rotates 9 times, the 6 inch pulley 12 times, the 4 inch pulley 12 times, and the 3 inch pulley 16 times while the 3 inch pulley gains 7 rotations on the 8 inch pulley.

2. If 5 apples are worth 3 oranges and 4 oranges are worth 3 lemons, how many apples are fairly exchanged for 9 lemons?

3. If 50 pounds of a certain solution contain 5 pounds of lime, how many pounds of pure water must be added so that 10 pounds of the new solution shall contain $\frac{2}{5}$ of a pound of lime?

4. If 3 drops of a certain acid are put into 60 drops of pure water for medicine, how many drops is a dose containing $\frac{1}{2}$ a drop of the acid?

5. In 100 pounds of potter's mixture there are 80 pounds of clay and the rest is sand; a vessel made of this mixture weighing 15 pounds contains how many pounds of sand?

6. In 100 pounds of potter's mixture 70 pounds are clay, 20 pounds sand, and the rest water; a vessel made of this mixture and weighing 10 pounds when dry contains how many pounds of clay?

7. A mixture of sugar containing $\frac{3}{4}$ at 8 cents per pound and the rest at 6 cents per pound should sell at what price per pound?

8. If 4 men and 6 boys earn $170 by a job at which the men worked 12 days and the boys worked 15 days, find the daily wages of each man and each boy if 3 men do as much as 5 boys?

9. A cog-wheel of 30 cogs is run by one of 20 cogs; in how many rotations of the smaller will it gain 6 rotations?

10. A pulley 12 inches in diameter drives a pulley 9 inches in diameter by a belt; in how many rotations of the larger pulley will the less gain 8 rotations?

11. A pulley 6 inches and a pulley 9 inches in diameter are on the same shaft: the 6 inch pulley is driven by a 12 inch pulley by a belt, and the 9 inch pulley drives a 6 inch pulley by a belt; how many rotations does each pulley make while the 6 inch pulley gains 4 rotations on the 12 inch pulley?

PARTNERSHIP PROBLEMS.

98.

1. John, Henry, and James rented a pasture for 60 horses for 40 days; if John paid \$15 more than $\frac{1}{3}$ the rent and Henry paid \$48 less than $\frac{1}{2}$ the rent and put in 24 horses for 30 days, find the amount of the rent and the amount each should pay.

SOLUTION.—Since 60 horses for 40 days equal 2400 horses for 1 day and Henry's 24 horses for 30 days equal 720 horses for 1 day, Henry has $1200-720=480$ days pasture less than half; and since he pays \$48 less than half the rent, the 480 days pasture are worth \$48, and one day's pasture is worth $\frac{1}{480}$ of \$48, which is 10 cents; and 2400 days pasture are worth 2400 times 10 cents, which are \$240. By the conditions of the problem John paid $\frac{1}{3}$ of the rent + \$15, which is \$95; Henry paid $\frac{1}{2}$ of the rent − \$48, which is \$72; and James paid the remainder, or \$73.

2. Frank, Fred, and Francis lunch together, Frank providing 5 sandwiches, Fred providing 4 sandwiches, and Francis paying 21 cents to be divided between Frank and Fred; how many cents went to each?

3. Twelve men order dinner at a hotel; but before it was ready 3 of them were called away, which caused each remaining man to pay 20 cents more than he had expected; what did each pay?

4. A and B gain \$120 in a business venture in which A furnished \$50 less than $\frac{2}{3}$ of the capital and gained \$70; find the entire venture and the share of each in the capital.

5. Thomas and Stanly bought 144 oranges for which Thomas paid 30 cents more than $\frac{1}{2}$ and got 80 oranges; find the cost of the oranges and the amount paid by each boy.

6. John and Henry put \$480 into a business venture: John put in \$280 and got \$20 less than $\frac{2}{5}$ of the gain; find the entire gain and each man's share.

7. Peter and James gained $360 in a business venture into which Peter put $60 more than $\frac{2}{5}$ of the capital and got $175 of the gain; find the entire capital and the share of each.

8. Mary and Susan put $750 into a business: Mary put in $600 and got $60 more than $\frac{4}{5}$ of the gain; find the entire gain and each woman's share.

9. Samuel and George paid $2.40 for a box of apples: Samuel got 80 more than $\frac{5}{6}$ of the apples and paid $1.60; find the whole number of apples and each man's share.

10. Mr. Jones and Mr. Smith hired a pasture for 50 cows for 30 days: Mr. Jones paid $30 less than $\frac{1}{2}$ the bill and put in 30 cows for 20 days; what was the full cost of the pasture and each man's share?

11. A, B, and C gain $420 in a business venture into which A put $40 more than $\frac{1}{8}$ and B $20 less than $\frac{1}{8}$ of the capital; if A gets $150 of the gain, find the entire venture and each man's share.

CONDITIONAL PRICE PROBLEMS.

99.

1. Matthew and Martin engage to work 30 days for $4 per day for their double day's work and board, but to pay $1 for board for each idle day: at the end of the time they received $84; how much should each have if Martin were idle twice as many days as Matthew?

SOLUTION.—If they had worked the full time, they should have received $120. Hence, $120 − $84 = $36 = loss by idleness. Each day both were idle made a loss of $4 + $2 = $6. Consequently, $36 ÷ $6 = 6 = half the number of idle days. Hence, there were 12 idle days. If Matthew was idle half as many days as Martin, both were idle 3 times as many days as Matthew, or 12 days. Matthew was idle $\frac{1}{3}$ of 12, which are 4 days, and Martin was idle 8 days.

Therefore, Matthew earned $52 and paid $4 for board, leaving him $48; and Martin earned $44 and paid $8 for board, leaving him $36.

2. A and B build a fence for \$36; if A builds 8 more than $\frac{4}{5}$ as many rods as B and gets \$16, how many rods did each build?

3. John bought a lot of melons for \$3.60: had he bought 10 less than 3 times as many at the same price per melon, the lot would have cost him \$6.40 more; how many melons did he buy?

4. A farmer bought a lot of calves for \$150: if he had bought 5 more than twice as many at the same price per calf, the lot would have cost him \$350; how many calves did he buy?

5. Frank and Fred made a walk for \$60: Frank works 3 more than $\frac{2}{3}$ as many days as Fred and gets \$30; how many days did each work?

6. James and William build a road for \$490; if James works 20 days less than William and $\frac{3}{4}$ as fast and gets \$180, how many days did each work?

7. A and B build a house for \$630; if A works 12 less than twice as many days as B and works $\frac{2}{3}$ as fast and gets \$328, how many days does each work?

8. A and B do a job for \$136; if $\frac{2}{3}$ of what A does is 6 rods less than $\frac{3}{4}$ of what B does, and A gets \$68, how many rods did each man do?

9. A drover bought a lot of hogs for \$80: if he had bought a second lot of 8 hogs at \$3 per head less than the first lot, the two lots would have cost him \$120; how many hogs did he buy?

10. John hires out to work for 30 days on condition that he shall get \$2 per day for every day he works, and shall pay \$1 per day for board for every day he is idle: at the end of the 30 days he gets \$30; how many days was he idle?

11. A and B engage to work for 40 days on condition that each shall get \$3 per day for each day he works, and pay \$1.25 for each day he is idle; if they get \$180 at the end of

the 40 days, how much does each get if A is idle twice as much as B?

RELATIVE AGE PROBLEMS.

100.

1. Three years since A was $\frac{4}{5}$ as old as B, but 6 years hence he will be $\frac{7}{8}$ as old; find the present age of each.

SOLUTION.—If A was $\frac{4}{5}$ as old as B, A should add $\frac{4}{5}$ of 9 years while B adds 9 years that A's age may remain $\frac{4}{5}$ of B's age. Therefore, $\frac{1}{5}$ of 9 years, or $\frac{9}{5}$ years $= \frac{7}{8} - \frac{4}{5}$, which are $\frac{3}{40}$ of B's age 6 years hence.

If $\frac{3}{40}$ of B's age 6 years hence $= \frac{9}{5}$ years, $\frac{40}{40}$ of B's age 6 years hence $= \frac{40}{3}$ of $\frac{9}{5}$, which are 24 years, and $\frac{7}{8}$ of B's age $= \frac{7}{8}$ of 24 years, which are 21 years.

If A will be 21 and B 24 years in 6 years, A is now 15 and B is 18 years old. Therefore, etc.

2. John's age plus Henry's age equals 24 years: two years ago John was twice as old as Henry; find the age of each now.

3. Martha's age plus her mother's age equals 40 years: four years hence her mother will be three times as old as Martha; find the age of each.

4. Peter's father is 25 years older than Peter; how old is each if the sum of their ages 5 years ago was 35 years?

5. May is 12 years older than Samuel, and 8 years hence the sum of their ages will be 32 years; find the age of each?

6. Jane is 4 years old and her mother is 30 years old; in how many years will Jane be $\frac{1}{5}$ as old as her mother?

7. Edward is 12 years old and his father is 40 years old; when was the father 5 times as old as Edward?

8. A is 4 times as old as B, but 4 years ago A was 5 times as old as B; find the age of each.

9. Emma is 3 times as old as her sister, but in 6 years she will be only twice as old; find the age of each.

10. George is $\frac{1}{2}$ as old as his father, but 5 years ago he was only $\frac{1}{3}$ as old; find the age of each.

11. Charles is $\frac{3}{4}$ as old as Matthew, but in 6 years he will be $\frac{5}{6}$ as old; find the ages of each.

TIME O'CLOCK PROBLEMS.

101.

NOTES.—1. *The hour hand* rotates over five of the 60 equal parts of the face of the clock or watch each hour.

2. *The minute hand* rotates over the 60 equal parts in each hour.

3. *The second hand* rotates over the 60 parts 60 times, or over 3600 parts each hour, the three hands rotating on the same center.

1. At what time between 4 and 5 o'clock are the minute and hour hands perpendicular to each other the second time, and how often are the second and hour hands together between 4 and 5 o'clock?

SOLUTION.—Since the minute and hour hands must be 15 spaces apart to be perpendicular to each other, the minute hand must gain 20 + 15 or 35 spaces to be in the desired position. Since the minute hand rotates over 12 spaces, while the hour hand rotates over 1 space, the gain is $1\frac{1}{2}$ of the space rotated over; hence, 35 spaces = $1\frac{1}{2}$ of the required rotation; therefore, $\frac{2}{11}$ of 35 = $38\frac{2}{11}$ spaces = $38\frac{2}{11}$ minutes after 4 o'clock.

Since the second hand rotates 60 times per hour, the hour and second hands will be together 60 times between 4 and 5 o'clock.

2. If the hour hand is 20 spaces or minutes ahead of the minute hand, how soon will they be together?

3. If the minute hand is 15 spaces or minutes ahead of the hour hand, how soon will they be opposite?

4. If the minute hand is 26 spaces ahead of the second hand, how soon will they be together?

5. How often will the second hand be with each of the other hands between 1 o'clock and 2 o'clock?

6. At what time between 4 and 5 o'clock will the second hand first be with each of the other two hands?

7. At what time between 3 and 4 o'clock are the hour and minute hands together?

8. At what time between 5 and 6 o'clock are the hour and minute hands opposite?

9. At what two times between 7 and 8 o'clock will the hour hand and minute hand be perpendicular to each other?

10. How many times between 4 and 5 o'clock will the second and minute hands be together? Find the first and last times.

11. How often between 8 and 9 o'clock will the hour hand and second hand be together? Find the first and last times.

TIME O'CLOCK PROBLEMS.

102.

1. If $\frac{3}{4}$ of the time past 8 A. M. equals $\frac{2}{3}$ of the time to 6 P. M.; find the time of day.

SOLUTION.—If $\frac{3}{4}$ of the time past 8 A. M. = $\frac{2}{3}$ of the time to 6 P. M., $\frac{1}{4}$ of the time past 8 A. M. = $\frac{1}{3}$ of $\frac{2}{3}$ = $\frac{2}{9}$ of the time to 6 P. M., and $\frac{4}{4}$ of the time past 8 A. M. = $4 \times \frac{2}{9} = \frac{8}{9}$ of the time to 6 P. M. Hence $\frac{8}{9} + \frac{9}{9} = \frac{17}{9}$ of the time to 6 P. M. = the time from 8 A. M. to 6 P. M. = 10 hours. If $\frac{17}{9}$ of the time to 6 P. M. = 10 hours, the time to 6 P. M. = $\frac{9}{17}$ of 10 hours = $\frac{90}{17}$ hours = $5\frac{5}{17}$ hours, and 6 hours − $5\frac{5}{17}$ hours = $\frac{12}{17}$ hours after noon. Therefore, it is $42\frac{6}{17}$ minutes after noon.

2. What is the time when the time past 8 A. M. equals the time to noon?

3. At what time in the day does the time to 6 P. M. equal $\frac{1}{2}$ the time past 3 P. M.?

4. If the time past 5 A. M. equals 3 times the time to 9 A. M., what time is it?

5. When does the time past noon equal $\frac{1}{2}$ the time past midnight?

6. At what time does the time past noon equal $\frac{3}{4}$ of the time to midnight?

7. At what time will $\frac{4}{5}$ of the time to noon equal $\frac{3}{7}$ of the time to midnight?

8. If $\frac{3}{10}$ of the time past 9 A. M. equal $\frac{6}{7}$ of the time to 9 P. M., what is the time?

9. What is the time when $\frac{2}{3}$ of time past noon equal $\frac{4}{5}$ of the time to midnight?

10. At what time does $\frac{3}{4}$ of the time past midnight equal $\frac{1}{2}$ the time past noon?

11. When does $\frac{2}{3}$ of the time past midnight equal $\frac{1}{2}$ of the time to midnight?

ROUND TRIP PROBLEMS.

103.

1. Samuel and Charles row the same round trip on a stream whose current is 2 miles per hour: Samuel started at 8 A. M., rowing up stream 2 miles per hr.: Charles started at 9 A. M., rowing up stream 3 miles per hr., overtaking Samuel $\frac{1}{2}$ of the way to the upper end of the trip; if each rests 1 hr. at the upper end of the trip, how long is each gone and how many miles in the round trip?

SOLUTION.—If Samuel starts at 8 A. M. rowing 2 miles per hr., he is 2 miles ahead of Charles who starts at 9 A. M. If Charles rows 3 miles per hour, he must row 6 miles, or two hours, to overtake Samuel. Hence the up trip is 12 miles and the round trip is 24 miles. Since Samuel rows up stream 2 miles per hr. and down stream 2+4 miles per hour, he will be 6 hr. on the up trip and 2 hr. on the down trip, and 1 hour rest makes 9 hr. for the round trip; and Charles rowing up stream 3 miles per hr. and down stream $3 + 4 = 7$ miles per hr. he will row the up trip in 4 hr. and the down trip in $1\frac{5}{7}$ hr., and 1 hr. rest makes $6\frac{5}{7}$ hr. on the round trip. Therefore, etc.

2. B can row 6 miles an hour on still water; what will be his rate up stream and his rate down stream if the current is 2 miles per hour?

3. A can row 5 miles an hour up stream and 8 miles an

hour down stream; find the rate of the current and A's rate of rowing on still water.

4. John can row 6 miles an hour on still water; how long a round trip can he make in 6 hours up and down a river whose rate of current is 3 miles per hour?

5. A farmer drove to town at the rate of 6 miles an hour, and after spending 2 hours in business transactions he drove home at the rate of 8 miles an hour; if he were gone five hours, how far did he live from town?

6. A train made a trip of 50 miles up the mountain and returned in 4 hours; if the stops aggregated 1 hour and the up rate was one-half the down rate, find these two rates of speed.

7. A steamer made an 80 mile round trip on a river in 10 hours, including 2 hours used in stops; find its rate of steaming on still water and the rate of the current, if it steamed 4 miles down stream in the same length of time that it steamed 3 miles up stream.

8. Peter can row a certain distance up stream in 3 hours and return in 2 hours; if the rate of the current is 1 mile per hour, find the distance he rows in the 5 hours.

9. Henry walked 3 miles an hour to get his bicycle which he rode back at the rate of 10 miles an hour; how far did he go if the round trip took him 5 hours?

10. A rides to town at the rate of 10 miles per hour and returns walking at the rate of 3 miles per hour, being $3\frac{1}{2}$ hours longer on the return trip; how far did he travel?

11. Two steamers, the first steaming 8 miles an hour and the second steaming 12 miles an hour on still water, start from the same wharf to make a round trip of 40 miles on a river whose current is 2 miles per hour, the first starting 1 hour before the second up stream; how long does it take each to make the round trip and how far from the starting place does the second boat pass the first; also meet it on the return trip?

CONDITIONAL DIVISION PROBLEMS.

104.

1. Alexander agreed to work 28 days for \$40 and 24 bushels of wheat, but becoming sick at the end of 21 days he received \$36 and 10 bushels of wheat; what was the price of the wheat per bushel?

SOLUTION.—Alexander worked $\frac{3}{4}$ of the time and should have had $\frac{3}{4}$ of \$40 + $\frac{3}{4}$ of 24 bushels = \$30 + 18 bushels; but he got \$6 more than \$30 and 8 bushels less than 18. Hence the 8 bushels are worth \$6, and 1 bushel is worth 75¢. Therefore, etc.

2. John and Matthew have equal sums of money, but if John gives Matthew $\frac{1}{4}$ of his and Matthew spends $\frac{1}{2}$ of all he then has, John will have \$6 more than Matthew; what sum has each?

3. Peter and Ben have each an equal number of marbles: if Peter gives Ben $\frac{1}{2}$ of his and then Ben gives Peter $\frac{1}{2}$ of all he then has, Peter will have 24 marbles more than Ben will have; how many marbles has each?

4. A and B have each a number of sheep equal to the other, but if A sells B $\frac{1}{4}$ of his and B then sells A $\frac{2}{5}$ of all he then has, A will then have 60 sheep more than B then has; how many has each?

5. George and Henry have each a certain sum of money, but after George earns \$30 of Henry's money and Henry earns \$20 of George's money he finds that he has $\frac{7}{8}$ as much money as George; how much had each at first if Henry had $\frac{9}{10}$ as much as George?

6. Charles has $\frac{2}{5}$ of the sum of his and Fred's marbles, but after Fred gives him 8 he has $\frac{3}{4}$ as many as Fred; how many had each at first?

7. Sam and Will go fishing: at the end of the first hour they share equally by Sam's giving Will 4 fish, and at the

end of the second hour by Will's giving Sam 12 fish; if they caught twice as many the second hour as they did the first and caught 84 altogether, how many fish did each catch each hour?

8. Frank, Fred, and Francis go nutting: Fred finds $\frac{1}{2}$ as many as Frank or 3 times as many as Francis the first hour, but at the end of the second hour Francis has twice as many as Frank, or $\frac{1}{3}$ as many as Fred; if they found 640 altogether and found 3 times as many the second hour as the first, how many did each find each hour?

9. John agreed to work one year for \$300 and a horse, but desiring to quit at the end of 8 months he got \$150 and a horse; find the value of the horse.

10. A agreed to work for 24 days for \$12 and 12 bushels of potatoes, but getting sick at the end of 16 days he received \$6 and 10 bushels of potatoes; find the value of 1 bushel of potatoes.

11. A father and son engage to work a year for \$640, but the father was absent for 3 months on account of sickness: they received \$540; find the monthly wages of each.

RACING PROBLEMS.

105.

1. In a walking race A is given 12 of his own steps the start, and loses by 15 of B's steps; find the length of the course if A takes 3 steps while B takes 4 steps, and if 3 of A's steps equal 2 of B's steps which are each 1 yard in length.

SOLUTION.—A's step is $\frac{1}{3}$ of 2 of B's steps = $\frac{2}{3}$ of 3 feet = 2 ft. Hence A walks 3×2 ft. = 6 ft. while B walks 4×3 ft. = 12 ft., consequently B gains 6 ft. of every 12 ft. that he walks. A has 12×2 ft. = 24 ft. the start. Hence, B must gain 24 ft. to overtake A, but he gains 15 of his own steps, or 45 ft., on A after overtaking him. B, consequently, gains $(24 + 45) = 69$ ft. on A in the race. Since B must walk

12 ft. to gain 6 ft., or 2 ft. to gain 1 ft., he must walk 2×69 ft. $= 138$ ft. to gain 69 ft. Hence, the length of the course is 138 ft. Therefore, etc.

2. In a race of 300 yards A runs 5 yards a second, and B runs 6 yards a second, but A has 5 seconds start of B; who finished first, and by how many yards?

3. In a race of 960 yards John has 24 yards start of James, but James runs 8 yards while John runs 6 yards; who finishes first, and by how many yards?

4. A dog sights a rabbit 20 rods ahead and gives chase: if the dog runs 5 rods in 2 seconds, and the rabbit runs 7 rods in 3 seconds, how far will the rabbit run before he is caught?

5. In a race of 840 rods Gideon has 40 steps the start of Edward, and takes 4 steps while Edward takes 3 steps: if 2 of Edward's steps equal 3 of Gideon's steps, who will finish first, and by how many rods?

6. A is 20 yards ahead of B and takes 6 steps while B takes 5 steps, but 5 of B's steps equal 8 of A's steps; how far will A walk before he is overtaken?

7. A hound ran 720 rods to catch a fox: what start had the fox if 2 leaps of the hound equal 5 leaps of the fox, and if he made 4 leaps while the fox made 7 leaps?

8. John ran 480 yards before he was overtaken by Jackson; how many yards start had John, if 5 of his steps equal 6 of Jackson's steps, and if he takes 2 steps while Jackson takes 3 steps?

9. A hare is 60 of his own leaps ahead of a hound in a chase: if the hound takes 2 leaps while the hare takes 3 leaps, and if 3 leaps of the hound equal 5 leaps of the hare, how many leaps will the hare and hound each take before the hare is overtaken?

10. Ralph and Reynolds are 60 yards apart and on opposite sides of a base, which each seeks to reach first; how far was each from the base, if Reynolds won by 5 yards by making 4

steps to Ralph's 3 steps, and by making 6 of his steps equal 5 of Ralph's steps?

11. A and B are 420 yards apart; how many steps will each take and how many yards will each walk to meet, if 4 of A's steps equal 5 of B's steps, and if A takes 5 steps while B takes 6 steps?

SHIFTING PARTS PROBLEMS.

106.

1. A has 3 watches and a chain: find the cost of each, if the first watch and chain cost twice as much as the second watch, or 3 times as much as the third watch, and if the second watch and chain cost 3 times as much as the first watch, and if the difference between the costs of the second and third watches is \$9.

SOLUTION.—Three times the cost of the third watch = twice the cost of the second watch = the cost of the first watch and chain. Hence, the third watch cost $\frac{1}{3}$ of 2 times = $\frac{2}{3}$ of the cost of the second watch, and $\frac{3}{3} - \frac{2}{3} = \frac{1}{3}$ of the cost of the second watch = \$9. Hence, the second watch cost \$27, and the third watch cost $\frac{2}{3}$ of \$27 = \$18. Consequently the first watch and chain cost 3 times \$18 = \$54. The second watch and chain cost 3 times as much as the first watch. Hence, the first watch and second watch and chain cost 4 times the first watch, but the cost of the first watch and chain and the second watch is \$54 + \$27 = \$81 = 4 times the cost of the first watch. Hence, the first watch cost $\frac{1}{4}$ of \$81 = \$20.25, and the chain cost \$54 − \$20.25 = \$33.75. Therefore, etc.

2. James weighs 80 pounds: John and James together weigh three times as much as James; find John's weight.

3. Henry has 60 cents: Henry and Peter together have four times as many cents as Peter; how many cents has Peter?

4. A's age is 30 years: A's and B's together equal three times B's age: B's and C's together equal twice A's age; find the ages of B and C respectively.

5. A company owning 3 railroads finds the combined lengths

of the first and second equal three times the length of the third, and, the combined lengths of the second and third equal four times the length of the first; if the third is 20 miles long, find the lengths of the first and second.

6. Find three numbers such that the sum of the first and second equals 5 times the first, and the sum of the second and third equals 3 times the second, if the third number is 48.

7. Find the amount of money A, B, C, and E each possess, if A and B together have twice as much as C, or three times as much as A, and if C and E together have 5 times as much as C, and if E has $120.

8. The distance from the first to the third station of a railroad is 4 times the distance from the second to the third: the distance from the second to the fourth is 3 times the distance from the third to the fourth, and the distance from the third to the fifth is twice the distance from the fourth to the fifth; find the length of the railroad, if it is 24 miles from the first to the second station.

9. A drover paid 5 times as much for a horse and colt as for the colt, 4 times as much for a cow and calf as for the calf: if the colt and calf cost twice as much as the cow, and if the cow cost $30, find the cost of the horse, colt, and calf, respectively.

10. Find four such numbers that the sum of the first and second equals 6 times the second, the sum of the second and third equals 4 times the third, and the sum of the third and fourth equals 3 times the fourth, if the second is 24.

11. A train running 30 miles per hour reaches its first stop in 20 minutes, 5 times this distance equal the distance from the first to the third stop: the distance from the second to the third stop equals $\frac{2}{3}$ of the distance from the start to the second stop; find the distances from the first to the second stop, and from the second to the third stop.

GAIN AND LOSS PROBLEMS.

107.

1. Harry spent 50¢ and then earned $\frac{2}{5}$ as much as he had left: he then spent 80¢ and then earned $\frac{1}{2}$ as much as he had left: he then spent \$1.50 and then earned $\frac{3}{5}$ as much as he had left: he then spent \$2.40 and found that he had nothing left; how much had he at first?

SOLUTION.—Before spending the \$2.40 he had $\frac{2}{5}+\frac{3}{5}=\frac{5}{5}$ of the last remainder, left by spending \$1.50. Hence, \$2.40 = $\frac{5}{5}$ of that remainder; and that remainder = $\frac{1}{5}$ of \$2.40 = \$1.50. Hence, \$1.50 + \$1.50 = \$3 = what he had before spending the \$1.50, when he had $\frac{2}{3}+\frac{1}{3}=\frac{3}{3}$ of the remainder left by spending the 80¢. Consequently, \$3 = $\frac{3}{3}$ of that remainder; and that remainder = $\frac{1}{3}$ of \$3 = \$2. Since \$2 + 80¢ = \$2.80 = what he had before spending the 80¢; and this \$2.80 = $\frac{5}{5}+\frac{2}{5}=\frac{7}{5}$ of the remainder after spending the 50¢. Hence, $\frac{1}{5}$ of \$2.80 = \$2 = the remainder after spending the 50¢; and \$2 + 50¢ = \$2.50 = the amount Harry had at first. Therefore, etc.

2. Samuel, having gained \$24, spent $\frac{1}{2}$ of all he then had, and found that he had remaining $\frac{3}{4}$ as much as at first; how much money had he at first?

3. After spending 40 cents Frances earned $\frac{2}{5}$ as much as she had remaining and found that she had $1\frac{1}{2}$ times as much as at first; how much had she at first?

4. A drover bought a lot of hogs and sold $\frac{1}{2}$ of them at $\frac{3}{4}$ the cost of half the lot, and the other $\frac{1}{2}$ at $1\frac{1}{2}$ times the cost of half the lot, thus gaining \$15 on the entire lot; what did the hogs cost him?

5. Edward, having a sum of money, earned $\frac{1}{2}$ as much more, then after losing 90 cents he found that he had $\frac{3}{4}$ as much as at first; how much had he at first?

6. Martha, having written $\frac{1}{2}$ her essay, spoiled 120 words with a blot, and then wrote 3 times as many as remained to finish the essay; how many words did her essay contain?

7. While resting in his boat the current carried Milton down stream $\frac{1}{5}$ of the distance he had rowed up: then after rowing up stream twice as far as he had rowed the first time he found that he was 6 miles from the starting place; how far did he row each time?

8. After spending 50 cents in the first store Jane borrows $\frac{1}{2}$ as much as she had left: after spending 23 cents in a second store she borrows $\frac{1}{5}$ as much as she had left: in the third store she spends all she had, which was \$1.20; how much had she at first?

9. A reporter, having written 78 words more than $\frac{1}{5}$ of his article before lunch, wrote twice as many after lunch as were written before lunch; how many words did the article contain?

10. Find that number that decreased by its $\frac{1}{5}$ and the remainder increased by 44 will give three times the number.

11. Find that number that increased by 24 and the sum decreased by $\frac{1}{3}$ of itself the remainder will be twice the number.

MIXTURE PROBLEMS.

108.

1. Samuel works 16 days and his father works 10 days, and together they get \$44.20, and at the same rate Samuel works 12 days and his father 14 days, and together they get \$49.40; find the daily wages of each.

SOLUTION.—In the second job Samuel works $\frac{3}{4}$ as long as in the first job; and if his father should work only $\frac{3}{4}$ as many days in the second job as he did in the first their combined wages should be $\frac{3}{4}$ of \$44.20 = \$33.15. \$49.40 − \$33.15 = \$16.25 = what the father got for $14 - \frac{3}{4}$ of $10 = 14 - 7\frac{1}{2} = 6\frac{1}{2}$ days = 6.5 days. Hence, \$16.25 ÷ 6.5 = \$2.50 = the father's daily wages; and \$25 = his wages for the 10 days of the first job and \$44.20 − \$25 = \$19.20 = Samuel's wages for his 16 days' work; and \$19.20 ÷ 16 = \$1.20 = Samuel's daily wages. Therefore, etc.

2. Eight pounds of 20 cent coffee mixed with 12 pounds of 15 cent coffee should sell at how much per pound in fairness to both parties?

3. A grocer mixes 15 pounds of 8 cent sugar with 5 cent sugar to sell at 6 cents a pound; how many pounds of 5 cent sugar does he use?

4. A grocer, having 40 cent molasses and 70 cent molasses, desires a new brand at 50 cents per gallon; in what ratio shall he mix the 40 cent and 70 cent molasses for the new brand?

5. A trucker sells 20 melons and 12 pumpkins for $6.20, and 30 melons and 40 pumpkins at the same rate for $11.50; find the price of each.

6. If John works 10 days and his father works 4 days, and together they get $14, find the daily wages of each if both together can earn $2.30 per day.

7. A bought 12 calves for $52, paying $5 each for the larger ones and $3 each for the smaller; how many did he get of each kind?

8. John has 36 gallons of vinegar worth 20 cents per gallon, but desiring to sell it at 15 cents per gallon he adds water enough to insure against loss; how many gallons of water did he add?

9. Robert bought equal numbers of oranges at 3¢ each and 5¢ each, and sold them 2 for 9¢, thereby gaining 35 cents; how many did he get at each price?

10. Samuel bought a certain number of lemons at 4¢ each and twice as many at 5¢ each, and gained 80¢ by selling them at the rate of 3 for 16 cents; how many did he buy at each price?

11. A fruit-dealer bought a certain number of apples at 1¢ each, twice as many at 2¢ each, and three times as many at $2\frac{1}{2}$¢ each, and gained $2.40 by selling all at the rate of 3 for 5¢; how many had he at each price?

PROBLEMS OF POWERS AND ROOTS.

109.

1. Four times the square of a number is 588 less than the square of 4 times the number; find the number.

SOLUTION.—Four times the square of the number = 4 times the number × the number, while the square of 4 times the number = 4 times the number × 4 times the number; but 4 × number × number = $\frac{1}{4}$ of 4 times 4 × number × number. Hence, 4 times 4 × number × number − 4 × number × number = 3 times 4 × number × number = 588; and $\frac{1}{3}$ of 588 = 196 = 4 × number × number, or 4 times the square of the number. Therefore, $\frac{1}{4}$ of 196 = 49 = the square of the number; and *the square root of 49 = 7 = the number*

2. A room $\frac{4}{5}$ as wide as it is long and $\frac{3}{4}$ as high as it is wide contains 7500 cubic feet; find its dimensions.

SOLUTION.—Since $\frac{4}{5}$ of the width = $\frac{3}{5}$ of the length, $\frac{1}{5}$ of the length is the greatest common measure of the three dimensions. Consequently, the floor contains 20 times the square of this common measure; and the room contains 3 × 20 = 60 times the cube of this common measure. Hence, 7500 cu. ft. ÷ 60 = 125 cu. ft. = the number of cu. ft. in the cube of this measure; and the cube root of 125 = 5 = this measure. Therefore, 5 × 5 = 25 ft., and 4 × 5 = 20 ft., and 3 × 5 = 15 ft., are the dimensions.

3. The square of twice a certain number is 72 more than twice the square of the number; find the number.

4. The square of 3 times a certain number is 150 more than 3 times the square of the number; find the number.

5. The square of 5 times a certain number is 1280 more than 5 times the square of the number; find the number.

6. The cube of twice a number is 875 more than the cube of the number; find the number.

7. The cube of twice a number is 384 more than twice the cube of the number; find the number.

8. A rectangle, containing 242 square feet, is twice as long as it is wide; find its dimensions.

9. A rectangle, containing 294 square inches, is $\frac{2}{3}$ as wide as it is long; find its dimensions.

10. A right rectangular prism twice as long as it is wide and twice as high as it is long contains 216 cubic inches; find its dimensions.

11. A tank $\frac{2}{3}$ as wide as it is long and 3 times as high as it is wide contains 288 cubic inches; find its dimensions.

12. A room $\frac{3}{4}$ as wide as it is long and $\frac{5}{8}$ as high as it is long contains 6480 cubic feet; find its dimensions.

MENSURATION PROBLEMS.

110.

NOTE.—The square on the hypotenuse of a right-angled triangle equals the sum of the squares on the other two sides.

1. Find the dimensions of a rectangle three times as long as it is wide that contains 15 sq. in. of area for every linear inch of perimeter.

SOLUTION.—Since the rectangle is three times as long as it is wide, the perimeter is 8 times the width. Hence, the number of sq. in. of area is 15 times 8 times the number of linear inches in the width; and for each inch of width there are 8 times 15, or 120 sq. in. of area. Therefore, the length is 120 inches and the width is 40 inches.

2. Find the dimensions of a rectangular prism twice as long as it is wide and twice as high as it is long and containing 10 cubic inches for every sq. in. of surface.

SOLUTION.—Since the rectangular prism is twice as long as it is wide and twice as high as it is long, the surface is 14 times one end. Hence, there are 10 times 14 times as many cubic inches as there are square inches on one end; and there are 140 cubic inches for every sq. in. on one end. Consequently, the height is 140 inches, the length is 70 in., and the width is 35 in.

3. John and Peter started from the same point, John going 6 miles east and Peter going 8 miles north; how far apart are they then?

4. A 20 foot rope fastened by an end to the top of a 12 foot stake will allow a calf fastened to the other end to graze over a circle how many feet in diameter?

5. A certain square contains 1 sq. in. of area for each linear inch of perimeter; find the side of the square.

6. Find the side of the square that contains 1 sq. ft. of area for every linear inch of perimeter.

7. Find the side of the square that contains 1 sq. yd. of area for every linear foot of perimeter.

8. Find the rectangle twice as long as it is wide that contains 1 sq. ft. of area for every linear inch of perimeter.

9. Find the edge of the cube that contains 1 cubic inch of contents for every sq. in. of surface.

10. Find the edge of the cube that contains 1 cubic yard for every sq. ft. of surface.

11. Find the dimensions of the square right prism that contains 1 cubic foot of contents for every sq. ft. of surface if the prism is twice as long as it is wide or thick.

12. Find the side of the base, the altitude, and the contents of the right square pyramid that contains 1 sq. in. of base for every linear inch of perimeter of base, and 1 cubic inch of contents for every sq. in. of surface of base.

111.

MISCELLANEOUS PROBLEMS.

NOTE.—Similar areas are to each other as the squares of their like dimensions.

1. Find the number which increased by its $\frac{1}{2}$ and $\frac{1}{3}$ will give 99.

2. The double of what number, increased by $\frac{3}{4}$ and $\frac{2}{5}$ of the number will give 126?

3. A starts to walk at 8 A. M. and B starts from the same place at 10 A. M. to overtake A, whom he overtakes at noon; if their combined rate is 6 miles per hour, find the distance each walked.

4. John, Henry, and Samuel travel from A to B, reaching B at the same time; if John was 6 hours on the trip, Henry 4 hours, and Samuel 3 hours, and if their combined rate was 39 miles per hour, how far is it from A to B?

5. Mr. Smith's son John is 15 years old and his son Peter is 18 years old when he puts a sum of money at 10% simple interest for each: when the boys shall be of age their amounts will be equal; how much does he put out for each if the sum for both is $5800?

6. A mother leaves $11,700 at 5% simple interest to her three sons, aged respectively 13 yr., 15 yr., and 17 yr., in such shares that each shall have the same amount when he is of age, and thereby comes into possession of it; find the amount of each son's share.

7. A sold each of two horses for $120, gaining 25% on one and losing 25% on the other; did he gain or lose on the two transactions? *If so, how much?*

8. A merchant marks goods, so that he can sell at 20% off for $11, and still gain 10%; *find the marked price.*

9. A father having a son 15 years old and a daughter 10 years old desires to put $8200 at 5% simple interest, dividing it so that the amount of the son's share when he is 21 shall be twice the amount of the daughter's when she is 18 years old; how much is put out for each?

10. A widow has 2 daughters and 1 son, for whom she puts $6790 at 10% simple interest in such shares that the son shall have as large an amount at 21 as the sum of the amounts of the daughters at 18 years of age, who then have equal amounts;

if the daughters are 10 and 12 respectively and the son is 8 years old, find the amount put to the credit of each.

11. Henry starts the day's trading with a certain sum of money and sold the first purchase at 25% gain, the second purchase at 50% gain, and the third purchase at 75% loss, when he found that he had $24; how much had he to start with?

12. George and Samuel do a job of work at which George does $\frac{3}{4}$ as much as Samuel, but Samuel's part was only $\frac{1}{2}$ as difficult as George's part of the work; what part of the pay should each receive?

13. A water tank is supplied by a 6 inch square pipe; how many outlets, each 2 inches square, may the tank have so that if they and the supply pipe are left open the water in the tank remains constant in amount?

14. The perimeter of a square is twice the perimeter of another square; what is the ratio of their areas?

15. A certain rectangle twice as long as a certain square contains the same area; find the ratio of their perimeters.

16. A certain square has a perimeter equal to $\frac{2}{3}$ the perimeter of a certain rectangle twice as long as wide; find the ratio of their areas.

17. A square inscribed in a circle whose radius is 10 feet, has how many square feet of area?

18. A square 40 feet on a side has a square within formed by joining the midpoints of adjacent sides; find the area of the inner square.

19. What is the ratio of the surfaces, the ratio of the sums of the edges, and the ratio of contents of two cubes, one of which is twice as long as the other?

20. Sixteen 2-inch drain pipes flow into a larger drain pipe; what is the least size it can be to accommodate their capacity?

21. A rectangle containing 972 sq. ft. has dimensions in the ratio of 3 to 4; find these dimensions.

22. After spending \$12 and $\frac{1}{5}$ of the remainder of his money, and $\frac{3}{4}$ of the second remainder, and $\frac{1}{4}$ of the third remainder, John found that he had $\frac{1}{5}$ of his money left; how many dollars had he at first?

23. Find the dimensions of a cube that contains 6 times as many sq. in. of surface as it contains cubic in. of contents.

24. Find dimensions of the cube having twice as many sq. in. of surface as it contains cubic in. of contents.

25. Find the dimensions of the cube that has 726 sq. in. of surface.

26. Find the surface of the cube the sum of whose edges is 300 inches.

27. A rectangular field 2 by 3 cost \$40 for fencing at 50¢ per rod: find its area?

28. John first spent $\frac{1}{2}$ his money and \$$\frac{1}{2}$ more, then $\frac{1}{2}$ of the remainder and \$$\frac{1}{2}$ more, and so continued for 5 expenditures, when all his money was spent; how much had he at first?

29. George spent in his first purchase 80¢ more than $\frac{2}{5}$ of his money, in the second 40¢ more than $\frac{1}{3}$ of the remainder, in the third purchase 50¢ more than $\frac{1}{2}$ of the second remainder, and in the fourth purchase 60¢ more than $\frac{2}{3}$ of the third remainder, and had nothing left; how much had he at first?

30. A cistern holding 1339 gallons is filled by two pipes, one 2 inches in diameter and one 3 inches in diameter; how many gallons does each pipe pour into the cistern in filling it?

31. In a 6 miles race A beat B by $\frac{1}{8}$ mile, and C beat A by 9 minutes, and B by $\frac{1}{8}$ mile; find the rate of each runner per minute.

32. After 20 days' work by each John received \$5 more than Henry, and James received 2 days' wages more than John, or \$9 more than Henry; find the daily wages of each.

33. If Edward bought 24 oranges for 72 cents, paying 5¢ each for the best and 2¢ each for the rest, how many of each kind did he buy?

34. John is 28 years younger than his father, $\frac{3}{4}$ of whose age is 12 years more than John's age; find the age of each.

35. A and B contribute to the erection of a schoolhouse $\frac{3}{4}$ mile from A's home and $1\frac{1}{2}$ miles from B's home, in proportion to the reciprocals of their distances from the schoolhouse; if their joint contribution is \$340, how much did each contribute?

36. A farmer tills 3 acres for every 7 cows and pastures 2 acres for every 5 cows that he keeps; how many cows may he thus keep on 70 acres of land?

37. If a stock raiser find it necessary to till 3 acres in grain for every 8 horses, 2 acres in meadow for every 3 horses, and 3 acres of pasture for every 5 horses; how many acres must be cultivated to keep 120 horses?

38. A carriage with wheels 5 ft. and 6 ft. in circumference will travel how far before the less wheel will have gained 60 rotations on the larger?

39. A grocer that uses a pound weight $\frac{1}{2}$ oz. too heavy in buying butter cheats his patron how much in buying \$6.40 worth of butter?

40. If a grocer buys butter by a pound weight $\frac{1}{2}$ oz. too heavy, and sells by a pound weight $\frac{1}{2}$ oz. too light, how much does he filch from his patrons in buying butter for \$9.60 and selling the same at \$12.40?

41. Mr. Smith left \$35,000 by will to his widow, his son, and his daughter: if the son died, the widow should have $\frac{2}{3}$, but if the daughter died the son should have $\frac{3}{4}$: all three lived; find each share as indicated by the will.

42. Why is the product of any two consecutive even numbers divisible by 8?

43. Why is the product of any three consecutive numbers divisible by 6?

44. Why is the product of any four consecutive numbers divisible by 24?

45. If $\frac{3}{4}$ of a mixture of water and alcohol is alcohol, and by adding 12 gallons of water the mixture has equal parts of each, how many gallons were there of each at first?

46. Find the area of a rectangle $\frac{3}{4}$ as wide as it is long, and having its diagonal 35 feet.

47. Find the dimensions of a rectangle $\frac{4}{5}$ as wide as it is long, containing 1620 square inches.

48. Find the area of a rectangle $\frac{5}{7}$ as wide as it is long whose perimeter is 288 rods.

49. A silversmith has a mixture of silver and copper, weighing 60 oz., and containing 4 oz. of copper; how many oz. of copper should be added to make 1 oz. of copper to 12 oz. of silver?

50. A chemist has a mixture of water and acid, measuring 36 gallons and containing 6 gallons of acid; how much water should be added so that the mixture shall be $\frac{1}{8}$ acid?

51. John bought a certain number of melons at 12¢ each, and had 48 cents left: if he had bought 3 times as many squashes at 8¢ each he would have lacked 60¢ for payment, how much money had John?

52. If $\frac{3}{5}$ of Henry's age 8 years ago equals $\frac{1}{2}$ of his age 4 years hence, how old is he?

53. A watch that gains 5 minutes in 20 hours, and is 10 minutes fast Monday noon, will mark 6 o'clock at what time Tuesday afternoon?

54. Find the number of which the square of its double is 688 more than double the square of its half.

55. A drover sold two horses for the same price, gaining 15% on one and losing 15% on the other: if his loss on the two sales was $10, find the cost price of each horse.

THE METRIC SYSTEM.

The *Metric System* is a system of weights and measures which is based upon a unit called a meter.

In 1795, France adopted this system, and it was regarded as so great an improvement upon the older methods, that it has since been adopted in Germany, Spain, Portugal, Switzerland, Italy, Austria, Sweden, Denmark, Belgium, Holland, British India, Turkey, Mexico, Brazil, and many other countries of South America.

The United States of America and Great Britain also authorized its use, and in many countries throughout the world it has been made compulsory. In our country its use has been confined principally to the sciences, the Coast Survey, and the Post Office Department.

The names of the units of measure are—

1. The METER for lengths.
2. The ARE, or square decameter, for surfaces.
3. The STERE, or cubic meter, for volumes.
4. The LITER, or cubic decimeter, for capacities.
5. The GRAM, or cubic centimeter, for weights.

Lower denominations are obtained by prefixing to the name of the unit the following:

MILLI = one-thousandth of the unit.
CENTI = one-hundredth of the unit.
DECI = one-tenth of the unit.

Higher denominations are obtained by prefixing to the name of the unit the following:

DECA = ten times the unit.
HECTO = one hundred times the unit.
KILO = one thousand times the unit.
MYRIA = ten thousand times the unit.

The Primary Unit of the system is the *meter*. It is one ten millionth part of the distance from the equator to either pole, measured on the earth's surface at the level of the sea, and is nearly equal to 39.37 inches.

The following are the tables used in the metric system:

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LINEAR MEASURE.

10 millimeters (mm.)	= 1 centimeter	(cm.)
10 centimeters	= 1 decimeter	(dm.)
10 decimeters	= 1 meter	(m.)
10 meters	= 1 decameter	(Dm.)
10 decameters	= 1 hectometer	(Hm.)
10 hectometers	= 1 kilometer	(Km.)
10 kilometers	= 1 myriameter	(Mm.)

EQUIVALENTS.

The DECIMETER is about 4 inches.
The METER is about 3 ft. $3\frac{3}{8}$ inches.
The KILOMETER is about $\frac{5}{8}$ of a mile.

NOTE.—The teacher should have the pupils fix these values well in mind by means of concrete illustrations.

How many—

1. Meters in a kilometer? Hectometer? Myriameter?
2. Decimeters in a meter? Centimeters? Millimeters?
3. Meters in a decameter? Hectometer? Kilometer?

SURFACE MEASURE.

100 sq. millimeters (sq. mm.)	= 1 sq. centimeter	(sq. cm.)
100 sq. centimeters	= 1 sq. decimeter	(sq. dm.)
100 sq. decimeters	= 1 sq. meter	(sq. m.)
100 sq. meters	= 1 sq. decameter	(sq. Dm.)
100 sq. decameters	= 1 sq. hectometer	(sq. Hm.)
100 sq. hectometers	= 1 sq. kilometer	(sq. Km.)
100 sq. kilometers	= 1 sq. myriameter	(sq. Mm.)

EQUIVALENTS.

The SQUARE METER is about 10¾ sq. ft., and is used in measuring surfaces?

The SQUARE DECAMETER, or ARE, is nearly 4 sq. rd., and the HECTARE is about 2½ acres.

How many—

1. Sq. meters in a sq. decameter? In a sq. hectometer?
2. Sq. decameters in a sq. hectometer? In a sq. kilometer?
3. Sq. centimeters in a sq. decimeters? In a sq. meter?

CUBIC MEASURE.

1000 cu. millimeters (cu. mm.)	= 1 cu. centimeter	(cu. cm.)
1000 cu. centimeters	= 1 cu. decimeter	(cu. dm.)
1000 cu. decimeters	= 1 cu. meter = 1 stere.	

EQUIVALENTS.

The CUBIC METER, or STERE, is about 1⅓ cu. yd., and is used for measuring ordinary volumes or solids.

How many—

1. Cubic millimeters in a cubic centimeter?
2. Cubic centimeters in a cubic decimeter?
3. Cubic centimeters in a cubic meter?

Liquid or Dry Measure.

10 milliters (ml.)	= 1 centiliter	(cl.)
10 centiliters	= 1 deciliter	(dl.)
10 deciliters	= 1 liter	(l.)
10 liters	= 1 decaliter	(Dl.)
10 decaliters	= 1 hectoliter	(Hl.)
10 hectoliters	= 1 kiloliter	(Kl.)
10 kiloliters	= 1 myrialiters	(Ml.)

Equivalents.

A Cubic Decimeter, or **Liter**, is the unit of the measure of capacity. It is equal to a cube whose edge is $\frac{1}{10}$ of a meter, and equivalent to about $1\frac{1}{16}$ liquid quarts, or $\frac{9}{10}$ of a quart dry measure.

The **Hectoliter** is about $2\frac{5}{8}$ bushels, and is used in measuring grain, vegetables, fruits, etc.

How many—

1. Centiliters in a liter? In a deciliter?
2. Deciliters in a decaliter? In a hectoliter?
3. Liters in a kiloliter? In a myrialiter?

Weight.

10 milligrams (mg.)	= 1 centigram	(cg.)
10 centigrams	= 1 decigram	(dg.)
10 decigrams	= 1 gram	(g.)
10 grams	= 1 decagram	(Dg.)
10 decagrams	= 1 hectogram	(Hg.)
10 hectograms	= 1 kilogram	(Kg.)
10 kilograms	= 1 myriagram	(Mg.)

Equivalents.

A Cubic Centimeter, or **Gram**, is the unit of weight. It is equal to a cube whose edge is $\frac{1}{100}$ of a meter, and is equiva-

lent to about $\frac{1}{28}$ of a Troy ounce. It is used chiefly in weighing precious metals and jewels and in mixing medicines.

The **Kilogram** is equal to about $2\frac{1}{5}$ pounds avoirdupois, and is used in weighing common articles.

The **Tonneau**, or Metric Ton, is about 2200 lbs., and is used in weighing heavy articles.

How many—

1. Grams in a decagram? In a hectogram?
2. Decagrams in a kilogram? In a myriagram?
3. Grams in a kilogram? In a myriagram?

MISCELLANEOUS PROBLEMS.

1. How many decimeters in a foot? In a yard?
2. If a meter is 3 ft. $3\frac{3}{8}$ inches, how much will two meters equal?
3. How many meters of wire can be cut from a piece of wire containing 5 yards?
4. If 10 meters of cloth cost \$20, how much will be gained by selling it at 30 cents a decimeter?
5. A man walked 5 kilometers in an hour; how far will he travel in 10 hours?
6. If a train goes at the rate of 5 myriameters an hour, how long will it take it to run 22.5 myriameters?
7. How many cubic feet in 2 steres? Cubic yards?
8. If 2 steres of wood are burned in 1 day, how long will 40 steres last?
9. Mr. Disston bought a farm containing 40 hectares at \$500 a hectare, and sold it at \$300 per acre; how much did he gain?
10. How many hectares in a rectangular farm 200 meters long and 100 meters wide? What is it worth at \$500 per acre?