Grade 8 Advanced Workbook

25 lessons · printable · answer key at the back

Name _____ Date _____

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Exponent Rules

WORKED EXAMPLE

$10^{13} \times 10^{1} = 10^{n}$, n = 14

1. Laws of exponents

Write each product as one power. Give the exponent n.

1 $2^{8} \times 2^{4} = 2^{n}$, n = ___

2 $9^{7} \times 9^{3} = 9^{n}$, n = ___

3 $8^{9} \times 8^{2} = 8^{n}$, n = ___

4 $8^{4} \times 8^{6} = 8^{n}$, n = ___

5 $8^{8} \times 8^{1} = 8^{n}$, n = ___

6 $8^{3} \times 8^{10} = 8^{n}$, n = ___

7 $4^{2} \times 4^{3} = 4^{n}$, n = ___

8 $7^{9} \times 7^{8} = 7^{n}$, n = ___

9 $9^{5} \times 9^{1} = 9^{n}$, n = ___

10 $12^{12} \times 12^{6} = 12^{n}$, n = ___

11 $8^{5} \times 8^{5} = 8^{n}$, n = ___

12 $3^{11} \times 3^{5} = 3^{n}$, n = ___

13 $5^{8} \times 5^{1} = 5^{n}$, n = ___

14 $5^{5} \times 5^{4} = 5^{n}$, n = ___

15 $3^{2} \times 3^{4} = 3^{n}$, n = ___

16 $3^{8} \times 3^{3} = 3^{n}$, n = ___

17 $12^{13} \times 12^{6} = 12^{n}$, n = ___

18 $10^{4} \times 10^{7} = 10^{n}$, n = ___

19 $4^{5} \times 4^{6} = 4^{n}$, n = ___

20 $12^{12} \times 12^{1} = 12^{n}$, n = ___

21 $3^{15} \times 3^{2} = 3^{n}$, n = ___

22 $8^{3} \times 8^{12} = 8^{n}$, n = ___

23 $10^{10} \times 10^{8} = 10^{n}$, n = ___

24 $6^{4} \times 6^{5} = 6^{n}$, n = ___

25 $4^{6} \times 4^{6} = 4^{n}$, n = ___

26 $11^{9} \times 11^{1} = 11^{n}$, n = ___

27 $7^{2} \times 7^{14} = 7^{n}$, n = ___

28 $8^{7} \times 8^{10} = 8^{n}$, n = ___

29 $2^{9} \times 2^{4} = 2^{n}$, n = ___

30 $5^{6} \times 5^{6} = 5^{n}$, n = ___

31 $5^{3} \times 5^{5} = 5^{n}$, n = ___

32 $2^{1} \times 2^{12} = 2^{n}$, n = ___

33 $12^{3} \times 12^{12} = 12^{n}$, n = ___

34 $2^{15} \times 2^{3} = 2^{n}$, n = ___

35 $7^{11} \times 7^{5} = 7^{n}$, n = ___

36 $6^{6} \times 6^{7} = 6^{n}$, n = ___

37 $12^{8} \times 12^{6} = 12^{n}$, n = ___

38 $6^{1} \times 6^{10} = 6^{n}$, n = ___

39 $7^{2} \times 7^{12} = 7^{n}$, n = ___

40 $3^{1} \times 3^{4} = 3^{n}$, n = ___

41 $9^{7} \times 9^{11} = 9^{n}$, n = ___

42 $7^{1} \times 7^{6} = 7^{n}$, n = ___

43 $4^{6} \times 4^{9} = 4^{n}$, n = ___

44 $11^{6} \times 11^{3} = 11^{n}$, n = ___

Square and Cube Roots

WORKED EXAMPLE $\sqrt{64} = 8$

2. Square and cube roots

Find each root. Check the symbol before you answer.

1 $\sqrt{729} =$ ___
2 $\sqrt[3]{1000} =$ ___
3 $\sqrt{676} =$ ___
4 $\sqrt[3]{27} =$ ___
5 $\sqrt{400} =$ ___
6 $\sqrt[3]{125} =$ ___
7 $\sqrt[3]{1728} =$ ___
8 $\sqrt{576} =$ ___
9 $\sqrt[3]{343} =$ ___
10 $\sqrt[3]{216} =$ ___
11 $\sqrt{625} =$ ___
12 $\sqrt{841} =$ ___
13 $\sqrt{900} =$ ___
14 $\sqrt{256} =$ ___
15 $\sqrt[3]{512} =$ ___
16 $\sqrt[3]{1331} =$ ___
17 $\sqrt{484} =$ ___
18 $\sqrt[3]{729} =$ ___
19 $\sqrt[3]{8} =$ ___
20 $\sqrt{324} =$ ___
21 $\sqrt[3]{64} =$ ___
22 $\sqrt{529} =$ ___
23 $\sqrt{196} =$ ___
24 $\sqrt{441} =$ ___
25 $\sqrt{361} =$ ___
26 $\sqrt{169} =$ ___
27 $\sqrt{784} =$ ___
28 $\sqrt{289} =$ ___
29 $\sqrt{25} =$ ___
30 $\sqrt{49} =$ ___
31 $\sqrt{4} =$ ___
32 $\sqrt{9} =$ ___
33 $\sqrt{100} =$ ___
34 $\sqrt{225} =$ ___
35 $\sqrt{144} =$ ___
36 $\sqrt{36} =$ ___
37 $\sqrt{16} =$ ___
38 $\sqrt{81} =$ ___

3. Laws of exponents

Write each product as one power. Give the exponent n.

39 $12^{8} \times 12^{4} = 12^{n}$, n = ___
40 $5^{2} \times 5^{4} = 5^{n}$, n = ___
41 $9^{7} \times 9^{3} = 9^{n}$, n = ___
42 $12^{4} \times 12^{2} = 12^{n}$, n = ___
43 $11^{9} \times 11^{3} = 11^{n}$, n = ___
44 $8^{8} \times 8^{1} = 8^{n}$, n = ___
45 $2^{5} \times 2^{11} = 2^{n}$, n = ___
46 $3^{13} \times 3^{5} = 3^{n}$, n = ___
47 $4^{2} \times 4^{2} = 4^{n}$, n = ___
48 $10^{3} \times 10^{3} = 10^{n}$, n = ___
49 $9^{5} \times 9^{1} = 9^{n}$, n = ___
50 $6^{11} \times 6^{3} = 6^{n}$, n = ___
51 $7^{5} \times 7^{11} = 7^{n}$, n = ___
52 $3^{11} \times 3^{5} = 3^{n}$, n = ___
53 $4^{5} \times 4^{8} = 4^{n}$, n = ___
54 $10^{11} \times 10^{7} = 10^{n}$, n = ___
55 $12^{1} \times 12^{5} = 12^{n}$, n = ___
56 $8^{7} \times 8^{9} = 8^{n}$, n = ___
57 $12^{9} \times 12^{10} = 12^{n}$, n = ___
58 $10^{4} \times 10^{7} = 10^{n}$, n = ___

Estimating Roots

WORKED EXAMPLE

$\sqrt{83} > 9$

$9^2 = 81$
$10^2 = 100$
$81 < 83 < 100$
$\sqrt{83}$ is between 9 and 10
$\sqrt{83} > 9$

4. Between which whole numbers

Each root lies between two whole numbers. Write the smaller one.

1 $\sqrt{260} > \_\_\_$

2 $\sqrt{419} > \_\_\_$

3 $\sqrt{299} > \_\_\_$

4 $\sqrt{471} > \_\_\_$

5 $\sqrt{267} > \_\_\_$

6 $\sqrt{464} > \_\_\_$

7 $\sqrt{475} > \_\_\_$

8 $\sqrt{232} > \_\_\_$

9 $\sqrt{436} > \_\_\_$

10 $\sqrt{370} > \_\_\_$

11 $\sqrt{197} > \_\_\_$

12 $\sqrt{482} > \_\_\_$

13 $\sqrt{453} > \_\_\_$

14 $\sqrt{258} > \_\_\_$

15 $\sqrt{375} > \_\_\_$

4. Between which whole numbers (continued)

Each root lies between two whole numbers. Write the smaller one.

16 $\sqrt{373} > \_\_\_$

17 $\sqrt{352} > \_\_\_$

18 $\sqrt{413} > \_\_\_$

19 $\sqrt{450} > \_\_\_$

20 $\sqrt{304} > \_\_\_$

21 $\sqrt{422} > \_\_\_$

5. To the nearest whole number

Round each root to the nearest whole number.

22 $\sqrt{300} \approx \_\_\_$

23 $\sqrt{416} \approx \_\_\_$

24 $\sqrt{246} \approx \_\_\_$

25 $\sqrt{485} \approx \_\_\_$

26 $\sqrt{354} \approx \_\_\_$

27 $\sqrt{425} \approx \_\_\_$

28 $\sqrt{456} \approx \_\_\_$

29 $\sqrt{224} \approx \_\_\_$

30 $\sqrt{470} \approx \_\_\_$

5. To the nearest whole number (continued)

Round each root to the nearest whole number.

31 $\sqrt{434} \approx$ ___

32 $\sqrt{292} \approx$ ___

33 $\sqrt{455} \approx$ ___

34 $\sqrt{486} \approx$ ___

35 $\sqrt{222} \approx$ ___

36 $\sqrt{489} \approx$ ___

37 $\sqrt{405} \approx$ ___

38 $\sqrt{291} \approx$ ___

39 $\sqrt{465} \approx$ ___

40 $\sqrt{499} \approx$ ___

41 $\sqrt{303} \approx$ ___

42 $\sqrt{429} \approx$ ___

6. To the nearest tenth

Round each root to one decimal place.

43 $\sqrt{293} \approx$ _____

44 $\sqrt{497} \approx$ _____

45 $\sqrt{90} \approx$ _____

6. To the nearest tenth (continued)

Round each root to one decimal place.

46 $\sqrt{317} \approx$ _____

47 $\sqrt{175} \approx$ _____

48 $\sqrt{424} \approx$ _____

49 $\sqrt{374} \approx$ _____

50 $\sqrt{268} \approx$ _____

51 $\sqrt{113} \approx$ _____

52 $\sqrt{407} \approx$ _____

53 $\sqrt{362} \approx$ _____

54 $\sqrt{19} \approx$ _____

55 $\sqrt{421} \approx$ _____

56 $\sqrt{387} \approx$ _____

57 $\sqrt{389} \approx$ _____

58 $\sqrt{38} \approx$ _____

Rational and Irrational Numbers

WORKED EXAMPLE

$\sqrt{576}$ **Rational** / Irrational

7. Rational or irrational

Is each number rational or irrational? Circle one.

1 $\sqrt{484}$ Rational / Irrational

2 $\sqrt{28}$ Rational / Irrational

3 $\sqrt{67}$ Rational / Irrational

4 $\sqrt[3]{729}$ Rational / Irrational

5 $\sqrt[3]{1331}$ Rational / Irrational

6 $\sqrt{121}$ Rational / Irrational

7 $\sqrt[3]{1000}$ Rational / Irrational

8 $\sqrt{25}$ Rational / Irrational

9 $\sqrt[3]{512}$ Rational / Irrational

10 $\sqrt{4}$ Rational / Irrational

11 $\sqrt{100}$ Rational / Irrational

12 $\sqrt[3]{1728}$ Rational / Irrational

13 $\sqrt{142}$ Rational / Irrational

14 $\sqrt{50}$ Rational / Irrational

15 $\sqrt{118}$ Rational / Irrational

16 $\sqrt{9}$ Rational / Irrational

17 $\sqrt{66}$ Rational / Irrational

18 $\sqrt{49}$ Rational / Irrational

19 $\sqrt{13}$ Rational / Irrational

20 $\sqrt{101}$ Rational / Irrational

21 $\sqrt[3]{343}$ Rational / Irrational

22 $\sqrt{102}$ Rational / Irrational

23 $\sqrt{170}$ Rational / Irrational

24 $\sqrt{33}$ Rational / Irrational

25 $\sqrt{628}$ Rational / Irrational

26 $\sqrt{624}$ Rational / Irrational

27 $\sqrt{528}$ Rational / Irrational

28 $\sqrt{361}$ Rational / Irrational

29 $\sqrt{439}$ Rational / Irrational

30 $\sqrt{625}$ Rational / Irrational

31 $\sqrt{36}$ Rational / Irrational

32 $\sqrt{529}$ Rational / Irrational

33 $\sqrt{167}$ Rational / Irrational

34 $\sqrt{83}$ Rational / Irrational

35 $\sqrt{225}$ Rational / Irrational

36 $\sqrt{34}$ Rational / Irrational

37 $\sqrt[3]{27}$ Rational / Irrational

8. Laws of exponents

Write each product as one power. Give the exponent n.

38 $2^{12} \times 2^{7} = 2^{n}$, n = ___

39 $12^{8} \times 12^{4} = 12^{n}$, n = ___

40 $5^{2} \times 5^{4} = 5^{n}$, n = ___

41 $6^{9} \times 6^{10} = 6^{n}$, n = ___

42 $10^{3} \times 10^{3} = 10^{n}$, n = ___

43 $9^{5} \times 9^{1} = 9^{n}$, n = ___

8. Laws of exponents (continued)

Write each product as one power. Give the exponent n.

44 $6^{11} \times 6^{3} = 6^{n}$, n = ___

45 $4^{2} \times 4^{9} = 4^{n}$, n = ___

46 $5^{5} \times 5^{4} = 5^{n}$, n = ___

47 $6^{12} \times 6^{3} = 6^{n}$, n = ___

Scientific Notation

WORKED EXAMPLE $4.4 \times 10^4 = 44000$

9. Writing numbers in full

Write each number in standard form.

1 $7.5 \times 10^6 =$ _____
2 $5.2 \times 10^7 =$ _____
3 $3.4 \times 10^6 =$ _____
4 $4.8 \times 10^8 =$ _____
5 $9.2 \times 10^5 =$ _____
6 $9.1 \times 10^7 =$ _____
7 $6.4 \times 10^8 =$ _____
8 $6.9 \times 10^5 =$ _____
9 $3.6 \times 10^7 =$ _____
10 $6.2 \times 10^7 =$ _____
11 $3.3 \times 10^6 =$ _____
12 $8.3 \times 10^8 =$ _____
13 $5.9 \times 10^8 =$ _____
14 $4.5 \times 10^6 =$ _____
15 $3.8 \times 10^7 =$ _____
16 $9.6 \times 10^7 =$ _____
17 $7.7 \times 10^6 =$ _____
18 $2.7 \times 10^8 =$ _____
19 $3.2 \times 10^8 =$ _____
20 $6.5 \times 10^5 =$ _____
21 $2.4 \times 10^8 =$ _____
22 $5.5 \times 10^7 =$ _____
23 $2.5 \times 10^8 =$ _____
24 $8.9 \times 10^6 =$ _____

10. Numbers smaller than one

Write each number in standard form. The exponent is negative, not the number.

25 $2.4 \times 10^{-4} =$ _____
26 $9.6 \times 10^{-5} =$ _____
27 $2.6 \times 10^{-3} =$ _____
28 $6.6 \times 10^{-5} =$ _____
29 $9.3 \times 10^{-3} =$ _____
30 $1.5 \times 10^{-5} =$ _____
31 $6 \times 10^{-5} =$ _____
32 $6.9 \times 10^{-3} =$ _____
33 $2 \times 10^{-5} =$ _____
34 $7.4 \times 10^{-5} =$ _____
35 $8.9 \times 10^{-4} =$ _____
36 $3.8 \times 10^{-5} =$ _____
37 $2.5 \times 10^{-5} =$ _____
38 $3.1 \times 10^{-3} =$ _____
39 $7.5 \times 10^{-5} =$ _____
40 $1.2 \times 10^{-5} =$ _____
41 $9.2 \times 10^{-4} =$ _____
42 $9.5 \times 10^{-5} =$ _____
43 $4 \times 10^{-5} =$ _____
44 $5.2 \times 10^{-4} =$ _____
45 $9.9 \times 10^{-5} =$ _____
46 $3 \times 10^{-5} =$ _____
47 $6.9 \times 10^{-5} =$ _____
48 $2.5 \times 10^{-4} =$ _____

11. Square and cube roots

Find each root. Check the symbol before you answer.

49 $\sqrt{256} =$ ___
50 $\sqrt[3]{1728} =$ ___
51 $\sqrt{361} =$ ___
52 $\sqrt[3]{125} =$ ___
53 $\sqrt{324} =$ ___
54 $\sqrt{900} =$ ___
55 $\sqrt[3]{64} =$ ___
56 $\sqrt{784} =$ ___
57 $\sqrt[3]{8} =$ ___
58 $\sqrt[3]{1331} =$ ___

Working in Scientific Notation

WORKED EXAMPLE

$(7.5 \times 10^4) \div (2.5 \times 10^5)$

$7.5 \div 2.5 = 3$
$4 - 5 = -1$
3×10^{-1}
$1 \le 3 < 10$

12. Multiplying and dividing in scientific notation

Work each one out. Write every answer in scientific notation.

1 $(4 \times 10^8) \times (2.5 \times 10^{-1})$

2 $(2 \times 10^{-2}) \div (5 \times 10^8)$

3 $(2.5 \times 10^3) \times (6 \times 10^3)$

4 $(3 \times 10^7) \div (5 \times 10^2)$

5 $(2 \times 10^4) \times (5 \times 10^{-3})$

6 $(6 \times 10^{-3}) \div (7.5 \times 10^5)$

7 $(3 \times 10^{-4}) \div (5 \times 10^{-5})$

8 $(7.5 \times 10^7) \times (6 \times 10^{-1})$

9 $(1.2 \times 10^{-3}) \div (2 \times 10^7)$

10 $(3 \times 10^{-1}) \div (5 \times 10^8)$

12. Multiplying and dividing in scientific notation (continued)

Work each one out. Write every answer in scientific notation.

11 $(4 \times 10^{5}) \times (2.5 \times 10^{5})$

12 $(2 \times 10^{-2}) \div (5 \times 10^{-3})$

13 $(3 \times 10^{8}) \div (6 \times 10^{-3})$

14 $(6 \times 10^{-2}) \times (4.5 \times 10^{8})$

15 $(2.5 \times 10^{-5}) \div (5 \times 10^{6})$

16 $(1.2 \times 10^{2}) \div (1.5 \times 10^{-1})$

17 $(4.5 \times 10^{3}) \times (8 \times 10^{8})$

18 $(1.2 \times 10^{-4}) \div (6 \times 10^{4})$

19 $(4 \times 10^{7}) \div (5 \times 10^{-2})$

20 $(7.5 \times 10^{-2}) \times (2 \times 10^{3})$

21 $(3 \times 10^{-3}) \div (5 \times 10^{7})$

22 $(1.2 \times 10^{3}) \div (1.5 \times 10^{7})$

23 $(2 \times 10^{4}) \div (2.5 \times 10^{-5})$

24 $(3 \times 10^{-5}) \times (5 \times 10^{-3})$

13. Between which whole numbers

Each root lies between two whole numbers. Write the smaller one.

25 $\sqrt{335} > \_\_\_$

26 $\sqrt{455} > \_\_\_$

27 $\sqrt{260} > \_\_\_$

28 $\sqrt{370} > \_\_\_$

29 $\sqrt{219} > \_\_\_$

30 $\sqrt{454} > \_\_\_$

31 $\sqrt{427} > \_\_\_$

32 $\sqrt{227} > \_\_\_$

33 $\sqrt{398} > \_\_\_$

34 $\sqrt{466} > \_\_\_$

Solving Equations

WORKED EXAMPLE

$7x + 7 = 12x + 2$ 1

14. Solving equations

Solve each equation for x.

1 $8x + 15 = 5x + 30$ ___

2 $10x + 19 = 12x + 3$ ___

3 $9x + 14 = 6x + 32$ ___

4 $9x + 35 = 11x + 13$ ___

5 $11x + 20 = 12x + 15$ ___

6 $2x + 4 = x + 17$ ___

7 $4x + 19 = 5x + 11$ ___

8 $5x + 38 = 9x + 14$ ___

9 $7x + 48 = 11x + 8$ ___

10 $10x + 5 = 9x + 17$ ___

11 $5x + 15 = 7x + 1$ ___

12 $4x + 31 = 6x + 5$ ___

13 $7x + 11 = 5x + 27$ ___

14 $6x + 18 = 7x + 11$ ___

15 $7x + 33 = 9x + 9$ ___

16 $2x + 37 = 6x + 5$ ___

17 $12x + 12 = 6x + 48$ ___

18 $9x + 13 = 7x + 35$ ___

19 $8x + 15 = 9x + 3$ ___

20 $4x + 29 = 9x + 4$ ___

21 $10x + 16 = 11x + 3$ ___

22 $8x + 3 = 5x + 42$ ___

23 $3x + 21 = 4x + 12$ ___

24 $10x + 10 = 7x + 25$ ___

25 $8x + 27 = 10x + 3$ ___

26 $8x + 12 = 6x + 28$ ___

27 $3x + 19 = 5x + 9$ ___

28 $11x + 14 = 8x + 47$ ___

29 $5x + 35 = 7x + 9$ ___

30 $7x + 1 = 4x + 16$ ___

31 $12x + 2 = 8x + 34$ ___

32 $6x + 50 = 11x + 10$ ___

33 $5x + 30 = 8x + 15$ ___

34 $5x + 14 = 2x + 47$ ___

35 $5x + 4 = 3x + 30$ ___

36 $9x + 1 = 8x + 13$ ___

37 $6x + 1 = 3x + 22$ ___

38 $4x + 8 = x + 35$ ___

39 $11x + 9 = 12x + 1$ ___

40 $8x + 29 = 10x + 15$ ___

41 $8x + 22 = 9x + 13$ ___

42 $6x + 9 = 2x + 45$ ___

43 $9x + 17 = 12x + 2$ ___

44 $4x + 37 = 7x + 7$ ___

15. Rational or irrational

Is each number rational or irrational? Circle one.

45 $\sqrt{484}$ Rational / Irrational

46 $\sqrt{259}$ Rational / Irrational

47 $\sqrt[3]{64}$ Rational / Irrational

48 $\sqrt{27}$ Rational / Irrational

49 $\sqrt{441}$ Rational / Irrational

50 $\sqrt{122}$ Rational / Irrational

15. Rational or irrational (continued)

Is each number rational or irrational? Circle one.

51 $\sqrt{289}$ **Rational** / **Irrational**

52 $\sqrt[3]{1331}$ **Rational** / **Irrational**

53 $\sqrt{172}$ **Rational** / **Irrational**

54 $\sqrt{25}$ **Rational** / **Irrational**

Systems of Equations

WORKED EXAMPLE

$-7x + 8y = -36$
$12x - 8y = 56$
$5x = 20$
$x = 4$
$y = -1$

16. Systems of equations

Solve each pair by adding the two equations.

1 $9x + 8y = -8$
$6x - 8y = 8$

2 $-8x + 3y = -53$
$-10x - 3y = -19$

3 $-2x + 6y = -10$
$11x - 6y = 55$

4 $11x + 5y = -30$
$3x - 5y = 30$

5 $9x + 6y = -3$
$-6x - 6y = 12$

6 $-2x + 10y = -24$
$12x - 10y = -56$

7 $7x + 11y = 42$
$6x - 11y = 36$

8 $-5x + 7y = -1$
$-9x - 7y = -41$

9 $-10x + 6y = -54$
$-5x - 6y = 54$

10 $-6x + y = -4$
$-2x - y = -4$

11 $-4x + 8y = 0$
$2x - 8y = -28$

12 $-12x + 9y = -30$
$11x - 9y = 26$

13 $-9x + 10y = -7$
$7x - 10y = 21$

14 $-8x + 2y = 50$
$-12x - 2y = 30$

15 $-3x + 9y = 18$
$5x - 9y = -6$

16 $-5x + 7y = 25$
$4x - 7y = -20$

17 $-5x + 11y = 9$
$x - 11y = -37$

18 $7x + 3y = -36$
$2x - 3y = -45$

16. Systems of equations (continued)

Solve each pair by adding the two equations.

19 $3x + 10y = -36$
$-7x - 10y = 4$

20 $-3x + 8y = -3$
$5x - 8y = 5$

21 $-3x + 10y = 45$
$7x - 10y = 15$

22 $2x + 12y = 26$
$12x - 12y = -12$

23 $9x + y = 3$
$12x - y = -3$

24 $6x + 6y = 24$
$10x - 6y = 24$

17. Writing numbers in full

Write each number in standard form.

25 $6.3 \times 10^6 =$ _____

26 $6.3 \times 10^7 =$ _____

27 $7.3 \times 10^6 =$ _____

28 $4.1 \times 10^8 =$ _____

29 $4.2 \times 10^6 =$ _____

30 $3.1 \times 10^8 =$ _____

31 $4.9 \times 10^8 =$ _____

32 $6.4 \times 10^5 =$ _____

33 $3 \times 10^7 =$ _____

34 $9.6 \times 10^7 =$ _____

How Many Solutions

WORKED EXAMPLE

3x + 9 = 9 + 3x

x is gone
9 = 9 is true
infinitely many solutions

18. How many solutions?

How many solutions does each equation have? Show how you know.

1 **6x − 29 = 6x − 26**

2 **x + 50 = 50 + x**

3 **18x + 50 = 50 + 18x**

4 **9x + 3 = 9x + 5**

5 **17x + 47 = x + 31**

6 **20x + 25 = 20x + 28**

7 **15x − 16 = 7x − 33**

8 **17x + 50 = 17x + 51**

9 **−2x + 12 = −2x + 14**

10 **−16x + 2 = 2 − 16x**

11 **7x + 40 = 40 + 7x**

12 **3x + 5 = 3x + 13**

13 **4x + 55 = 55 + 4x**

14 **5x − 50 = 12x + 24**

15 **−8x − 54 = −54 − 8x**

16 **12x − 50 = 12x − 56**

17 **4x + 15 = 5x + 20**

18 **20x − 34 = −34 + 20x**

19 **5x − 29 = 5x − 30**

20 **−9x − 56 = −9x − 53**

19. Multiplying and dividing in scientific notation

Work each one out. Write every answer in scientific notation.

21 $(4.5 \times 10^{-5}) \times (4 \times 10^{-1})$

22 $(1.5 \times 10^{3}) \div (3 \times 10^{7})$

23 $(8 \times 10^{7}) \times (5 \times 10^{-1})$

24 $(2 \times 10^{-2}) \div (5 \times 10^{-3})$

25 $(5 \times 10^{-1}) \times (4 \times 10^{-2})$

26 $(1.2 \times 10^{3}) \div (1.5 \times 10^{7})$

27 $(1.5 \times 10^{3}) \div (2.5 \times 10^{6})$

28 $(5 \times 10^{2}) \times (4 \times 10^{-4})$

29 $(1.2 \times 10^{-1}) \div (6 \times 10^{3})$

30 $(3 \times 10^{7}) \div (5 \times 10^{2})$

Slope

WORKED EXAMPLE

$y = 5x + 37$ $m = 5$

20. Finding the slope

Write the slope of each line.

1. $y = 10x + 28$ $m =$ ____
2. $y = 12x + 1$ $m =$ ____
3. $y = 8x + 22$ $m =$ ____
4. $y = -4x - 25$ $m =$ ____
5. $y = -6x - 17$ $m =$ ____
6. $y = 8x - 28$ $m =$ ____
7. $y = x + 5$ $m =$ ____
8. $y = -10x - 20$ $m =$ ____
9. $y = -2x - 2$ $m =$ ____
10. $y = x + 26$ $m =$ ____
11. $y = 10x + 38$ $m =$ ____
12. $y = -12x - 24$ $m =$ ____
13. $y = -4x - 23$ $m =$ ____
14. $y = -6x - 24$ $m =$ ____
15. $y = 6x - 7$ $m =$ ____
16. $y = -21$ $m =$ ____
17. $y = x - 22$ $m =$ ____
18. $y = 6x + 37$ $m =$ ____
19. $y = -11x - 19$ $m =$ ____
20. $y = -6x - 29$ $m =$ ____
21. $y = 11x + 25$ $m =$ ____
22. $y = x + 10$ $m =$ ____
23. $y = 4x - 22$ $m =$ ____
24. $y = 11x + 24$ $m =$ ____

21. Finding the y-intercept

Write the y-intercept of each line.

25. $y = -11x - 17$ $b =$ ____
26. $y = -6x - 24$ $b =$ ____
27. $y = -2x - 26$ $b =$ ____
28. $y = -10x - 27$ $b =$ ____
29. $y = -6x - 22$ $b =$ ____
30. $y = 5x - 26$ $b =$ ____
31. $y = 3x - 25$ $b =$ ____
32. $y = 9x - 9$ $b =$ ____
33. $y = 6x + 40$ $b =$ ____
34. $y = 3x - 23$ $b =$ ____
35. $y = -9x - 21$ $b =$ ____
36. $y = 5x + 3$ $b =$ ____
37. $y = -x - 4$ $b =$ ____
38. $y = -7x + 38$ $b =$ ____
39. $y = -11x + 17$ $b =$ ____
40. $y = -5x - 18$ $b =$ ____
41. $y = 11x + 19$ $b =$ ____
42. $y = 11x + 33$ $b =$ ____
43. $y = -6x + 36$ $b =$ ____
44. $y = -7x - 12$ $b =$ ____
45. $y = 6x + 2$ $b =$ ____
46. $y = 12x - 14$ $b =$ ____
47. $y = 3x - 15$ $b =$ ____
48. $y = -4x + 33$ $b =$ ____

22. Solving equations

Solve each equation for x.

49 $12x + 2 = 6x + 32$ ___

50 $11x + 13 = 9x + 31$ ___

51 $4x + 40 = 9x + 15$ ___

52 $11x + 25 = 12x + 15$ ___

53 $6x + 13 = x + 43$ ___

54 $x + 38 = 3x + 12$ ___

55 $6x + 7 = 3x + 46$ ___

56 $3x + 50 = 10x + 1$ ___

57 $6x + 33 = 9x + 6$ ___

58 $7x + 41 = 9x + 15$ ___

Rate of Change

WORKED EXAMPLE

x	5	6	7	8
y	29	24	19	14

rate → -5

y step = −5, x step = 1
−5 ÷ 1 = −5
rate of change = −5

23. Rate of change from a table

Each table is a straight line. Find what each one asks for.

1

x	1	4	7	10
y	33	48	63	78

rate → ___

2

x	7	11	15	19
y	39	47	55	63

rate → ___

3

x	1	2	3	4
y	42	33	24	15

rate → ___

4

x	9	13	17	21
y	37	41	45	49

rate → ___

5

x	6	10	14	18
y	59	83	107	131

rate → ___

6

x	4	8	12	16
y	49	89	129	169

rate → ___

7

x	3	4	5	6
y	35	32	29	26

rate → ___

8

x	2	8	14	20
y	21	81	141	201

rate → ___

23. Rate of change from a table (continued)

Each table is a straight line. Find what each one asks for.

9

x	2	7	12	17
y	154	109	64	19

rate → ___

10

x	2	3	4	5
y	51	57	63	69

rate → ___

11

x	3	5	7	9
y	50	34	18	2

rate → ___

12

x	2	7	12	17
y	38	48	58	68

rate → ___

13

x	6	7	8	9
y	55	47	39	31

rate → ___

14

x	7	10	13	16
y	51	36	21	6

rate → ___

15

x	3	4	5	6
y	18	12	6	0

rate → ___

16

x	9	11	13	15
y	34	32	30	28

rate → ___

17

x	1	3	5	7
y	42	60	78	96

rate → ___

18

x	4	5	6	7
y	59	65	71	77

rate → ___

19

x	7	10	13	16
y	62	74	86	98

rate → ___

20

x	4	9	14	19
y	42	47	52	57

rate → ___

23. Rate of change from a table (continued)

Each table is a straight line. Find what each one asks for.

21

x	9	10	11	12
y	58	52	46	40

rate → ___

22

x	7	12	17	22
y	62	102	142	182

rate → ___

23

x	4	8	12	16
y	31	39	47	55

rate → ___

24

x	6	7	8	9
y	61	65	69	73

rate → ___

24. Systems of equations

Solve each pair by adding the two equations.

25 $11x + 9y = -4$
$-8x - 9y = -29$

26 $3x + 6y = -18$
$4x - 6y = 18$

27 $-10x + 2y = 0$
$4x - 2y = -6$

28 $7x + 11y = 42$
$6x - 11y = 36$

29 $-8x + 6y = -52$
$5x - 6y = 46$

30 $-10x + 6y = -54$
$-5x - 6y = 54$

31 $8x + 4y = 32$
$-3x - 4y = 8$

32 $-2x + 6y = 60$
$10x - 6y = 36$

33 $10x + 8y = 56$
$5x - 8y = 4$

34 $6x + 9y = 36$
$4x - 9y = -36$

Comparing Rates

WORKED EXAMPLE

A 72 dollars in 6 weeks
B y = 14x, y dollars and x weeks

A / (B)

25. Which rate is greater?

Which one is greater, A or B? Work out each rate first. Circle one.

1 A y = 10x, y meters and x seconds
B 39 meters in 3 seconds
A / B

2 A 84 km in 7 hours
B y = 6x, y km and x hours
A / B

3 A 12 km in 2 hours
B y = 13x, y km and x hours
A / B

4 A y = 11x, y km and x hours
B 28 km in 7 hours
A / B

5 A y = 12x, y meters and x seconds
B 49 meters in 7 seconds
A / B

6 A 35 km in 7 hours
B y = 10x, y km and x hours
A / B

7 A 84 km in 7 hours
B y = 10x, y km and x hours
A / B

8 A 40 dollars in 5 weeks
B y = 5x, y dollars and x weeks
A / B

9 A y = 2x, y meters and x seconds
B 12 meters in 4 seconds
A / B

10 A y = 9x, y km and x hours
B 64 km in 8 hours
A / B

11 A y = 13x, y meters and x seconds
B 49 meters in 7 seconds
A / B

12 A y = 13x, y words and x minutes
B 66 words in 6 minutes
A / B

13 A y = 4x, y km and x hours
B 30 km in 3 hours
A / B

14 A y = 13x, y pages and x days
B 18 pages in 2 days
A / B

26. How many solutions?

How many solutions does each equation have? Show how you know.

15 $-19x - 32 = -32 - 19x$

16 $17x - 21 = 17x - 29$

17 $11x - 39 = -39 + 11x$

18 $12x + 49 = x + 18$

19 $-8x - 5 = -8x$

20 $2x - 24 = -7x + 1$

21 $-20x + 25 = -20x + 20$

22 $2x - 6 = 2x - 4$

23 $18x - 54 = -54 + 18x$

24 $x - 33 = 15x - 39$

Is It Linear?

WORKED EXAMPLE

$y = 13x + 17$ **Linear** / Nonlinear

27. Linear or nonlinear

Is each equation linear or nonlinear? Circle one.

1. $y = 7x^2 + 33$ Linear / Nonlinear
2. $y = 25/x$ Linear / Nonlinear
3. $y = 7x^3 + 39$ Linear / Nonlinear
4. $y = 92$ Linear / Nonlinear
5. $y = 4x^2 + 33$ Linear / Nonlinear
6. $y = 54/x$ Linear / Nonlinear
7. $y = 61/x$ Linear / Nonlinear
8. $y = 4x^2 + 25$ Linear / Nonlinear
9. $y = 43/x$ Linear / Nonlinear
10. $y = 45$ Linear / Nonlinear
11. $y = 5x^2 + 18$ Linear / Nonlinear
12. $y = 94$ Linear / Nonlinear
13. $y = 59/x$ Linear / Nonlinear
14. $y = 4x^2 + 22$ Linear / Nonlinear
15. $y = 55/x$ Linear / Nonlinear
16. $y = 50/x$ Linear / Nonlinear
17. $y = 12x^3 + 4$ Linear / Nonlinear
18. $y = 95$ Linear / Nonlinear
19. $y = 49/x$ Linear / Nonlinear
20. $y = 11x^2 + 3$ Linear / Nonlinear
21. $y = 10/x$ Linear / Nonlinear
22. $y = 32/x$ Linear / Nonlinear
23. $y = 47$ Linear / Nonlinear
24. $y = 2x^2 + 39$ Linear / Nonlinear

28. Finding the slope

Write the slope of each line.

25. $y = -x - 27$ $m =$ ___
26. $y = 12x + 1$ $m =$ ___
27. $y = 12x - 6$ $m =$ ___
28. $y = 8x + 35$ $m =$ ___
29. $y = -3x + 29$ $m =$ ___
30. $y = -19$ $m =$ ___
31. $y = -2x - 22$ $m =$ ___
32. $y = 10x - 20$ $m =$ ___
33. $y = 10x + 32$ $m =$ ____
34. $y = -12x + 40$ $m =$ ____
35. $y = -10x - 20$ $m =$ ____
36. $y = -2x - 2$ $m =$ ____
37. $y = -6x - 19$ $m =$ ____
38. $y = -x - 10$ $m =$ ____
39. $y = 9x + 9$ $m =$ ____
40. $y = 9x + 19$ $m =$ ____
41. $y = 8x + 31$ $m =$ ____
42. $y = 11x - 17$ $m =$ ____
43. $y = 4x - 27$ $m =$ ____
44. $y = 10x + 24$ $m =$ ____

Is It a Function?

WORKED EXAMPLE

x	4	6	15	6
y	58	38	32	49

6 → 38 and 6 → 49
Not a function

29. Is it a function?

Does each table show a function? Show how you know.

1

x	16	9	21	10
y	46	16	22	22

2

x	10	3	6	21
y	42	42	23	43

3

x	10	15	14	15
y	40	52	33	56

4

x	23	17	10	18
y	40	11	36	40

5

x	2	22	6	14
y	45	17	31	31

6

x	2	9	8	0
y	21	21	1	32

7

x	8	16	24	8
y	22	49	24	17

8

x	5	6	2	10
y	24	3	60	60

9

x	17	0	24	21
y	9	25	25	47

10

x	5	15	12	22
y	42	28	6	60

11

x	6	20	4	21
y	32	16	48	16

12

x	0	17	20	14
y	41	14	14	32

13

x	5	19	5	12
y	48	27	14	33

14

x	21	5	12	23
y	37	42	40	37

30. Finding the slope

Write the slope of each line.

15 $y = -3x + 30$ m = _____

16 $y = 12x + 1$ m = _____

17 $y = 12x - 6$ m = _____

18 $y = -4x - 17$ m = _____

19 $y = -19$ m = _____

20 $y = -12x + 34$ m = _____

21 $y = -6x + 9$ m = _____

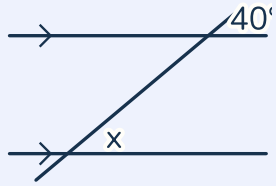
22 $y = 12x + 36$ m = _____

23 $y = -8x + 35$ m = _____

24 $y = 9x + 9$ m = _____

Angles in Parallel Lines

WORKED EXAMPLE

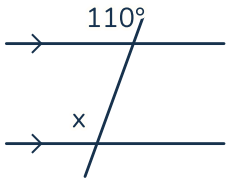


40

31. Angles in parallel lines

The two lines are parallel. Find x.

1



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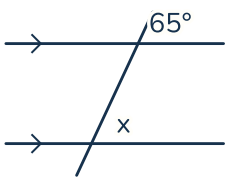

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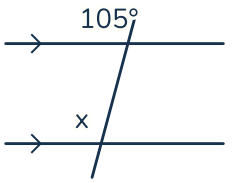

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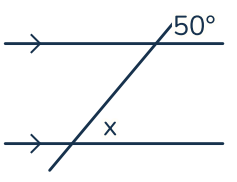

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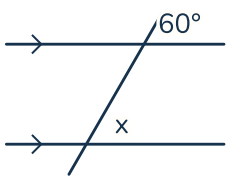

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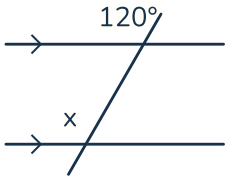

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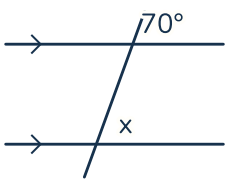

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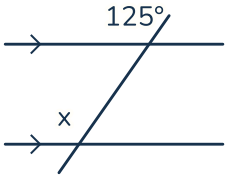

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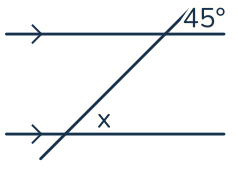

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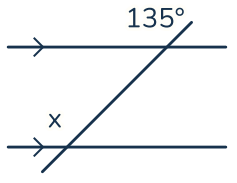

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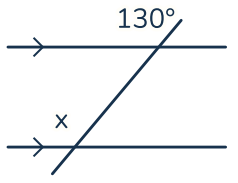

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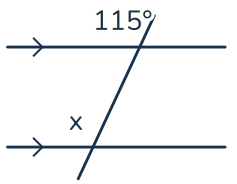

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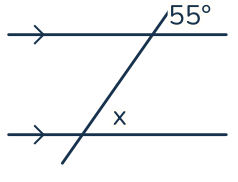

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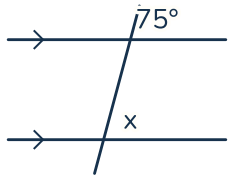


32. Rate of change from a table

Each table is a straight line. Find what each one asks for.

15

x	4	8	12	16
y	56	100	144	188

rate → ___

16

x	5	8	11	14
y	29	44	59	74

rate → ___

17

x	9	10	11	12
y	43	42	41	40

rate → ___

18

x	6	11	16	21
y	46	71	96	121

rate → ___

19

x	2	7	12	17
y	33	63	93	123

rate → ___

20

x	7	11	15	19
y	28	36	44	52

rate → ___

21

x	1	2	3	4
y	15	17	19	21

rate → ___

22

x	3	5	7	9
y	50	34	18	2

rate → ___

23

x	9	11	13	15
y	115	139	163	187

rate → ___

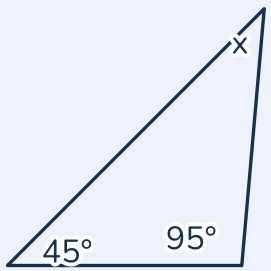
24

x	6	7	8	9
y	93	102	111	120

rate → ___

Angles in a Triangle

WORKED EXAMPLE

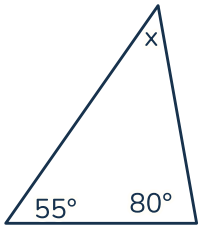


40 degrees

33. The third angle of a triangle

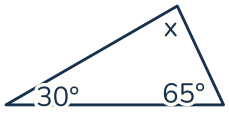
Find the angle marked x. Give each answer in degrees.

1



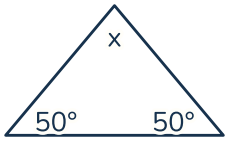
_____ degrees

2



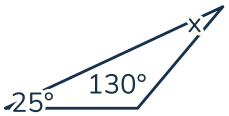
_____ degrees

3



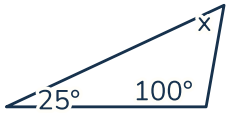
_____ degrees

4



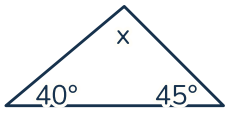
_____ degrees

5



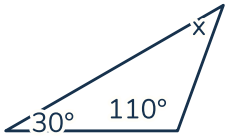
_____ degrees

6



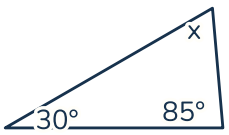
_____ degrees

7



_____ degrees

8

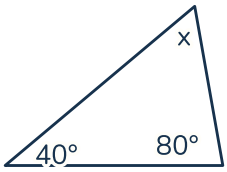


_____ degrees

9

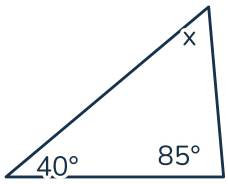
_____ degrees

10



_____ degrees

11



_____ degrees

12

_____ degrees

34. Which rate is greater?

Which one is greater, A or B? Work out each rate first. Circle one.

13 A **y = 2x, y pages and x days**
B **42 pages in 7 days**
A / B

14 A **84 km in 7 hours**
B **y = 6x, y km and x hours**
A / B

15 A **y = 11x, y km and x hours**
B **28 km in 7 hours**
A / B

34. Which rate is greater? (continued)

Which one is greater, A or B? Work out each rate first. Circle one.

16 A 56 dollars in 7 weeks
B y = 14x, y dollars and x weeks
A / B

17 A y = 9x, y km and x hours
B 64 km in 8 hours
A / B

18 A y = 11x, y words and x minutes
B 20 words in 5 minutes
A / B

19 A 40 meters in 5 seconds
B y = 11x, y meters and x seconds
A / B

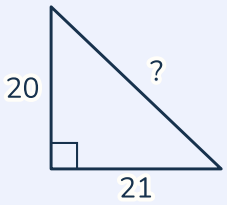
20 A 88 km in 8 hours
B y = 8x, y km and x hours
A / B

21 A y = 2x, y words and x minutes
B 60 words in 5 minutes
A / B

22 A y = 8x, y km and x hours
B 12 km in 6 hours
A / B

Pythagoras

WORKED EXAMPLE

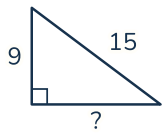


29 cm

35. Pythagorean theorem

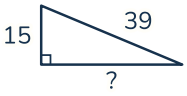
Find the missing side. All lengths are in centimeters.

1



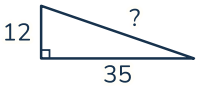
_____ cm

2



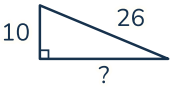
_____ cm

3



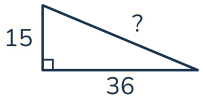
_____ cm

4



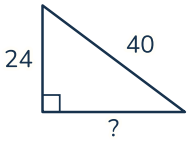
_____ cm

5



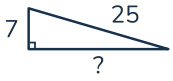
_____ cm

6



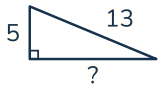
_____ cm

7



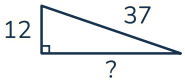
_____ cm

8



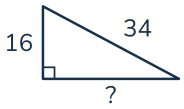
_____ cm

9



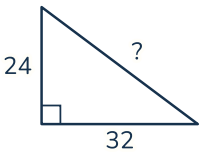
_____ cm

10



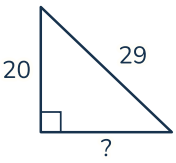
_____ cm

11



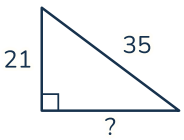
_____ cm

12



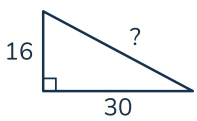
_____ cm

13



_____ cm

14



_____ cm

36. Linear or nonlinear

Is each equation linear or nonlinear? Circle one.

15 $y = 4x^2 + 19$ Linear / Nonlinear

16 $y = 79/x$ Linear / Nonlinear

17 $y = 8x^2 + 2$ Linear / Nonlinear

18 $y = 2/x$ Linear / Nonlinear

19 $y = 2x^2 + 3$ Linear / Nonlinear

20 $y = 91/x$ Linear / Nonlinear

21 $y = 6$ Linear / Nonlinear

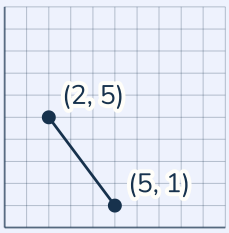
22 $y = 10x^2 + 21$ Linear / Nonlinear

23 $y = 61/x$ Linear / Nonlinear

24 $y = 39/x$ Linear / Nonlinear

Distance Between Points

WORKED EXAMPLE

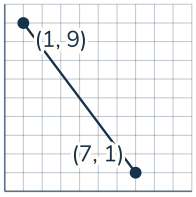


5 units

37. Distance between two points

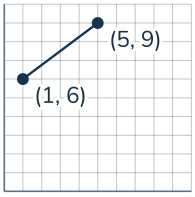
Find the distance between the two points.

1



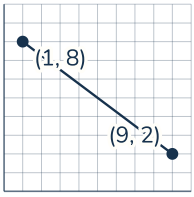
_____ units

2



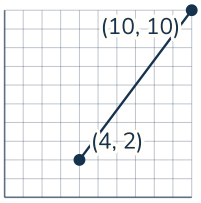
_____ units

3



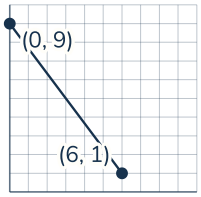
_____ units

4



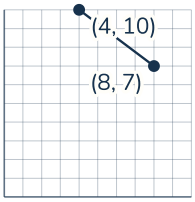
_____ units

5



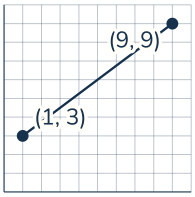
_____ units

6



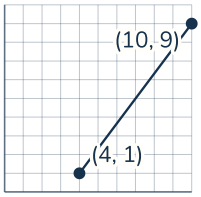
_____ units

7



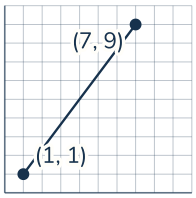
_____ units

8



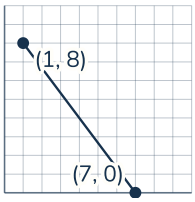
_____ units

9



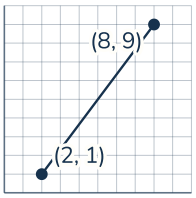
_____ units

10



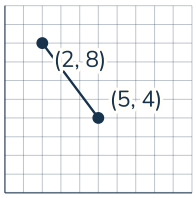
_____ units

11



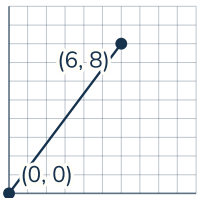
_____ units

12



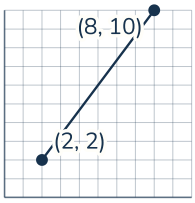
_____ units

13



_____ units

14



_____ units

38. Is it a function?

Does each table show a function? Show how you know.

15

x	13	12	17	18
y	33	57	57	30

16

x	14	23	15	16
y	28	45	14	28

17

x	7	23	7	20
y	40	23	48	38

18

x	21	11	10	18
y	25	45	25	50

19

x	17	20	9	19
y	1	3	1	44

20

x	1	24	6	11
y	59	52	54	59

21

x	4	16	16	23
y	43	19	30	57

22

x	24	10	3	13
y	44	59	25	25

23

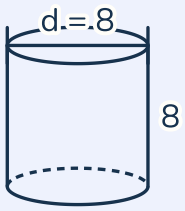
x	15	18	4	2
y	59	12	21	12

24

x	6	1	6	22
y	52	35	26	59

Volume of Cylinders

WORKED EXAMPLE

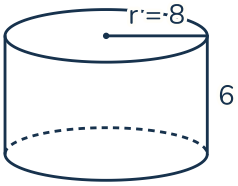


401.92

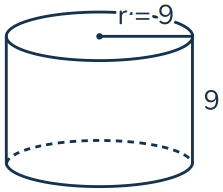
39. Volume of a cylinder

Find the volume of each cylinder. Use π = 3.14.

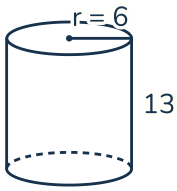
1



2



3



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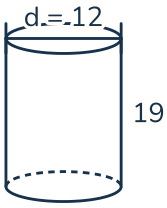

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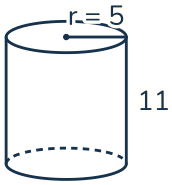

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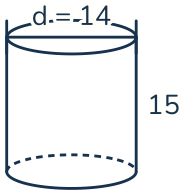

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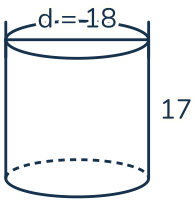


40. Laws of exponents

Write each product as one power. Give the exponent n.

8 $2^{12} \times 2^{7} = 2^{n}$, n = ___

9 $2^{2} \times 2^{6} = 2^{n}$, n = ___

10 $2^{8} \times 2^{4} = 2^{n}$, n = ___

11 $8^{9} \times 8^{10} = 8^{n}$, n = ___

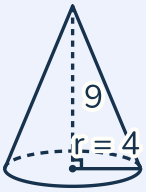
12 $11^{9} \times 11^{3} = 11^{n}$, n = ___

13 $5^{2} \times 5^{7} = 5^{n}$, n = ___

14 $2^{5} \times 2^{11} = 2^{n}$, n = ___

Volume of Cones

WORKED EXAMPLE

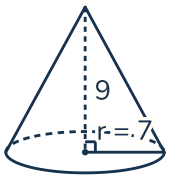


150.72

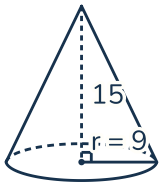
41. Volume of a cone

Find the volume of each cone. Use π = 3.14.

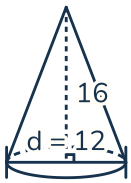
1



2



3



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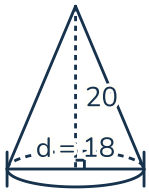
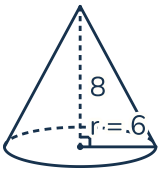
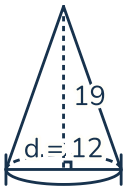


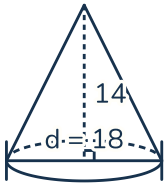
5



6



7



42. Square and cube roots

Find each root. Check the symbol before you answer.

8 $\sqrt{484} =$ ___

9 $\sqrt[3]{125} =$ ___

10 $\sqrt{441} =$ ___

11 $\sqrt{841} =$ ___

12 $\sqrt{676} =$ ___

13 $\sqrt[3]{343} =$ ___

14 $\sqrt[3]{8} =$ ___

Volume of Spheres

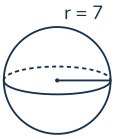
WORKED EXAMPLE

523.33

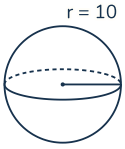
43. Volume of a sphere

Find the volume of each sphere. Use π = 3.14. Round to the hundredth.

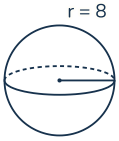
1



2



3



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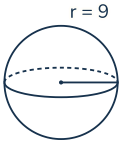

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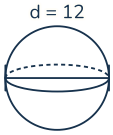

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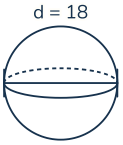

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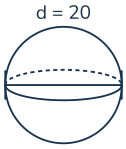
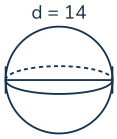
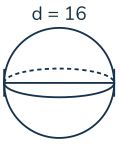


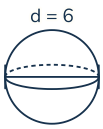
8



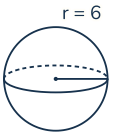
9



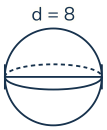
10



11



12

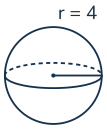


13

14

15

16



44. Between which whole numbers

Each root lies between two whole numbers. Write the smaller one.

17 $\sqrt{227} > \_\_\_$

18 $\sqrt{450} > \_\_\_$

19 $\sqrt{291} > \_\_\_$

20 $\sqrt{373} > \_\_\_$

21 $\sqrt{286} > \_\_\_$

22 $\sqrt{487} > \_\_\_$

23 $\sqrt{394} > \_\_\_$

24 $\sqrt{191} > \_\_\_$

25 $\sqrt{419} > \_\_\_$

26 $\sqrt{499} > \_\_\_$

Two-Way Tables

WORKED EXAMPLE

	WALKED	DROVE	TOTAL
SUNNY	5	20	25
RAINY	5	20	25
TOTAL	10	40	50

25 – 20 = 5
10 – 5 = 5

45. Two-way tables

One number is missing from each table. Use the totals to find it.

1

	CASH	CARD	TOTAL
WEEKDAY	18	19	37
WEEKEND	___	18	20
TOTAL	20	37	57

2

	HELMET	NONE	TOTAL
BIKES	14	___	20
SCOOTERS	15	14	29
TOTAL	29	20	49

3

	FINISHED	GAVE UP	TOTAL
INDOORS	___	30	50
OUTDOORS	11	22	33
TOTAL	31	52	83

4

	HELMET	NONE	TOTAL
BIKES	___	12	25
SCOOTERS	9	10	19
TOTAL	22	22	44

5

	PET	NO PET	TOTAL
GRADE 7	4	7	11
GRADE 8	9	___	10
TOTAL	13	8	21

6

	CHESS	CARDS	TOTAL
JUNIORS	19	12	31
SENIORS	30	___	50
TOTAL	49	32	81

7

	CASH	CARD	TOTAL
WEEKDAY	7	___	25
WEEKEND	7	24	31
TOTAL	14	42	56

8

	SOLD	LEFT	TOTAL
SMALL	22	14	36
LARGE	___	25	50
TOTAL	47	39	86

46. Rational or irrational

Is each number rational or irrational? Circle one.

9 $\sqrt{484}$ Rational / Irrational

10 $\sqrt[3]{64}$ Rational / Irrational

11 $\sqrt{441}$ Rational / Irrational

12 $\sqrt{289}$ Rational / Irrational

13 $\sqrt{222}$ Rational / Irrational

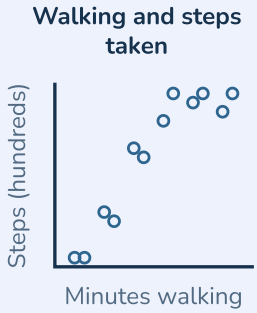
14 $\sqrt[3]{729}$ Rational / Irrational

15 $\sqrt{481}$ Rational / Irrational

16 $\sqrt[3]{1000}$ Rational / Irrational

Scatter Plots

WORKED EXAMPLE

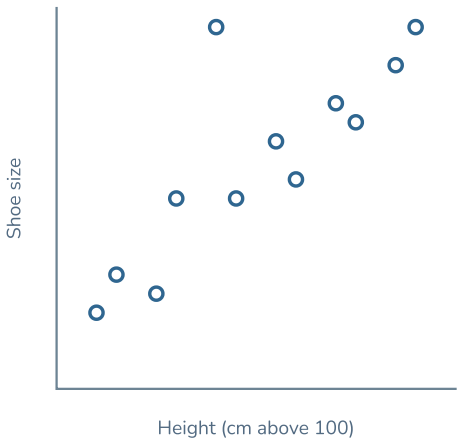


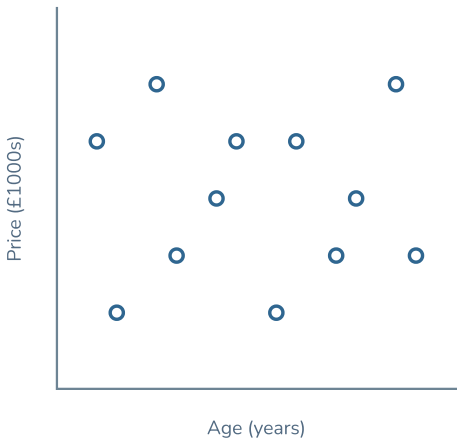
Is the association positive, negative or none?

(positive) negative none

47. Scatter plots

Read each scatter plot and circle the answer.





1 **Is the association positive, negative or none?**

positive negative none

2 **Is the pattern linear or nonlinear?**

linear nonlinear

3 **Is there a point well away from the rest?**

yes no

4 **Do the points cluster along a line, or spread out?**

along a line spread out

48. Writing numbers in full

Write each number in standard form.

5 $1.1 \times 10^{6} =$ _____

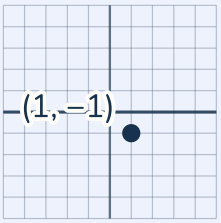
6 $7.1 \times 10^{8} =$ _____

7 $6.5 \times 10^{5} =$ _____

8 $5.4 \times 10^{8} =$ _____

Transformations

WORKED EXAMPLE



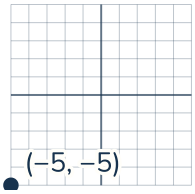
in the x-axis

(1 , 1)

49. Transformations on a grid

Move each point as described. Write where it lands.

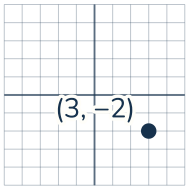
1



180° about O

(_____ , _____)

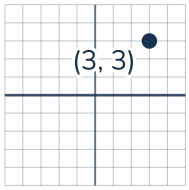
2



90° counterclockwise about O

(_____ , _____)

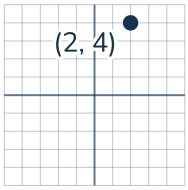
3



in the x-axis

(_____ , _____)

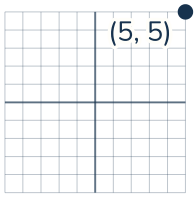
4



90° clockwise about O

(_____ , _____)

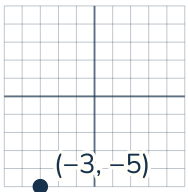
5



90° counterclockwise about O

(_____ , _____)

6



180° about O

(_____ , _____)

50. Multiplying and dividing in scientific notation

Work each one out. Write every answer in scientific notation.

7 $(8 \times 10^{-1}) \times (7.5 \times 10^{7})$

8 $(3 \times 10^{8}) \div (6 \times 10^{-3})$

9 $(4 \times 10^{-2}) \times (2.5 \times 10^{-5})$

10 $(3 \times 10^{-3}) \div (5 \times 10^{7})$

11 $(6 \times 10^{5}) \times (6 \times 10^{2})$

12 $(1.2 \times 10^{-2}) \div (3 \times 10^{-2})$

Check the Powers

51. Check the powers

Read each line of working and choose the answer that is correct.

1 **Sam wrote $(x^3)^2 \cdot x^3 = x^{18}$. Which is correct?**

x^6 x^8 x^{18} x^9

Why? .....

2 **Priya wrote $(x^4)^4 \cdot x^2 = x^{32}$. What should it be?**

x^{18} x^{32} x^{10} x^{16}

Why? .....

3 **On Ana's paper: $x^4 \cdot x^3 \div x^2 = x^9$. Which line should replace it?**

x^5 x^{10} x^9 x^3

Why? .....

4 **$(x^4)^3 \cdot x^2 = x^{24}$ is wrong. Which is right?**

x^{14} x^9 x^{24} x^{12}

Why? .....

5 **$(x^4)^4 \cdot x^3 = x^{11}$ is wrong. Which is right?**

x^{16} x^{19} x^{11} x^{48}

Why? .....

6 **Spot the mistake: $(x^3)^2 \cdot x^2 = x^{12}$. Which answer is right?**

x^{12} x^6 x^7 x^8

Why? .....

7 **Theo wrote $x^3 \cdot x^4 \div x^3 = x^2$. What should it be?**

x^4 x^{10} x^2 x^9

Why? .....

8 **Check this line: $(x^3)^3 \cdot x^2 = x^{18}$. Which is correct?**

x^{11} x^8 x^9 x^{18}

Why? .....

Answer Key (1 of 12)

Exponent Rules

Laws of exponents

1. $2^{8} \times 2^{4} = 2^{12}$
2. $9^{7} \times 9^{3} = 9^{10}$
3. $8^{9} \times 8^{2} = 8^{11}$
4. $8^{4} \times 8^{6} = 8^{10}$
5. $8^{8} \times 8^{1} = 8^{9}$
6. $8^{3} \times 8^{10} = 8^{13}$
7. $4^{2} \times 4^{3} = 4^{5}$
8. $7^{9} \times 7^{8} = 7^{17}$
9. $9^{5} \times 9^{1} = 9^{6}$
10. $12^{12} \times 12^{6} = 12^{18}$
11. $8^{5} \times 8^{5} = 8^{10}$
12. $3^{11} \times 3^{5} = 3^{16}$
13. $5^{8} \times 5^{1} = 5^{9}$
14. $5^{5} \times 5^{4} = 5^{9}$
15. $3^{2} \times 3^{4} = 3^{6}$
16. $3^{8} \times 3^{3} = 3^{11}$
17. $12^{13} \times 12^{6} = 12^{19}$
18. $10^{4} \times 10^{7} = 10^{11}$
19. $4^{5} \times 4^{6} = 4^{11}$
20. $12^{12} \times 12^{1} = 12^{13}$
21. $3^{15} \times 3^{2} = 3^{17}$
22. $8^{3} \times 8^{12} = 8^{15}$
23. $10^{10} \times 10^{8} = 10^{18}$
24. $6^{4} \times 6^{5} = 6^{9}$
25. $4^{6} \times 4^{6} = 4^{12}$
26. $11^{9} \times 11^{1} = 11^{10}$
27. $7^{2} \times 7^{14} = 7^{16}$
28. $8^{7} \times 8^{10} = 8^{17}$
29. $2^{9} \times 2^{4} = 2^{13}$
30. $5^{6} \times 5^{6} = 5^{12}$
31. $5^{3} \times 5^{5} = 5^{8}$
32. $2^{1} \times 2^{12} = 2^{13}$
33. $12^{3} \times 12^{12} = 12^{15}$
34. $2^{15} \times 2^{3} = 2^{18}$
35. $7^{11} \times 7^{5} = 7^{16}$
36. $6^{6} \times 6^{7} = 6^{13}$
37. $12^{8} \times 12^{6} = 12^{14}$
38. $6^{1} \times 6^{10} = 6^{11}$
39. $7^{2} \times 7^{12} = 7^{14}$
40. $3^{1} \times 3^{4} = 3^{5}$
41. $9^{7} \times 9^{11} = 9^{18}$
42. $7^{1} \times 7^{6} = 7^{7}$
43. $4^{6} \times 4^{9} = 4^{15}$
44. $11^{6} \times 11^{3} = 11^{9}$

Square and Cube Roots

Square and cube roots

1. $\sqrt{729} = 27$
2. $\sqrt[3]{1000} = 10$
3. $\sqrt{676} = 26$
4. $\sqrt[3]{27} = 3$
5. $\sqrt{400} = 20$
6. $\sqrt[3]{125} = 5$
7. $\sqrt[3]{1728} = 12$
8. $\sqrt{576} = 24$
9. $\sqrt[3]{343} = 7$
10. $\sqrt[3]{216} = 6$
11. $\sqrt{625} = 25$
12. $\sqrt{841} = 29$
13. $\sqrt{900} = 30$
14. $\sqrt{256} = 16$
15. $\sqrt[3]{512} = 8$
16. $\sqrt[3]{1331} = 11$
17. $\sqrt{484} = 22$
18. $\sqrt[3]{729} = 9$
19. $\sqrt[3]{8} = 2$
20. $\sqrt{324} = 18$
21. $\sqrt[3]{64} = 4$
22. $\sqrt{529} = 23$
23. $\sqrt{196} = 14$
24. $\sqrt{441} = 21$
25. $\sqrt{361} = 19$
26. $\sqrt{169} = 13$
27. $\sqrt{784} = 28$
28. $\sqrt{289} = 17$
29. $\sqrt{25} = 5$
30. $\sqrt{49} = 7$
31. $\sqrt{4} = 2$
32. $\sqrt{9} = 3$
33. $\sqrt{100} = 10$
34. $\sqrt{225} = 15$
35. $\sqrt{144} = 12$
36. $\sqrt{36} = 6$
37. $\sqrt{16} = 4$
38. $\sqrt{81} = 9$

Laws of exponents

39. $12^{8} \times 12^{4} = 12^{12}$
40. $5^{2} \times 5^{4} = 5^{6}$
41. $9^{7} \times 9^{3} = 9^{10}$
42. $12^{4} \times 12^{2} = 12^{6}$
43. $11^{9} \times 11^{3} = 11^{12}$
44. $8^{8} \times 8^{1} = 8^{9}$
45. $2^{5} \times 2^{11} = 2^{16}$

Answer Key (2 of 12)

Square and Cube Roots (continued)

Laws of exponents (continued)

46. $3^{13} \times 3^5 = 3^{18}$
47. $4^2 \times 4^2 = 4^4$
48. $10^3 \times 10^3 = 10^6$
49. $9^5 \times 9^1 = 9^6$
50. $6^{11} \times 6^3 = 6^{14}$
51. $7^5 \times 7^{11} = 7^{16}$
52. $3^{11} \times 3^5 = 3^{16}$
53. $4^5 \times 4^8 = 4^{13}$
54. $10^{11} \times 10^7 = 10^{18}$
55. $12^1 \times 12^5 = 12^6$
56. $8^7 \times 8^9 = 8^{16}$
57. $12^9 \times 12^{10} = 12^{19}$
58. $10^4 \times 10^7 = 10^{11}$

Estimating Roots

Between which whole numbers

1. √260 is between 16 and 17: 16
2. √419 is between 20 and 21: 20
3. √299 is between 17 and 18: 17
4. √471 is between 21 and 22: 21
5. √267 is between 16 and 17: 16
6. √464 is between 21 and 22: 21
7. √475 is between 21 and 22: 21
8. √232 is between 15 and 16: 15
9. √436 is between 20 and 21: 20
10. √370 is between 19 and 20: 19
11. √197 is between 14 and 15: 14
12. √482 is between 21 and 22: 21
13. √453 is between 21 and 22: 21
14. √258 is between 16 and 17: 16
15. √375 is between 19 and 20: 19
16. √373 is between 19 and 20: 19
17. √352 is between 18 and 19: 18
18. √413 is between 20 and 21: 20
19. √450 is between 21 and 22: 21
20. √304 is between 17 and 18: 17
21. √422 is between 20 and 21: 20

To the nearest whole number

22. √300 is between 17 and 18: 17
23. √416 is between 20 and 21: 20
24. √246 is between 15 and 16: 16
25. √485 is between 22 and 23: 22
26. √354 is between 18 and 19: 19
27. √425 is between 20 and 21: 21
28. √456 is between 21 and 22: 21
29. √224 is between 14 and 15: 15

Estimating Roots (continued)

To the nearest whole number (continued)

30. √470 is between 21 and 22: 22
31. √434 is between 20 and 21: 21
32. √292 is between 17 and 18: 17
33. √455 is between 21 and 22: 21
34. √486 is between 22 and 23: 22
35. √222 is between 14 and 15: 15
36. √489 is between 22 and 23: 22
37. √405 is between 20 and 21: 20
38. √291 is between 17 and 18: 17
39. √465 is between 21 and 22: 22
40. √499 is between 22 and 23: 22
41. √303 is between 17 and 18: 17
42. √429 is between 20 and 21: 21

To the nearest tenth

43. √293 is between 17 and 18: 17.1
44. √497 is between 22 and 23: 22.3
45. √90 is between 9 and 10: 9.5
46. √317 is between 17 and 18: 17.8
47. √175 is between 13 and 14: 13.2
48. √424 is between 20 and 21: 20.6
49. √374 is between 19 and 20: 19.3
50. √268 is between 16 and 17: 16.4
51. √113 is between 10 and 11: 10.6
52. √407 is between 20 and 21: 20.2
53. √362 is between 19 and 20: 19
54. √19 is between 4 and 5: 4.4
55. √421 is between 20 and 21: 20.5
56. √387 is between 19 and 20: 19.7
57. √389 is between 19 and 20: 19.7
58. √38 is between 6 and 7: 6.2

Rational and Irrational Numbers

Rational or irrational

1. √484: rational — it is exactly 22, and any whole number counts as a fraction over one
2. √28: irrational — 28 is not a perfect square, so its root never ends and never repeats
3. √67: irrational — 67 is not a perfect square, so its root never ends and never repeats
4. $\sqrt[3]{729}$: rational — it is exactly 9, and any whole number counts as a fraction over one
5. $\sqrt[3]{1331}$: rational — it is exactly 11, and any whole number counts as a fraction over one
6. √121: rational — it is exactly 11, and any whole number counts as a fraction over one
7. $\sqrt[3]{1000}$: rational — it is exactly 10, and any whole number counts as a fraction over one

Answer Key (3 of 12)

Rational and Irrational Numbers (continued)

Rational or irrational (continued)

8. $\sqrt{25}$: rational — it is exactly 5, and any whole number counts as a fraction over one
9. $\sqrt[3]{512}$: rational — it is exactly 8, and any whole number counts as a fraction over one
10. $\sqrt{4}$: rational — it is exactly 2, and any whole number counts as a fraction over one
11. $\sqrt{100}$: rational — it is exactly 10, and any whole number counts as a fraction over one
12. $\sqrt[3]{1728}$: rational — it is exactly 12, and any whole number counts as a fraction over one
13. $\sqrt{142}$: irrational — 142 is not a perfect square, so its root never ends and never repeats
14. $\sqrt{50}$: irrational — 50 is not a perfect square, so its root never ends and never repeats
15. $\sqrt{118}$: irrational — 118 is not a perfect square, so its root never ends and never repeats
16. $\sqrt{9}$: rational — it is exactly 3, and any whole number counts as a fraction over one
17. $\sqrt{66}$: irrational — 66 is not a perfect square, so its root never ends and never repeats
18. $\sqrt{49}$: rational — it is exactly 7, and any whole number counts as a fraction over one
19. $\sqrt{13}$: irrational — 13 is not a perfect square, so its root never ends and never repeats
20. $\sqrt{101}$: irrational — 101 is not a perfect square, so its root never ends and never repeats
21. $\sqrt[3]{343}$: rational — it is exactly 7, and any whole number counts as a fraction over one
22. $\sqrt{102}$: irrational — 102 is not a perfect square, so its root never ends and never repeats
23. $\sqrt{170}$: irrational — 170 is not a perfect square, so its root never ends and never repeats
24. $\sqrt{33}$: irrational — 33 is not a perfect square, so its root never ends and never repeats
25. $\sqrt{628}$: irrational — 628 is not a perfect square, so its root never ends and never repeats
26. $\sqrt{624}$: irrational — 624 is not a perfect square, so its root never ends and never repeats
27. $\sqrt{528}$: irrational — 528 is not a perfect square, so its root never ends and never repeats
28. $\sqrt{361}$: rational — it is exactly 19, and any whole number counts as a fraction over one
29. $\sqrt{439}$: irrational — 439 is not a perfect square, so its root never ends and never repeats
30. $\sqrt{625}$: rational — it is exactly 25, and any whole number counts as a fraction over one
31. $\sqrt{36}$: rational — it is exactly 6, and any whole number counts as a fraction over one
32. $\sqrt{529}$: rational — it is exactly 23, and any whole number counts as a fraction over one

Rational and Irrational Numbers (continued)

Rational or irrational (continued)

33. $\sqrt{167}$: irrational — 167 is not a perfect square, so its root never ends and never repeats
34. $\sqrt{83}$: irrational — 83 is not a perfect square, so its root never ends and never repeats
35. $\sqrt{225}$: rational — it is exactly 15, and any whole number counts as a fraction over one
36. $\sqrt{34}$: irrational — 34 is not a perfect square, so its root never ends and never repeats
37. $\sqrt[3]{27}$: rational — it is exactly 3, and any whole number counts as a fraction over one

Laws of exponents

38. $2^{12} \times 2^{7} = 2^{19}$
39. $12^{8} \times 12^{4} = 12^{12}$
40. $5^{2} \times 5^{4} = 5^{6}$
41. $6^{9} \times 6^{10} = 6^{19}$
42. $10^{3} \times 10^{3} = 10^{6}$
43. $9^{5} \times 9^{1} = 9^{6}$
44. $6^{11} \times 6^{3} = 6^{14}$
45. $4^{2} \times 4^{9} = 4^{11}$
46. $5^{5} \times 5^{4} = 5^{9}$
47. $6^{12} \times 6^{3} = 6^{15}$

Scientific Notation

Writing numbers in full

1. $7.5 \times 10^{6} = 7500000$
2. $5.2 \times 10^{7} = 52000000$
3. $3.4 \times 10^{6} = 3400000$
4. $4.8 \times 10^{8} = 480000000$
5. $9.2 \times 10^{5} = 920000$
6. $9.1 \times 10^{7} = 91000000$
7. $6.4 \times 10^{8} = 640000000$
8. $6.9 \times 10^{5} = 690000$
9. $3.6 \times 10^{7} = 36000000$
10. $6.2 \times 10^{7} = 62000000$
11. $3.3 \times 10^{6} = 3300000$
12. $8.3 \times 10^{8} = 830000000$
13. $5.9 \times 10^{8} = 590000000$
14. $4.5 \times 10^{6} = 4500000$
15. $3.8 \times 10^{7} = 38000000$
16. $9.6 \times 10^{7} = 96000000$
17. $7.7 \times 10^{6} = 7700000$
18. $2.7 \times 10^{8} = 270000000$
19. $3.2 \times 10^{8} = 320000000$
20. $6.5 \times 10^{5} = 650000$
21. $2.4 \times 10^{8} = 240000000$
22. $5.5 \times 10^{7} = 55000000$
23. $2.5 \times 10^{8} = 250000000$

Answer Key (4 of 12)

Scientific Notation (continued)

Writing numbers in full (continued)

24. $8.9 \times 10^{6} = 8900000$

Numbers smaller than one

25. $2.4 \times 10^{-4} = 0.00024$
26. $9.6 \times 10^{-5} = 0.000096$
27. $2.6 \times 10^{-3} = 0.0026$
28. $6.6 \times 10^{-5} = 0.000066$
29. $9.3 \times 10^{-3} = 0.0093$
30. $1.5 \times 10^{-5} = 0.000015$
31. $6 \times 10^{-5} = 0.00006$
32. $6.9 \times 10^{-3} = 0.0069$
33. $2 \times 10^{-5} = 0.00002$
34. $7.4 \times 10^{-5} = 0.000074$
35. $8.9 \times 10^{-4} = 0.00089$
36. $3.8 \times 10^{-5} = 0.000038$
37. $2.5 \times 10^{-5} = 0.000025$
38. $3.1 \times 10^{-3} = 0.0031$
39. $7.5 \times 10^{-5} = 0.000075$
40. $1.2 \times 10^{-5} = 0.000012$
41. $9.2 \times 10^{-4} = 0.00092$
42. $9.5 \times 10^{-5} = 0.000095$
43. $4 \times 10^{-5} = 0.00004$
44. $5.2 \times 10^{-4} = 0.00052$
45. $9.9 \times 10^{-5} = 0.000099$
46. $3 \times 10^{-5} = 0.00003$
47. $6.9 \times 10^{-5} = 0.000069$
48. $2.5 \times 10^{-4} = 0.00025$

Square and cube roots

49. $\sqrt{256} = 16$
50. $\sqrt[3]{1728} = 12$
51. $\sqrt{361} = 19$
52. $\sqrt[3]{125} = 5$
53. $\sqrt{324} = 18$
54. $\sqrt{900} = 30$
55. $\sqrt[3]{64} = 4$
56. $\sqrt{784} = 28$
57. $\sqrt[3]{8} = 2$
58. $\sqrt[3]{1331} = 11$

Working in Scientific Notation

Multiplying and dividing in scientific notation

1. $(4 \times 10^{8}) \times (2.5 \times 10^{-1}) = 1 \times 10^{8}$
2. $(2 \times 10^{-2}) \div (5 \times 10^{8}) = 4 \times 10^{-11}$
3. $(2.5 \times 10^{3}) \times (6 \times 10^{3}) = 1.5 \times 10^{7}$
4. $(3 \times 10^{7}) \div (5 \times 10^{2}) = 6 \times 10^{4}$
5. $(2 \times 10^{4}) \times (5 \times 10^{-3}) = 1 \times 10^{2}$
6. $(6 \times 10^{-3}) \div (7.5 \times 10^{5}) = 8 \times 10^{-9}$

Working in Scientific Notation (continued)

Multiplying and dividing in scientific notation (continued)

7. $(3 \times 10^{-4}) \div (5 \times 10^{-5}) = 6 \times 10^{0}$
8. $(7.5 \times 10^{7}) \times (6 \times 10^{-1}) = 4.5 \times 10^{7}$
9. $(1.2 \times 10^{-3}) \div (2 \times 10^{7}) = 6 \times 10^{-11}$
10. $(3 \times 10^{-1}) \div (5 \times 10^{8}) = 6 \times 10^{-10}$
11. $(4 \times 10^{5}) \times (2.5 \times 10^{5}) = 1 \times 10^{11}$
12. $(2 \times 10^{-2}) \div (5 \times 10^{-3}) = 4 \times 10^{0}$
13. $(3 \times 10^{8}) \div (6 \times 10^{-3}) = 5 \times 10^{10}$
14. $(6 \times 10^{-2}) \times (4.5 \times 10^{8}) = 2.7 \times 10^{7}$
15. $(2.5 \times 10^{-5}) \div (5 \times 10^{6}) = 5 \times 10^{-12}$
16. $(1.2 \times 10^{2}) \div (1.5 \times 10^{-1}) = 8 \times 10^{2}$
17. $(4.5 \times 10^{3}) \times (8 \times 10^{8}) = 3.6 \times 10^{12}$
18. $(1.2 \times 10^{-4}) \div (6 \times 10^{4}) = 2 \times 10^{-9}$
19. $(4 \times 10^{7}) \div (5 \times 10^{-2}) = 8 \times 10^{8}$
20. $(7.5 \times 10^{-2}) \times (2 \times 10^{3}) = 1.5 \times 10^{2}$
21. $(3 \times 10^{-3}) \div (5 \times 10^{7}) = 6 \times 10^{-11}$
22. $(1.2 \times 10^{3}) \div (1.5 \times 10^{7}) = 8 \times 10^{-5}$
23. $(2 \times 10^{4}) \div (2.5 \times 10^{-5}) = 8 \times 10^{8}$
24. $(3 \times 10^{-5}) \times (5 \times 10^{-3}) = 1.5 \times 10^{-7}$

Between which whole numbers

25. $\sqrt{335}$ is between 18 and 19: 18
26. $\sqrt{455}$ is between 21 and 22: 21
27. $\sqrt{260}$ is between 16 and 17: 16
28. $\sqrt{370}$ is between 19 and 20: 19
29. $\sqrt{219}$ is between 14 and 15: 14
30. $\sqrt{454}$ is between 21 and 22: 21
31. $\sqrt{427}$ is between 20 and 21: 20
32. $\sqrt{227}$ is between 15 and 16: 15
33. $\sqrt{398}$ is between 19 and 20: 19
34. $\sqrt{466}$ is between 21 and 22: 21

Solving Equations

Solving equations

1. $8x + 15 = 5x + 30 \rightarrow x = 5$
2. $10x + 19 = 12x + 3 \rightarrow x = 8$
3. $9x + 14 = 6x + 32 \rightarrow x = 6$
4. $9x + 35 = 11x + 13 \rightarrow x = 11$
5. $11x + 20 = 12x + 15 \rightarrow x = 5$
6. $2x + 4 = x + 17 \rightarrow x = 13$
7. $4x + 19 = 5x + 11 \rightarrow x = 8$
8. $5x + 38 = 9x + 14 \rightarrow x = 6$
9. $7x + 48 = 11x + 8 \rightarrow x = 10$
10. $10x + 5 = 9x + 17 \rightarrow x = 12$
11. $5x + 15 = 7x + 1 \rightarrow x = 7$
12. $4x + 31 = 6x + 5 \rightarrow x = 13$
13. $7x + 11 = 5x + 27 \rightarrow x = 8$
14. $6x + 18 = 7x + 11 \rightarrow x = 7$

Answer Key (5 of 12)

Solving Equations (continued)

Solving equations (continued)

15. $7x + 33 = 9x + 9 \rightarrow x = 12$
16. $2x + 37 = 6x + 5 \rightarrow x = 8$
17. $12x + 12 = 6x + 48 \rightarrow x = 6$
18. $9x + 13 = 7x + 35 \rightarrow x = 11$
19. $8x + 15 = 9x + 3 \rightarrow x = 12$
20. $4x + 29 = 9x + 4 \rightarrow x = 5$
21. $10x + 16 = 11x + 3 \rightarrow x = 13$
22. $8x + 3 = 5x + 42 \rightarrow x = 13$
23. $3x + 21 = 4x + 12 \rightarrow x = 9$
24. $10x + 10 = 7x + 25 \rightarrow x = 5$
25. $8x + 27 = 10x + 3 \rightarrow x = 12$
26. $8x + 12 = 6x + 28 \rightarrow x = 8$
27. $3x + 19 = 5x + 9 \rightarrow x = 5$
28. $11x + 14 = 8x + 47 \rightarrow x = 11$
29. $5x + 35 = 7x + 9 \rightarrow x = 13$
30. $7x + 1 = 4x + 16 \rightarrow x = 5$
31. $12x + 2 = 8x + 34 \rightarrow x = 8$
32. $6x + 50 = 11x + 10 \rightarrow x = 8$
33. $5x + 30 = 8x + 15 \rightarrow x = 5$
34. $5x + 14 = 2x + 47 \rightarrow x = 11$
35. $5x + 4 = 3x + 30 \rightarrow x = 13$
36. $9x + 1 = 8x + 13 \rightarrow x = 12$
37. $6x + 1 = 3x + 22 \rightarrow x = 7$
38. $4x + 8 = x + 35 \rightarrow x = 9$
39. $11x + 9 = 12x + 1 \rightarrow x = 8$
40. $8x + 29 = 10x + 15 \rightarrow x = 7$
41. $8x + 22 = 9x + 13 \rightarrow x = 9$
42. $6x + 9 = 2x + 45 \rightarrow x = 9$
43. $9x + 17 = 12x + 2 \rightarrow x = 5$
44. $4x + 37 = 7x + 7 \rightarrow x = 10$

Rational or irrational

45. $\sqrt{484}$: rational — it is exactly 22, and any whole number counts as a fraction over one
46. $\sqrt{259}$: irrational — 259 is not a perfect square, so its root never ends and never repeats
47. $\sqrt[3]{64}$: rational — it is exactly 4, and any whole number counts as a fraction over one
48. $\sqrt{27}$: irrational — 27 is not a perfect square, so its root never ends and never repeats
49. $\sqrt{441}$: rational — it is exactly 21, and any whole number counts as a fraction over one
50. $\sqrt{122}$: irrational — 122 is not a perfect square, so its root never ends and never repeats
51. $\sqrt{289}$: rational — it is exactly 17, and any whole number counts as a fraction over one
52. $\sqrt[3]{1331}$: rational — it is exactly 11, and any whole number counts as a fraction over one

Solving Equations (continued)

Rational or irrational (continued)

53. $\sqrt{172}$: irrational — 172 is not a perfect square, so its root never ends and never repeats
54. $\sqrt{25}$: rational — it is exactly 5, and any whole number counts as a fraction over one

Systems of Equations

Systems of equations

1. $9x + 8y = -8, 6x - 8y = 8 \rightarrow (0, -1)$
2. $-8x + 3y = -53, -10x - 3y = -19 \rightarrow (4, -7)$
3. $-2x + 6y = -10, 11x - 6y = 55 \rightarrow (5, 0)$
4. $11x + 5y = -30, 3x - 5y = 30 \rightarrow (0, -6)$
5. $9x + 6y = -3, -6x - 6y = 12 \rightarrow (3, -5)$
6. $-2x + 10y = -24, 12x - 10y = -56 \rightarrow (-8, -4)$
7. $7x + 11y = 42, 6x - 11y = 36 \rightarrow (6, 0)$
8. $-5x + 7y = -1, -9x - 7y = -41 \rightarrow (3, 2)$
9. $-10x + 6y = -54, -5x - 6y = 54 \rightarrow (0, -9)$
10. $-6x + y = -4, -2x - y = -4 \rightarrow (1, 2)$
11. $-4x + 8y = 0, 2x - 8y = -28 \rightarrow (14, 7)$
12. $-12x + 9y = -30, 11x - 9y = 26 \rightarrow (4, 2)$
13. $-9x + 10y = -7, 7x - 10y = 21 \rightarrow (-7, -7)$
14. $-8x + 2y = 50, -12x - 2y = 30 \rightarrow (-4, 9)$
15. $-3x + 9y = 18, 5x - 9y = -6 \rightarrow (6, 4)$
16. $-5x + 7y = 25, 4x - 7y = -20 \rightarrow (-5, 0)$
17. $-5x + 11y = 9, x - 11y = -37 \rightarrow (7, 4)$
18. $7x + 3y = -36, 2x - 3y = -45 \rightarrow (-9, 9)$
19. $3x + 10y = -36, -7x - 10y = 4 \rightarrow (8, -6)$
20. $-3x + 8y = -3, 5x - 8y = 5 \rightarrow (1, 0)$
21. $-3x + 10y = 45, 7x - 10y = 15 \rightarrow (15, 9)$
22. $2x + 12y = 26, 12x - 12y = -12 \rightarrow (1, 2)$
23. $9x + y = 3, 12x - y = -3 \rightarrow (0, 3)$
24. $6x + 6y = 24, 10x - 6y = 24 \rightarrow (3, 1)$

Writing numbers in full

25. $6.3 \times 10^6 = 6300000$
26. $6.3 \times 10^7 = 63000000$
27. $7.3 \times 10^6 = 7300000$
28. $4.1 \times 10^8 = 410000000$
29. $4.2 \times 10^6 = 4200000$
30. $3.1 \times 10^8 = 310000000$
31. $4.9 \times 10^8 = 490000000$
32. $6.4 \times 10^5 = 640000$
33. $3 \times 10^7 = 30000000$
34. $9.6 \times 10^7 = 96000000$

How Many Solutions

How many solutions?

1. $6x - 29 = 6x - 26$: no solution

Answer Key (6 of 12)

How Many Solutions (continued)

How many solutions? (continued)

2. $x + 50 = 50 + x$: infinitely many
3. $18x + 50 = 50 + 18x$: infinitely many
4. $9x + 3 = 9x + 5$: no solution
5. $17x + 47 = x + 31$: one solution
6. $20x + 25 = 20x + 28$: no solution
7. $15x - 16 = 7x - 33$: one solution
8. $17x + 50 = 17x + 51$: no solution
9. $-2x + 12 = -2x + 14$: no solution
10. $-16x + 2 = 2 - 16x$: infinitely many
11. $7x + 40 = 40 + 7x$: infinitely many
12. $3x + 5 = 3x + 13$: no solution
13. $4x + 55 = 55 + 4x$: infinitely many
14. $5x - 50 = 12x + 24$: one solution
15. $-8x - 54 = -54 - 8x$: infinitely many
16. $12x - 50 = 12x - 56$: no solution
17. $4x + 15 = 5x + 20$: one solution
18. $20x - 34 = -34 + 20x$: infinitely many
19. $5x - 29 = 5x - 30$: no solution
20. $-9x - 56 = -9x - 53$: no solution

Multiplying and dividing in scientific notation

21. $(4.5 \times 10^{-5}) \times (4 \times 10^{-1}) = 1.8 \times 10^{-5}$
22. $(1.5 \times 10^{3}) \div (3 \times 10^{7}) = 5 \times 10^{-5}$
23. $(8 \times 10^{7}) \times (5 \times 10^{-1}) = 4 \times 10^{7}$
24. $(2 \times 10^{-2}) \div (5 \times 10^{-3}) = 4 \times 10^{0}$
25. $(5 \times 10^{-1}) \times (4 \times 10^{-2}) = 2 \times 10^{-2}$
26. $(1.2 \times 10^{3}) \div (1.5 \times 10^{7}) = 8 \times 10^{-5}$
27. $(1.5 \times 10^{3}) \div (2.5 \times 10^{6}) = 6 \times 10^{-4}$
28. $(5 \times 10^{2}) \times (4 \times 10^{-4}) = 2 \times 10^{-1}$
29. $(1.2 \times 10^{-1}) \div (6 \times 10^{3}) = 2 \times 10^{-5}$
30. $(3 \times 10^{7}) \div (5 \times 10^{2}) = 6 \times 10^{4}$

Slope

Finding the slope

1. $y = 10x + 28 \rightarrow m = 10$
2. $y = 12x + 1 \rightarrow m = 12$
3. $y = 8x + 22 \rightarrow m = 8$
4. $y = -4x - 25 \rightarrow m = -4$
5. $y = -6x - 17 \rightarrow m = -6$
6. $y = 8x - 28 \rightarrow m = 8$
7. $y = x + 5 \rightarrow m = 1$
8. $y = -10x - 20 \rightarrow m = -10$
9. $y = -2x - 2 \rightarrow m = -2$
10. $y = x + 26 \rightarrow m = 1$
11. $y = 10x + 38 \rightarrow m = 10$
12. $y = -12x - 24 \rightarrow m = -12$
13. $y = -4x - 23 \rightarrow m = -4$

Slope (continued)

Finding the slope (continued)

14. $y = -6x - 24 \rightarrow m = -6$
15. $y = 6x - 7 \rightarrow m = 6$
16. $y = -21 \rightarrow m = 0$
17. $y = x - 22 \rightarrow m = 1$
18. $y = 6x + 37 \rightarrow m = 6$
19. $y = -11x - 19 \rightarrow m = -11$
20. $y = -6x - 29 \rightarrow m = -6$
21. $y = 11x + 25 \rightarrow m = 11$
22. $y = x + 10 \rightarrow m = 1$
23. $y = 4x - 22 \rightarrow m = 4$
24. $y = 11x + 24 \rightarrow m = 11$

Finding the y-intercept

25. $y = -11x - 17 \rightarrow b = -17$
26. $y = -6x - 24 \rightarrow b = -24$
27. $y = -2x - 26 \rightarrow b = -26$
28. $y = -10x - 27 \rightarrow b = -27$
29. $y = -6x - 22 \rightarrow b = -22$
30. $y = 5x - 26 \rightarrow b = -26$
31. $y = 3x - 25 \rightarrow b = -25$
32. $y = 9x - 9 \rightarrow b = -9$
33. $y = 6x + 40 \rightarrow b = 40$
34. $y = 3x - 23 \rightarrow b = -23$
35. $y = -9x - 21 \rightarrow b = -21$
36. $y = 5x + 3 \rightarrow b = 3$
37. $y = -x - 4 \rightarrow b = -4$
38. $y = -7x + 38 \rightarrow b = 38$
39. $y = -11x + 17 \rightarrow b = 17$
40. $y = -5x - 18 \rightarrow b = -18$
41. $y = 11x + 19 \rightarrow b = 19$
42. $y = 11x + 33 \rightarrow b = 33$
43. $y = -6x + 36 \rightarrow b = 36$
44. $y = -7x - 12 \rightarrow b = -12$
45. $y = 6x + 2 \rightarrow b = 2$
46. $y = 12x - 14 \rightarrow b = -14$
47. $y = 3x - 15 \rightarrow b = -15$
48. $y = -4x + 33 \rightarrow b = 33$

Solving equations

49. $12x + 2 = 6x + 32 \rightarrow x = 5$
50. $11x + 13 = 9x + 31 \rightarrow x = 9$
51. $4x + 40 = 9x + 15 \rightarrow x = 5$
52. $11x + 25 = 12x + 15 \rightarrow x = 10$
53. $6x + 13 = x + 43 \rightarrow x = 6$
54. $x + 38 = 3x + 12 \rightarrow x = 13$
55. $6x + 7 = 3x + 46 \rightarrow x = 13$
56. $3x + 50 = 10x + 1 \rightarrow x = 7$
57. $6x + 33 = 9x + 6 \rightarrow x = 9$

Answer Key (7 of 12)

Slope (continued)

Solving equations (continued)

58. 7x + 41 = 9x + 15 → x = 13

Rate of Change

Rate of change from a table

1. x: 1, 4, 7, 10 y: 33, 48, 63, 78 → 5 (y moves 15 while x moves 3, and 15 ÷ 3 = 5)
2. x: 7, 11, 15, 19 y: 39, 47, 55, 63 → 2 (y moves 8 while x moves 4, and 8 ÷ 4 = 2)
3. x: 1, 2, 3, 4 y: 42, 33, 24, 15 → −9 (y moves −9 while x moves 1, and −9 ÷ 1 = −9)
4. x: 9, 13, 17, 21 y: 37, 41, 45, 49 → 1 (y moves 4 while x moves 4, and 4 ÷ 4 = 1)
5. x: 6, 10, 14, 18 y: 59, 83, 107, 131 → 6 (y moves 24 while x moves 4, and 24 ÷ 4 = 6)
6. x: 4, 8, 12, 16 y: 49, 89, 129, 169 → 10 (y moves 40 while x moves 4, and 40 ÷ 4 = 10)
7. x: 3, 4, 5, 6 y: 35, 32, 29, 26 → −3 (y moves −3 while x moves 1, and −3 ÷ 1 = −3)
8. x: 2, 8, 14, 20 y: 21, 81, 141, 201 → 10 (y moves 60 while x moves 6, and 60 ÷ 6 = 10)
9. x: 2, 7, 12, 17 y: 154, 109, 64, 19 → −9 (y moves −45 while x moves 5, and −45 ÷ 5 = −9)
10. x: 2, 3, 4, 5 y: 51, 57, 63, 69 → 6 (y moves 6 while x moves 1, and 6 ÷ 1 = 6)
11. x: 3, 5, 7, 9 y: 50, 34, 18, 2 → −8 (y moves −16 while x moves 2, and −16 ÷ 2 = −8)
12. x: 2, 7, 12, 17 y: 38, 48, 58, 68 → 2 (y moves 10 while x moves 5, and 10 ÷ 5 = 2)
13. x: 6, 7, 8, 9 y: 55, 47, 39, 31 → −8 (y moves −8 while x moves 1, and −8 ÷ 1 = −8)
14. x: 7, 10, 13, 16 y: 51, 36, 21, 6 → −5 (y moves −15 while x moves 3, and −15 ÷ 3 = −5)
15. x: 3, 4, 5, 6 y: 18, 12, 6, 0 → −6 (y moves −6 while x moves 1, and −6 ÷ 1 = −6)
16. x: 9, 11, 13, 15 y: 34, 32, 30, 28 → −1 (y moves −2 while x moves 2, and −2 ÷ 2 = −1)
17. x: 1, 3, 5, 7 y: 42, 60, 78, 96 → 9 (y moves 18 while x moves 2, and 18 ÷ 2 = 9)
18. x: 4, 5, 6, 7 y: 59, 65, 71, 77 → 6 (y moves 6 while x moves 1, and 6 ÷ 1 = 6)
19. x: 7, 10, 13, 16 y: 62, 74, 86, 98 → 4 (y moves 12 while x moves 3, and 12 ÷ 3 = 4)
20. x: 4, 9, 14, 19 y: 42, 47, 52, 57 → 1 (y moves 5 while x moves 5, and 5 ÷ 5 = 1)
21. x: 9, 10, 11, 12 y: 58, 52, 46, 40 → −6 (y moves −6 while x moves 1, and −6 ÷ 1 = −6)
22. x: 7, 12, 17, 22 y: 62, 102, 142, 182 → 8 (y moves 40 while x moves 5, and 40 ÷ 5 = 8)
23. x: 4, 8, 12, 16 y: 31, 39, 47, 55 → 2 (y moves 8 while x moves 4, and 8 ÷ 4 = 2)

Rate of Change (continued)

Rate of change from a table (continued)

24. x: 6, 7, 8, 9 y: 61, 65, 69, 73 → 4 (y moves 4 while x moves 1, and 4 ÷ 1 = 4)

Systems of equations

25. 11x + 9y = −4, −8x − 9y = −29 → (−11, 13)
26. 3x + 6y = −18, 4x − 6y = 18 → (0, −3)
27. −10x + 2y = 0, 4x − 2y = −6 → (1, 5)
28. 7x + 11y = 42, 6x − 11y = 36 → (6, 0)
29. −8x + 6y = −52, 5x − 6y = 46 → (2, −6)
30. −10x + 6y = −54, −5x − 6y = 54 → (0, −9)
31. 8x + 4y = 32, −3x − 4y = 8 → (8, −8)
32. −2x + 6y = 60, 10x − 6y = 36 → (12, 14)
33. 10x + 8y = 56, 5x − 8y = 4 → (4, 2)
34. 6x + 9y = 36, 4x − 9y = −36 → (0, 4)

Comparing Rates

Which rate is greater?

1. A y = 10x, y meters and x seconds B 39 meters in 3 seconds → B (A is 10 and B is 13 per second)
2. A 84 km in 7 hours B y = 6x, y km and x hours → A (A is 12 and B is 6 per hour)
3. A 12 km in 2 hours B y = 13x, y km and x hours → B (A is 6 and B is 13 per hour)
4. A y = 11x, y km and x hours B 28 km in 7 hours → A (A is 11 and B is 4 per hour)
5. A y = 12x, y meters and x seconds B 49 meters in 7 seconds → A (A is 12 and B is 7 per second)
6. A 35 km in 7 hours B y = 10x, y km and x hours → B (A is 5 and B is 10 per hour)
7. A 84 km in 7 hours B y = 10x, y km and x hours → A (A is 12 and B is 10 per hour)
8. A 40 dollars in 5 weeks B y = 5x, y dollars and x weeks → A (A is 8 and B is 5 per week)
9. A y = 2x, y meters and x seconds B 12 meters in 4 seconds → B (A is 2 and B is 3 per second)
10. A y = 9x, y km and x hours B 64 km in 8 hours → A (A is 9 and B is 8 per hour)
11. A y = 13x, y meters and x seconds B 49 meters in 7 seconds → A (A is 13 and B is 7 per second)
12. A y = 13x, y words and x minutes B 66 words in 6 minutes → A (A is 13 and B is 11 per minute)
13. A y = 4x, y km and x hours B 30 km in 3 hours → B (A is 4 and B is 10 per hour)
14. A y = 13x, y pages and x days B 18 pages in 2 days → A (A is 13 and B is 9 per day)

How many solutions?

15. −19x − 32 = −32 − 19x: infinitely many
16. 17x − 21 = 17x − 29: no solution
17. 11x − 39 = −39 + 11x: infinitely many

Answer Key (8 of 12)

Comparing Rates (continued)

How many solutions? (continued)

18. 12x + 49 = x + 18: one solution
19. −8x − 5 = −8x: no solution
20. 2x − 24 = −7x + 1: one solution
21. −20x + 25 = −20x + 20: no solution
22. 2x − 6 = 2x − 4: no solution
23. 18x − 54 = −54 + 18x: infinitely many
24. x − 33 = 15x − 39: one solution

Is It Linear?

Linear or nonlinear

1. $y = 7x^2 + 33$: Nonlinear — x is squared, so the steps in y grow as x grows
2. y = 25/x: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again
3. $y = 7x^3 + 39$: Nonlinear — x is cubed, so the steps in y grow as x grows
4. y = 92: Linear — y is always 92 whatever x does — that graph is a flat line, and flat is a slope of zero rather than no slope
5. $y = 4x^2 + 33$: Nonlinear — x is squared, so the steps in y grow as x grows
6. y = 54/x: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again
7. y = 61/x: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again
8. $y = 4x^2 + 25$: Nonlinear — x is squared, so the steps in y grow as x grows
9. y = 43/x: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again
10. y = 45: Linear — y is always 45 whatever x does — that graph is a flat line, and flat is a slope of zero rather than no slope
11. $y = 5x^2 + 18$: Nonlinear — x is squared, so the steps in y grow as x grows
12. y = 94: Linear — y is always 94 whatever x does — that graph is a flat line, and flat is a slope of zero rather than no slope
13. y = 59/x: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again
14. $y = 4x^2 + 22$: Nonlinear — x is squared, so the steps in y grow as x grows
15. y = 55/x: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again
16. y = 50/x: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again
17. $y = 12x^3 + 4$: Nonlinear — x is cubed, so the steps in y grow as x grows
18. y = 95: Linear — y is always 95 whatever x does — that graph is a flat line, and flat is a slope of zero rather than no slope

Is It Linear? (continued)

Linear or nonlinear (continued)

19. y = 49/x: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again
20. $y = 11x^2 + 3$: Nonlinear — x is squared, so the steps in y grow as x grows
21. y = 10/x: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again
22. y = 32/x: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again
23. y = 47: Linear — y is always 47 whatever x does — that graph is a flat line, and flat is a slope of zero rather than no slope
24. $y = 2x^2 + 39$: Nonlinear — x is squared, so the steps in y grow as x grows

Finding the slope

25. y = −x − 27 → m = −1
26. y = 12x + 1 → m = 12
27. y = 12x − 6 → m = 12
28. y = 8x + 35 → m = 8
29. y = −3x + 29 → m = −3
30. y = −19 → m = 0
31. y = −2x − 22 → m = −2
32. y = 10x − 20 → m = 10
33. y = 10x + 32 → m = 10
34. y = −12x + 40 → m = −12
35. y = −10x − 20 → m = −10
36. y = −2x − 2 → m = −2
37. y = −6x − 19 → m = −6
38. y = −x − 10 → m = −1
39. y = 9x + 9 → m = 9
40. y = 9x + 19 → m = 9
41. y = 8x + 31 → m = 8
42. y = 11x − 17 → m = 11
43. y = 4x − 27 → m = 4
44. y = 10x + 24 → m = 10

Is It a Function?

Is it a function?

1. (16, 46) (9, 16) (21, 22) (10, 22): Yes — every input appears once — 22 turns up twice, but that is an output, and two inputs may land on the same one
2. (10, 42) (3, 42) (6, 23) (21, 43): Yes — every input appears once — 42 turns up twice, but that is an output, and two inputs may land on the same one
3. (10, 40) (15, 52) (14, 33) (15, 56): No — the input 15 goes to 52 and also to 56, and one input may only go to one place
4. (23, 40) (17, 11) (10, 36) (18, 40): Yes — every input appears once — 40 turns up twice, but that is an output, and two inputs may land on the same one

Answer Key (9 of 12)

Is It a Function? (continued)

Is it a function? (continued)

5. (2, 45) (22, 17) (6, 31) (14, 31): Yes — every input appears once — 31 turns up twice, but that is an output, and two inputs may land on the same one
6. (2, 21) (9, 21) (8, 1) (0, 32): Yes — every input appears once — 21 turns up twice, but that is an output, and two inputs may land on the same one
7. (8, 22) (16, 49) (24, 24) (8, 17): No — the input 8 goes to 22 and also to 17, and one input may only go to one place
8. (5, 24) (6, 3) (2, 60) (10, 60): Yes — every input appears once — 60 turns up twice, but that is an output, and two inputs may land on the same one
9. (17, 9) (0, 25) (24, 25) (21, 47): Yes — every input appears once — 25 turns up twice, but that is an output, and two inputs may land on the same one
10. (5, 42) (15, 28) (12, 6) (22, 60): Yes — every input appears once, so no input can go to two places
11. (6, 32) (20, 16) (4, 48) (21, 16): Yes — every input appears once — 16 turns up twice, but that is an output, and two inputs may land on the same one
12. (0, 41) (17, 14) (20, 14) (14, 32): Yes — every input appears once — 14 turns up twice, but that is an output, and two inputs may land on the same one
13. (5, 48) (19, 27) (5, 14) (12, 33): No — the input 5 goes to 48 and also to 14, and one input may only go to one place
14. (21, 37) (5, 42) (12, 40) (23, 37): Yes — every input appears once — 37 turns up twice, but that is an output, and two inputs may land on the same one

Finding the slope

15. $y = -3x + 30 \rightarrow m = -3$
16. $y = 12x + 1 \rightarrow m = 12$
17. $y = 12x - 6 \rightarrow m = 12$
18. $y = -4x - 17 \rightarrow m = -4$
19. $y = -19 \rightarrow m = 0$
20. $y = -12x + 34 \rightarrow m = -12$
21. $y = -6x + 9 \rightarrow m = -6$
22. $y = 12x + 36 \rightarrow m = 12$
23. $y = -8x + 35 \rightarrow m = -8$
24. $y = 9x + 9 \rightarrow m = 9$

Angles in Parallel Lines

Angles in parallel lines

1. corresponding, 110°: 110°
2. corresponding, 65°: 65°
3. corresponding, 105°: 105°
4. corresponding, 50°: 50°
5. corresponding, 60°: 60°
6. corresponding, 120°: 120°
7. corresponding, 70°: 70°
8. corresponding, 125°: 125°

Angles in Parallel Lines (continued)

Angles in parallel lines (continued)

9. corresponding, 45°: 45°
10. corresponding, 135°: 135°
11. corresponding, 130°: 130°
12. corresponding, 115°: 115°
13. corresponding, 55°: 55°
14. corresponding, 75°: 75°

Rate of change from a table

15. x: 4, 8, 12, 16 y: 56, 100, 144, 188 → 11 (y moves 44 while x moves 4, and 44 ÷ 4 = 11)
16. x: 5, 8, 11, 14 y: 29, 44, 59, 74 → 5 (y moves 15 while x moves 3, and 15 ÷ 3 = 5)
17. x: 9, 10, 11, 12 y: 43, 42, 41, 40 → −1 (y moves −1 while x moves 1, and −1 ÷ 1 = −1)
18. x: 6, 11, 16, 21 y: 46, 71, 96, 121 → 5 (y moves 25 while x moves 5, and 25 ÷ 5 = 5)
19. x: 2, 7, 12, 17 y: 33, 63, 93, 123 → 6 (y moves 30 while x moves 5, and 30 ÷ 5 = 6)
20. x: 7, 11, 15, 19 y: 28, 36, 44, 52 → 2 (y moves 8 while x moves 4, and 8 ÷ 4 = 2)
21. x: 1, 2, 3, 4 y: 15, 17, 19, 21 → 2 (y moves 2 while x moves 1, and 2 ÷ 1 = 2)
22. x: 3, 5, 7, 9 y: 50, 34, 18, 2 → −8 (y moves −16 while x moves 2, and −16 ÷ 2 = −8)
23. x: 9, 11, 13, 15 y: 115, 139, 163, 187 → 12 (y moves 24 while x moves 2, and 24 ÷ 2 = 12)
24. x: 6, 7, 8, 9 y: 93, 102, 111, 120 → 9 (y moves 9 while x moves 1, and 9 ÷ 1 = 9)

Angles in a Triangle

The third angle of a triangle

1. 55° + 80° = 135°: 45°
2. 30° + 65° = 95°: 85°
3. 50° + 50° = 100°: 80°
4. 25° + 130° = 155°: 25°
5. 25° + 100° = 125°: 55°
6. 40° + 45° = 85°: 95°
7. 30° + 110° = 140°: 40°
8. 30° + 85° = 115°: 65°
9. 25° + 40° = 65°: 115°
10. 40° + 80° = 120°: 60°
11. 40° + 85° = 125°: 55°
12. 30° + 35° = 65°: 115°

Which rate is greater?

13. A y = 2x, y pages and x days B 42 pages in 7 days → B (A is 2 and B is 6 per day)
14. A 84 km in 7 hours B y = 6x, y km and x hours → A (A is 12 and B is 6 per hour)

Answer Key (10 of 12)

Angles in a Triangle (continued)

Which rate is greater? (continued)

15. A y = 11x, y km and x hours B 28 km in 7 hours → A (A is 11 and B is 4 per hour)
16. A 56 dollars in 7 weeks B y = 14x, y dollars and x weeks → B (A is 8 and B is 14 per week)
17. A y = 9x, y km and x hours B 64 km in 8 hours → A (A is 9 and B is 8 per hour)
18. A y = 11x, y words and x minutes B 20 words in 5 minutes → A (A is 11 and B is 4 per minute)
19. A 40 meters in 5 seconds B y = 11x, y meters and x seconds → B (A is 8 and B is 11 per second)
20. A 88 km in 8 hours B y = 8x, y km and x hours → A (A is 11 and B is 8 per hour)
21. A y = 2x, y words and x minutes B 60 words in 5 minutes → B (A is 2 and B is 12 per minute)
22. A y = 8x, y km and x hours B 12 km in 6 hours → A (A is 8 and B is 2 per hour)

Pythagoras

Pythagorean theorem

1. 9, 12, 15 — leg: 12 cm
2. 15, 36, 39 — leg: 36 cm
3. 12, 35, 37 — hypotenuse: 37 cm
4. 10, 24, 26 — leg: 24 cm
5. 15, 36, 39 — hypotenuse: 39 cm
6. 24, 32, 40 — leg: 32 cm
7. 7, 24, 25 — leg: 24 cm
8. 5, 12, 13 — leg: 12 cm
9. 12, 35, 37 — leg: 35 cm
10. 16, 30, 34 — leg: 30 cm
11. 24, 32, 40 — hypotenuse: 40 cm
12. 20, 21, 29 — leg: 21 cm
13. 21, 28, 35 — leg: 28 cm
14. 16, 30, 34 — hypotenuse: 34 cm

Linear or nonlinear

15. $y = 4x^2 + 19$: Nonlinear — x is squared, so the steps in y grow as x grows
16. y = 79/x: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again
17. $y = 8x^2 + 2$: Nonlinear — x is squared, so the steps in y grow as x grows
18. y = 2/x: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again
19. $y = 2x^2 + 3$: Nonlinear — x is squared, so the steps in y grow as x grows
20. y = 91/x: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again
21. y = 6: Linear — y is always 6 whatever x does — that graph is a flat line, and flat is a slope of zero rather than no slope

Pythagoras (continued)

Linear or nonlinear (continued)

22. $y = 10x^2 + 21$: Nonlinear — x is squared, so the steps in y grow as x grows
23. y = 61/x: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again
24. y = 39/x: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again

Distance Between Points

Distance between two points

1. (1, 9) to (7, 1): 10 units
2. (1, 6) to (5, 9): 5 units
3. (1, 8) to (9, 2): 10 units
4. (4, 2) to (10, 10): 10 units
5. (0, 9) to (6, 1): 10 units
6. (4, 10) to (8, 7): 5 units
7. (1, 3) to (9, 9): 10 units
8. (4, 1) to (10, 9): 10 units
9. (1, 1) to (7, 9): 10 units
10. (1, 8) to (7, 0): 10 units
11. (2, 1) to (8, 9): 10 units
12. (2, 8) to (5, 4): 5 units
13. (0, 0) to (6, 8): 10 units
14. (2, 2) to (8, 10): 10 units

Is it a function?

15. (13, 33) (12, 57) (17, 57) (18, 30): Yes — every input appears once — 57 turns up twice, but that is an output, and two inputs may land on the same one
16. (14, 28) (23, 45) (15, 14) (16, 28): Yes — every input appears once — 28 turns up twice, but that is an output, and two inputs may land on the same one
17. (7, 40) (23, 23) (7, 48) (20, 38): No — the input 7 goes to 40 and also to 48, and one input may only go to one place
18. (21, 25) (11, 45) (10, 25) (18, 50): Yes — every input appears once — 25 turns up twice, but that is an output, and two inputs may land on the same one
19. (17, 1) (20, 3) (9, 1) (19, 44): Yes — every input appears once — 1 turns up twice, but that is an output, and two inputs may land on the same one
20. (1, 59) (24, 52) (6, 54) (11, 59): Yes — every input appears once — 59 turns up twice, but that is an output, and two inputs may land on the same one
21. (4, 43) (16, 19) (16, 30) (23, 57): No — the input 16 goes to 19 and also to 30, and one input may only go to one place
22. (24, 44) (10, 59) (3, 25) (13, 25): Yes — every input appears once — 25 turns up twice, but that is an output, and two inputs may land on the same one

Answer Key (11 of 12)

Distance Between Points (continued)

Is it a function? (continued)

23. (15, 59) (18, 12) (4, 21) (2, 12): Yes — every input appears once — 12 turns up twice, but that is an output, and two inputs may land on the same one
24. (6, 52) (1, 35) (6, 26) (22, 59): No — the input 6 goes to 52 and also to 26, and one input may only go to one place

Volume of Cylinders

Volume of a cylinder

1. r = 8, h = 6: 1205.76 cm³
2. r = 9, h = 9: 2289.06 cm³
3. r = 6, h = 13: 1469.52 cm³
4. d = 12, h = 19: 2147.76 cm³
5. r = 5, h = 11: 863.5 cm³
6. d = 14, h = 15: 2307.9 cm³
7. d = 18, h = 17: 4323.78 cm³

Laws of exponents

8. $2^{12} \times 2^{7} = 2^{19}$
9. $2^{2} \times 2^{6} = 2^{8}$
10. $2^{8} \times 2^{4} = 2^{12}$
11. $8^{9} \times 8^{10} = 8^{19}$
12. $11^{9} \times 11^{3} = 11^{12}$
13. $5^{2} \times 5^{7} = 5^{9}$
14. $2^{5} \times 2^{11} = 2^{16}$

Volume of Cones

Volume of a cone

1. r = 7, h = 9: 461.58 cm³
2. r = 9, h = 15: 1271.7 cm³
3. d = 12, h = 16: 602.88 cm³
4. d = 18, h = 20: 1695.6 cm³
5. r = 6, h = 8: 301.44 cm³
6. d = 12, h = 19: 715.92 cm³
7. d = 18, h = 14: 1186.92 cm³

Square and cube roots

8. $\sqrt{484} = 22$
9. $\sqrt[3]{125} = 5$
10. $\sqrt{441} = 21$
11. $\sqrt{841} = 29$
12. $\sqrt{676} = 26$
13. $\sqrt[3]{343} = 7$
14. $\sqrt[3]{8} = 2$

Volume of Spheres

Volume of a sphere

1. r = 7: 1436.03 cm³
2. r = 10: 4186.67 cm³
3. r = 8: 2143.57 cm³

Volume of Spheres (continued)

Volume of a sphere (continued)

4. r = 9: 3052.08 cm³
5. d = 12: 904.32 cm³
6. d = 18: 3052.08 cm³
7. d = 20: 4186.67 cm³
8. d = 14: 1436.03 cm³
9. d = 16: 2143.57 cm³
10. d = 6: 113.04 cm³
11. r = 6: 904.32 cm³
12. d = 8: 267.95 cm³
13. r = 2: 33.49 cm³
14. d = 4: 33.49 cm³
15. r = 3: 113.04 cm³
16. r = 4: 267.95 cm³

Between which whole numbers

17. $\sqrt{227}$ is between 15 and 16: 15
18. $\sqrt{450}$ is between 21 and 22: 21
19. $\sqrt{291}$ is between 17 and 18: 17
20. $\sqrt{373}$ is between 19 and 20: 19
21. $\sqrt{286}$ is between 16 and 17: 16
22. $\sqrt{487}$ is between 22 and 23: 22
23. $\sqrt{394}$ is between 19 and 20: 19
24. $\sqrt{191}$ is between 13 and 14: 13
25. $\sqrt{419}$ is between 20 and 21: 20
26. $\sqrt{499}$ is between 22 and 23: 22

Two-Way Tables

Two-way tables

1. Weekend and Cash = 2
2. Bikes and None = 6
3. Indoors and Finished = 20
4. Bikes and Helmet = 13
5. Grade 8 and No pet = 1
6. Seniors and Cards = 20
7. Weekday and Card = 18
8. Large and Sold = 25

Rational or irrational

9. $\sqrt{484}$: rational — it is exactly 22, and any whole number counts as a fraction over one
10. $\sqrt[3]{64}$: rational — it is exactly 4, and any whole number counts as a fraction over one
11. $\sqrt{441}$: rational — it is exactly 21, and any whole number counts as a fraction over one
12. $\sqrt{289}$: rational — it is exactly 17, and any whole number counts as a fraction over one
13. $\sqrt{222}$: irrational — 222 is not a perfect square, so its root never ends and never repeats

Answer Key (12 of 12)

Two-Way Tables (continued)

Rational or irrational (continued)

14. $\sqrt[3]{729}$: rational — it is exactly 9, and any whole number counts as a fraction over one
15. $\sqrt{481}$: irrational — 481 is not a perfect square, so its root never ends and never repeats
16. $\sqrt[3]{1000}$: rational — it is exactly 10, and any whole number counts as a fraction over one

Scatter Plots

Scatter plots

1. Shoe size against Height (cm above 100) — Is the association positive, negative or none? positive
2. Shoe size against Height (cm above 100) — Is the pattern linear or nonlinear? linear
3. Shoe size against Height (cm above 100) — Is there a point well away from the rest? yes
4. Price (£1000s) against Age (years) — Do the points cluster along a line, or spread out? spread out

Writing numbers in full

5. $1.1 \times 10^{6} = 1100000$
6. $7.1 \times 10^{8} = 710000000$
7. $6.5 \times 10^{5} = 650000$
8. $5.4 \times 10^{8} = 540000000$

Transformations

Transformations on a grid

1. $(-5, -5)$ 180° about O: $(5, 5)$
2. $(3, -2)$ 90° counterclockwise about O: $(2, 3)$
3. $(3, 3)$ in the x-axis: $(3, -3)$
4. $(2, 4)$ 90° clockwise about O: $(4, -2)$
5. $(5, 5)$ 90° counterclockwise about O: $(-5, 5)$
6. $(-3, -5)$ 180° about O: $(3, 5)$

Multiplying and dividing in scientific notation

7. $(8 \times 10^{-1}) \times (7.5 \times 10^{7}) = 6 \times 10^{7}$
8. $(3 \times 10^{8}) \div (6 \times 10^{-3}) = 5 \times 10^{10}$
9. $(4 \times 10^{-2}) \times (2.5 \times 10^{-5}) = 1 \times 10^{-6}$
10. $(3 \times 10^{-3}) \div (5 \times 10^{7}) = 6 \times 10^{-11}$
11. $(6 \times 10^{5}) \times (6 \times 10^{2}) = 3.6 \times 10^{8}$
12. $(1.2 \times 10^{-2}) \div (3 \times 10^{-2}) = 4 \times 10^{-1}$

Check the Powers

Check the powers

1. $(x^3)^2 \cdot x^3 = x^9$, not x^{18} (the last power was multiplied in as well as the first two)
2. $(x^4)^4 \cdot x^2 = x^{18}$, not x^{32} (the last power was multiplied in as well as the first two)

Check the Powers (continued)

Check the powers (continued)

3. $x^4 \cdot x^3 \div x^2 = x^5$, not x^9 (the dividing step added its power instead of taking it away)
4. $(x^4)^3 \cdot x^2 = x^{14}$, not x^{24} (the last power was multiplied in as well as the first two)
5. $(x^4)^4 \cdot x^3 = x^{19}$, not x^{11} (the stacked powers were added where they should be multiplied)
6. $(x^3)^2 \cdot x^2 = x^8$, not x^{12} (the last power was multiplied in as well as the first two)
7. $x^3 \cdot x^4 \div x^3 = x^4$, not x^2 (the second power was taken away and the third one added)
8. $(x^3)^3 \cdot x^2 = x^{11}$, not x^{18} (the last power was multiplied in as well as the first two)

Solutions (1 of 28)

Exponent Rules

Laws of exponents

1. $2^8 \times 2^4 = 2^n$, n = ___

$$2^8 \times 2^4 = 2^{12}$$
$$n = 12$$

2^8 means 8 2s multiplied together, and 2^4 means 4 2s multiplied together. The question multiplies those two lots together.

So altogether that is 8 2s and 4 more — 8 + 4 = 12 of them.

12 2s multiplied together is 2^{12}. So n = 12. That is the shortcut: multiplying powers of the same base ADDS the exponents.

2. $9^7 \times 9^3 = 9^n$, n = ___

$$9^7 \times 9^3 = 9^{10}$$
$$n = 10$$

9^7 means 7 9s multiplied together, and 9^3 means 3 9s multiplied together. The question multiplies those two lots together.

So altogether that is 7 9s and 3 more — 7 + 3 = 10 of them.

10 9s multiplied together is 9^{10}. So n = 10. That is the shortcut: multiplying powers of the same base ADDS the exponents.

Square and Cube Roots

Square and cube roots

1. $\sqrt{729}$ = ___

$$27 \times 27 = 729$$
$$\sqrt{729} = 27$$

√ asks a question: which number times itself gives 729? It is not an instruction to halve 729 — that is the mistake this symbol collects.

Bracket it first. $20^2 = 400$, which is under 729, and $30^2 = 900$, which is over. So the answer is between 20 and 30.

Now the last digit. 729 ends in 9, and the only digits whose square ends in 9 are 3 and 7. Between 20 and 30 that leaves 23 or 27.

Two left, and the bracket picks between them: 729 is nearer 900 than 400, so take the bigger one — 27.

Check it: 27 × 27 = 729. So √729 = 27.

Solutions (2 of 28)

Square and Cube Roots (continued)

Square and cube roots (continued)

2. $\sqrt[3]{1000} =$ ___

$$10 \times 10 \times 10 = 1000$$

$$\sqrt[3]{1000} = \mathbf{10}$$

$\sqrt[3]{}$ asks a question: which number, used three times as a factor, gives 1000? It is not an instruction to divide 1000 by 3 — that is the mistake this symbol collects.

1000 is a round one: 10 is a whole ten, and $10 \times 10 \times 10 = 1000$. Powers of whole tens are worth knowing on sight — they are where a bracket starts.

So $\sqrt[3]{1000} = 10$.

Estimating Roots

Between which whole numbers

1. $\sqrt{260} >$ ___

$$\sqrt{260} > \mathbf{16}$$

Find the perfect squares on either side. 256 is 16^2 and 289 is 17^2, and 260 sits between them.

So the root is between those two whole numbers: $\sqrt{260}$ is between 16 and 17.

The smaller of the two is 16.

2. $\sqrt{419} >$ ___

$$\sqrt{419} > \mathbf{20}$$

Find the perfect squares on either side. 400 is 20^2 and 441 is 21^2, and 419 sits between them.

So the root is between those two whole numbers: $\sqrt{419}$ is between 20 and 21.

The smaller of the two is 20.

Solutions (3 of 28)

Rational and Irrational Numbers

Rational or irrational

1. **√484** **Rational** / **Irrational**

√484 is **rational**

One question decides it: can this be written as a fraction of two whole numbers? Not "does it look tidy", and not "is there a root sign" — those are the two guesses that go wrong.

Work it out rather than judging by the sign: it is exactly 22, and any whole number counts as a fraction over one.

So it CAN be written as a fraction. That makes it rational.

2. **√28** **Rational** / **Irrational**

√28 is **irrational**

One question decides it: can this be written as a fraction of two whole numbers? Not "does it look tidy", and not "is there a root sign" — those are the two guesses that go wrong.

Try to work the root out and it does not come out: 28 is not a perfect square, so its root never ends and never repeats.

So it cannot be written as a fraction of two whole numbers. That makes it irrational.

Solutions (4 of 28)

Scientific Notation

Writing numbers in full

1. **$7.5 \times 10^6 =$ _____**

7.5

75

750

7500

75000

750000

7500000

7.5×10^6 = **7500000**

10^6 is 6 tens multiplied together, which is 1000000. So this asks for 7.5 lots of 1000000.

Multiplying by ten moves every digit up one place, which shows up as the point moving one place right. There are 6 of them here, so the point moves 6 places right.

Following it the whole way: 7.5 → 75 → 750 → 7500 → 75000 → 750000 → 7500000. So 7.5×10^6 = 7500000.

2. **$5.2 \times 10^7 =$ _____**

5.2

52

520

5200

52000

520000

5200000

52000000

5.2×10^7 = **52000000**

10^7 is 7 tens multiplied together, which is 10000000. So this asks for 5.2 lots of 10000000.

Multiplying by ten moves every digit up one place, which shows up as the point moving one place right. There are 7 of them here, so the point moves 7 places right.

Following it the whole way: 5.2 → 52 → 520 → 5200 → 52000 → 520000 → 5200000 → 52000000. So 5.2×10^7 = 52000000.

Solutions (5 of 28)

Working in Scientific Notation

Multiplying and dividing in scientific notation

1. **$(4 \times 10^{8}) \times (2.5 \times 10^{-1})$**

$$(4 \times 10^{8}) \times (2.5 \times 10^{-1}) = 1 \times 10^{8}$$

A number in scientific notation is two things multiplied: a coefficient and a power of ten. They travel separately — the coefficients multiply with each other and the powers add with each other — so take them one at a time.

Multiply the coefficients: $4 \times 2.5 = 10$.

Now the powers. Multiplying powers of the same base ADDS the exponents: $8 + -1 = 7$. So the powers give 10^{7}.

Put them together: 10×10^{7}. Now CHECK it — a coefficient has to be at least 1 and less than 10, and 10 is not. This is a true number and it is not in scientific notation yet.

Move one factor of ten across: make the coefficient ten times SMALLER and the power ten times BIGGER. $10 \div 10 = 1$, and $7 + 1 = 8$. The quantity has not changed — that is why the line above was true.

So the answer is 1×10^{8} — $4 \times 2.5 = 10$ and the powers give 10^{7}, and 10 is not between 1 and 10 — so it becomes 1×10^{8}.

Solutions (6 of 28)

Working in Scientific Notation (continued)

Multiplying and dividing in scientific notation (continued)

2. **$(2 \times 10^{-2}) \div (5 \times 10^{8})$**

$(2 \times 10^{-2}) \div (5 \times 10^{8}) =$

4×10^{-11}

A number in scientific notation is two things multiplied: a coefficient and a power of ten. They travel separately — the coefficients divide with each other and the powers subtract with each other — so take them one at a time.

Divide the coefficients: $2 \div 5 = 0.4$.

Now the powers. Dividing powers of the same base SUBTRACTS the exponents: $-2 - 8 = -10$. So the powers give 10^{-10}.

Put them together: 0.4×10^{-10}. Now CHECK it — a coefficient has to be at least 1 and less than 10, and 0.4 is not. This is a true number and it is not in scientific notation yet.

Move one factor of ten the other way: make the coefficient ten times BIGGER and the power ten times SMALLER. $0.4 \times 10 = 4$, and $-10 - 1 = -11$. The quantity has not changed — that is why the line above was true.

So the answer is 4×10^{-11} — $2 \div 5 = 0.4$ and the powers give 10^{-10}, and 0.4 is not between 1 and 10 — so it becomes 4×10^{-11}.

Solutions (7 of 28)

Solving Equations

Solving equations

1. **8x + 15 = 5x + 30** ___

8x + 15 = 5x + 30

55 = 55 ✓

This one has x on BOTH sides, so nothing can be undone yet — subtracting 15 would still leave an x on the right. Collect the x terms first.

Take 5x off BOTH sides. That clears x from the right, leaving 3x + 15 = 30. That is an equation you have already met.

Two things were done to x: multiplied by 3, then 15 added. Undo them in the REVERSE order — whatever happened last comes off first.

The 15 went on last, so it comes off first — and off BOTH sides, or the two halves stop being equal. 30 – 15 = 15.

That leaves 3x, which means 3 lots of x. Divide both sides by 3: 15 ÷ 3 = 5.

Check by putting it back into the ORIGINAL, both sides: 8(5) + 15 = 55, and 5(5) + 30 = 55 — both 55, so x = 5.

2. **10x + 19 = 12x + 3** ___

10x + 19 = 12x + 3

99 = 99 ✓

This one has x on BOTH sides, so nothing can be undone yet — subtracting 19 would still leave an x on the right. Collect the x terms first.

Take 10x off BOTH sides. That clears x from the left, leaving 19 = 2x + 3. An equals sign does not care which side is which, so write it as 2x + 3 = 19. That is an equation you have already met.

Two things were done to x: multiplied by 2, then 3 added. Undo them in the REVERSE order — whatever happened last comes off first.

The 3 went on last, so it comes off first — and off BOTH sides, or the two halves stop being equal. 19 – 3 = 16.

That leaves 2x, which means 2 lots of x. Divide both sides by 2: 16 ÷ 2 = 8.

Check by putting it back into the ORIGINAL, both sides: 10(8) + 19 = 99, and 12(8) + 3 = 99 — both 99, so x = 8.

Solutions (8 of 28)

Systems of Equations

Systems of equations

1. $9x + 8y = -8$
   $6x - 8y = 8$

$x = 0$

$y = -1$

Two equations, two letters. Neither one can be solved on its own — so the first move, whichever method you use, is to get down to ONE equation with ONE letter in it.

Look at the y terms: 8y in the first and −8y in the second. They are opposites, so adding the two equations makes them cancel.

Adding is allowed because both sides of each equation are equal — adding left to left and right to right keeps the balance, the same as adding a number to both sides. That gives $15x = 0$.

One letter left. $0 \div 15 = 0$, so $x = 0$.

Now put x back into either equation to get y — this is the half that gets forgotten. It gives $y = -1$, so the solution is $(0, -1)$.

Solutions (9 of 28)

Systems of Equations (continued)

Systems of equations (continued)

2. **$-8x + 3y = -53$**
   $-10x - 3y = -19$

$x = 4$

$y = -7$

Two equations, two letters. Neither one can be solved on its own — so the first move, whichever method you use, is to get down to ONE equation with ONE letter in it.

Look at the y terms: 3y in the first and −3y in the second. They are opposites, so adding the two equations makes them cancel.

Adding is allowed because both sides of each equation are equal — adding left to left and right to right keeps the balance, the same as adding a number to both sides. That gives −18x = −72.

One letter left. −72 ÷ (−18) = 4, so x = 4.

Now put x back into either equation to get y — this is the half that gets forgotten. It gives y = −7, so the solution is (4, −7).

How Many Solutions

How many solutions?

1. **$6x - 29 = 6x - 26$**

−29 = −26 **is false**

no solution

Do not start by hunting for x. Ask a smaller question first: what is left when the x terms are collected on one side?

Both sides have the SAME number of x, so taking it off both sides removes x completely. That is not a mistake — it is the answer arriving early.

What is left is −29 = −26, which is never true, whatever x is. So there is no solution.

Solutions (10 of 28)

How Many Solutions (continued)

How many solutions? (continued)

2. **x + 50 = 50 + x**

50 = 50 **is true**

infinitely many solutions

Do not start by hunting for x. Ask a smaller question first: what is left when the x terms are collected on one side?

Both sides have the SAME number of x, so taking it off both sides removes x completely. That is not a mistake — it is the answer arriving early.

What is left is 50 = 50, which is true whatever x is. So every number works — infinitely many solutions.

Slope

Finding the slope

1. **y = 10x + 28** **m = ___**

y = 10x + 28

m = **10**

A line written this way carries two facts: how much y moves for each step of x, and where it already is when x is 0. The slope is the first.

The number multiplying x is 10, so each step of x moves y by 10.

So m = 10, and the 28 is where it starts rather than how it climbs.

2. **y = 12x + 1** **m = ___**

y = 12x + 1

m = **12**

A line written this way carries two facts: how much y moves for each step of x, and where it already is when x is 0. The slope is the first.

The number multiplying x is 12, so each step of x moves y by 12.

So m = 12, and the 1 is where it starts rather than how it climbs.

Solutions (11 of 28)

Rate of Change

Rate of change from a table

1.

x	1	4	7	10
y	33	48	63	78

rate → ___

rate of change = 5

Rate of change means how much y moves for every ONE x. So it is a division, and the two things being divided are both differences: how far y went, over how far x went.

Take both rows of steps. x moves 3, 3, 3 — the same each time — and y moves 15, 15, 15. They are steady, so this table really does have one rate rather than a different one in every gap.

Written out, that is one step of each: y moved 15 while x moved 3. Those two numbers are the whole of the division below.

Now divide: 15 ÷ 3 = 5. This is the step that gets skipped — 15 is how far y went over 3 of them, not over one.

So the rate of change is 5: y moves 15 while x moves 3, and 15 ÷ 3 = 5.

Solutions (12 of 28)

Rate of Change (continued)

Rate of change from a table (continued)

2.

x	7	11	15	19
y	39	47	55	63

rate → ___

rate of change = 2

Rate of change means how much y moves for every ONE x. So it is a division, and the two things being divided are both differences: how far y went, over how far x went.

Take both rows of steps. x moves 4, 4, 4 — the same each time — and y moves 8, 8, 8. They are steady, so this table really does have one rate rather than a different one in every gap.

Written out, that is one step of each: y moved 8 while x moved 4. Those two numbers are the whole of the division below.

Now divide: 8 ÷ 4 = 2. This is the step that gets skipped — 8 is how far y went over 4 of them, not over one.

So the rate of change is 2: y moves 8 while x moves 4, and 8 ÷ 4 = 2.

Comparing Rates

Which rate is greater?

1. A y = 10x, y meters and x seconds
   B 39 meters in 3 seconds

   A / B

A 10 B 13

greater: B

These two are written in different ways, so there is nothing to compare yet — the numbers on the page are not the same kind of number. Turn each one into a rate PER ONE second first, and do not look at which looks bigger until you have.

A: the number in front of x, which is already a rate per one second: 10. So A is 10 meters per second.

B: 39 ÷ 3 = 13. So B is 13 meters per second.

Now they can be compared: A is 10 and B is 13 per second, so B is greater.

Solutions (13 of 28)

Comparing Rates (continued)

Which rate is greater? (continued)

2. A 84 km in 7 hours
   B y = 6x, y km and x hours
   A / B

A 12 B 6

greater: A

These two are written in different ways, so there is nothing to compare yet — the numbers on the page are not the same kind of number. Turn each one into a rate PER ONE hour first, and do not look at which looks bigger until you have.

A: 84 ÷ 7 = 12. So A is 12 km per hour.

B: the number in front of x, which is already a rate per one hour: 6. So B is 6 km per hour.

Now they can be compared: A is 12 and B is 6 per hour, so A is greater.

Is It Linear?

Linear or nonlinear

1. $y = 7x^2 + 33$ Linear / Nonlinear

Linear or nonlinear?

Nonlinear

Linear means the graph is a straight line, and one thing decides it: what is being DONE to x. Multiplied by a number and added to — that is a line. Anything else is not.

Look at what x is carrying: it is squared. Squaring is not multiplying by a fixed number — going from x = 1 to 2 to 3 gives 1, 4, 9, and those gaps are 3 then 5.

So equal steps in x do NOT give equal steps in y: x is squared, so the steps in y grow as x grows. The graph curves, so it is not a line.

Solutions (14 of 28)

Is It Linear? (continued)

Linear or nonlinear (continued)

2. **y = 25/x** **Linear** / **Nonlinear**

Linear or nonlinear?

Nonlinear

Linear means the graph is a straight line, and one thing decides it: what is being DONE to x. Multiplied by a number and added to — that is a line. Anything else is not.

Look at where x sits: it is underneath, on the bottom of the fraction. Making x bigger makes y SMALLER, and not by a fixed amount each time.

So equal steps in x do NOT give equal steps in y: x is underneath, so doubling x halves y instead of adding the same amount again. The graph curves, so it is not a line.

Is It a Function?

Is it a function?

1.

x	16	9	21	10
y	46	16	22	22

inputs 16, 9, 21, 10 — no repeat

A function

A function has one rule: every input gets exactly ONE output. So there is only one column to check — the inputs, which are the top row of the table.

Pull the inputs out on their own and look at them together: 16, 9, 21, 10. Nothing about the outputs matters yet.

Now the check: every input appears once — 22 turns up twice, but that is an output, and two inputs may land on the same one.

Two different inputs are ALLOWED to land on the same output — the way both 2 and −2 square to 4, or every hour of a flat day has the same temperature. It is the input column that may not repeat, and it is the only one.

Every input has exactly one output, so this relation is a function.

Is It a Function? (continued)

Is it a function? (continued)

2.

x	10	3	6	21
y	42	42	23	43

inputs 10, 3, 6, 21 — no repeat

A function

A function has one rule: every input gets exactly ONE output. So there is only one column to check — the inputs, which are the top row of the table.

Pull the inputs out on their own and look at them together: 10, 3, 6, 21. Nothing about the outputs matters yet.

Now the check: every input appears once — 42 turns up twice, but that is an output, and two inputs may land on the same one.

Two different inputs are ALLOWED to land on the same output — the way both 2 and −2 square to 4, or every hour of a flat day has the same temperature. It is the input column that may not repeat, and it is the only one.

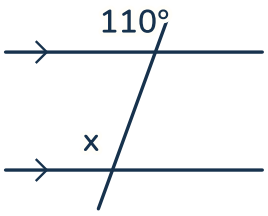
Every input has exactly one output, so this relation is a function.

Solutions (16 of 28)

Angles in Parallel Lines

Angles in parallel lines

1.



___

$110° = x$

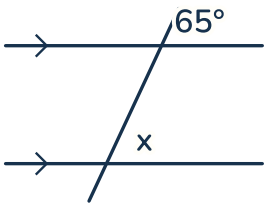
$x = 110°$

Start with the arrows: they say the two lines are parallel. Without that, none of the angle facts apply and this picture would not have an answer.

Now find where the two marked angles sit. They are in the same corner at each crossing — both above their line and both on the same side of the slanted one. That makes them corresponding angles.

Corresponding angles are equal, so x is the same as the angle already marked. x = 110°. Nothing to work out — but only once you have seen which pair it is.

2.



___

$65° = x$

$x = 65°$

Start with the arrows: they say the two lines are parallel. Without that, none of the angle facts apply and this picture would not have an answer.

Now find where the two marked angles sit. They are in the same corner at each crossing — both above their line and both on the same side of the slanted one. That makes them corresponding angles.

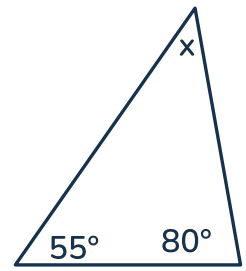
Corresponding angles are equal, so x is the same as the angle already marked. x = 65°. Nothing to work out — but only once you have seen which pair it is.

Solutions (17 of 28)

Angles in a Triangle

The third angle of a triangle

1.



___ degrees

$55 + 80 = 135$

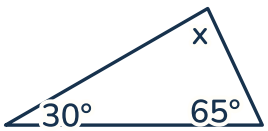
$180 - 135 = \mathbf{45°}$

Every triangle's three angles add to 180 — and that is not a number to take on trust. Tear the three corners off any triangle you like and they fit together into a straight line, every time.

Two of them are given: 55 and 80, which is 135 between them.

So the third takes up what is left of the 180: 180 – 135 = 45°.

2.



___ degrees

$30 + 65 = 95$

$180 - 95 = \mathbf{85°}$

Every triangle's three angles add to 180 — and that is not a number to take on trust. Tear the three corners off any triangle you like and they fit together into a straight line, every time.

Two of them are given: 30 and 65, which is 95 between them.

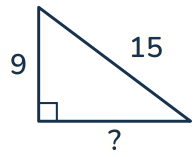
So the third takes up what is left of the 180: 180 – 95 = 85°.

Solutions (18 of 28)

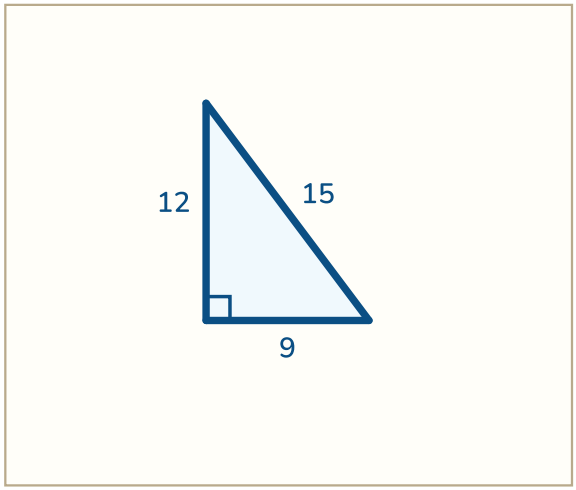
Pythagoras

Pythagorean theorem

1.



___ cm



The hypotenuse is the side OPPOSITE the right angle — never one of the two that make the corner. It is also always the longest, so you can check yourself twice.

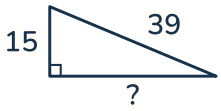
Here the hypotenuse is given — 15 cm — and a LEG is missing. That is the case where the sum is a subtraction, not an addition.

Square the two you have: $15^2 = 225$ and $9^2 = 81$.

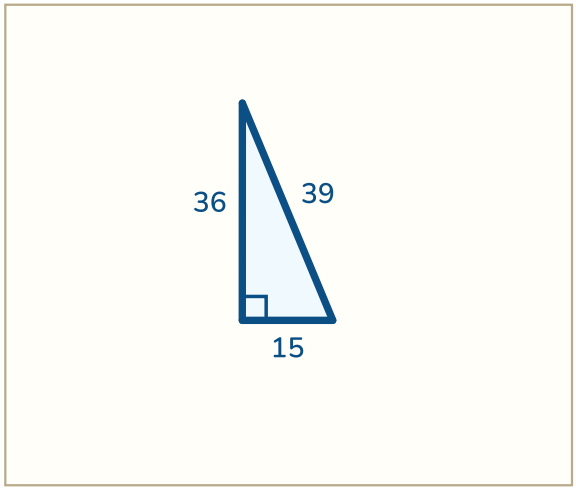
The leg's square is what is LEFT when you take the other leg's square off the hypotenuse's: $225 - 81 = 144$.

That is the square, not the side. Take the square root: $\sqrt{144} = 12$ cm.

2.



___ cm



The hypotenuse is the side OPPOSITE the right angle — never one of the two that make the corner. It is also always the longest, so you can check yourself twice.

Here the hypotenuse is given — 39 cm — and a LEG is missing. That is the case where the sum is a subtraction, not an addition.

Square the two you have: $39^2 = 1521$ and $15^2 = 225$.

The leg's square is what is LEFT when you take the other leg's square off the hypotenuse's: $1521 - 225 = 1296$.

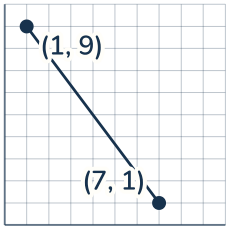
That is the square, not the side. Take the square root: $\sqrt{1296} = 36$ cm.

Solutions (19 of 28)

Distance Between Points

Distance between two points

1.



___ units

$6^2 + 8^2 = 100$

distance = **10 units**

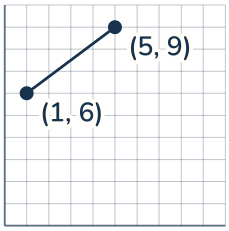
There is no new formula here. Draw the horizontal and vertical steps between the two points and they make a right triangle — the line you were given is its longest side.

Across: 7 − 1 = 6, so that side is 6 long. Up: 1 − 9 = −8, so that side is 8. A length has no sign, so take both as positive.

Now it is the theorem you already know: $6^2 + 8^2 = 36 + 64 = 100$.

The distance is the square root of that: $\sqrt{100} = 10$. So the two points are 10 units apart.

2.



___ units

$4^2 + 3^2 = 25$

distance = **5 units**

There is no new formula here. Draw the horizontal and vertical steps between the two points and they make a right triangle — the line you were given is its longest side.

Across: 5 − 1 = 4, so that side is 4 long. Up: 9 − 6 = 3, so that side is 3. A length has no sign, so take both as positive.

Now it is the theorem you already know: $4^2 + 3^2 = 16 + 9 = 25$.

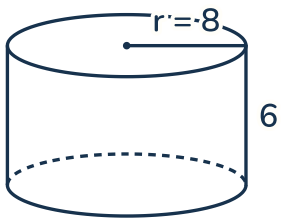
The distance is the square root of that: $\sqrt{25} = 5$. So the two points are 5 units apart.

Solutions (20 of 28)

Volume of Cylinders

Volume of a cylinder

1.



base: 200.96

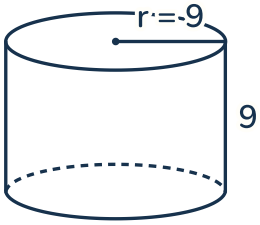
200.96 × 6 = **1205.76**

Same idea as a box: the area of the base times how tall it is. Here the base is a circle, and that is the only difference.

The circle's area is π × r × r = 3.14 × 8 × 8 = 200.96 square cm.

Times the height: 200.96 × 6 = 1205.76 cubic cm.

2.



base: 254.34

254.34 × 9 = **2289.06**

Same idea as a box: the area of the base times how tall it is. Here the base is a circle, and that is the only difference.

The circle's area is π × r × r = 3.14 × 9 × 9 = 254.34 square cm.

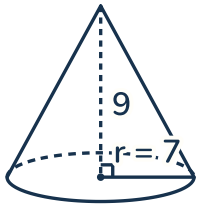
Times the height: 254.34 × 9 = 2289.06 cubic cm.

Solutions (21 of 28)

Volume of Cones

Volume of a cone

1.



cylinder: 1384.74

3 cones fill 1 cylinder

1384.74 ÷ 3 =

461.58 cubic cm

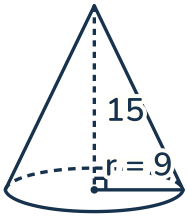
Same idea as a box: the area of the base times how tall it is. Here the base is a circle, and that is the only difference.

The circle's area is π × r × r = 3.14 × 7 × 7 = 153.86 square cm.

Times the height: 153.86 × 9 = 1384.74 cubic cm. That is the CYLINDER it fits inside, not the cone yet.

Now the part that gets forgotten. Exactly THREE cones fill the cylinder they sit inside — it is a fact about cones, not a number bolted onto a formula. So take a third: 1384.74 ÷ 3 = 461.58 cubic cm.

2.



cylinder: 3815.1

3 cones fill 1 cylinder

3815.1 ÷ 3 =

1271.7 cubic cm

Same idea as a box: the area of the base times how tall it is. Here the base is a circle, and that is the only difference.

The circle's area is π × r × r = 3.14 × 9 × 9 = 254.34 square cm.

Times the height: 254.34 × 15 = 3815.1 cubic cm. That is the CYLINDER it fits inside, not the cone yet.

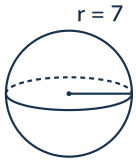
Now the part that gets forgotten. Exactly THREE cones fill the cylinder they sit inside — it is a fact about cones, not a number bolted onto a formula. So take a third: 3815.1 ÷ 3 = 1271.7 cubic cm.

Solutions (22 of 28)

Volume of Spheres

Volume of a sphere

1.



radius: 7 cm

$7 \times 7 \times 7 = 343$

$4/3 \times 3.14 \times 343 \approx 1436.03$

$1436.03\ cm^3$

The 7 cm marked here runs from the center to the surface, so it is already the radius — which is what the formula wants.

Cube the radius on a line of its own. r^3 means $r \times r \times r$, not $r \times 3$: $7 \times 7 \times 7 = 343$.

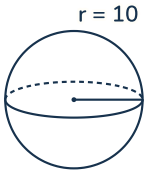
Then four-thirds of that, times π: $4/3 \times 3.14 \times 343$ comes to 1436.0267..., which is 1436.03 to two decimal places. A third rarely lands on a whole number of hundredths, so this kind of answer is usually rounded.

So the volume is 1436.03 cubic cm. Cubic, not square — a volume fills a space, and the unit is the quickest way to notice you have answered a surface-area question instead.

Volume of Spheres (continued)

Volume of a sphere (continued)

2.



radius: 10 cm

$10 \times 10 \times 10 = \mathbf{1000}$

$4/3 \times 3.14 \times 1000 \approx$

4186.67

4186.67 cm³

The 10 cm marked here runs from the center to the surface, so it is already the radius — which is what the formula wants.

Cube the radius on a line of its own. r^3 means $r \times r \times r$, not $r \times 3$: $10 \times 10 \times 10 = 1000$.

Then four-thirds of that, times π: $4/3 \times 3.14 \times 1000$ comes to 4186.6667..., which is 4186.67 to two decimal places. A third rarely lands on a whole number of hundredths, so this kind of answer is usually rounded.

So the volume is 4186.67 cubic cm. Cubic, not square — a volume fills a space, and the unit is the quickest way to notice you have answered a surface-area question instead.

Solutions (24 of 28)

Two-Way Tables

Two-way tables

1.

	CASH	CARD	TOTAL
WEEKDAY	18	19	37
WEEKEND	___	18	20
TOTAL	20	37	57

	Cash	Card	Total
Weekday	18	19	37
Weekend	**2**	18	20
Total	20	37	57

Every number in a two-way table belongs to a row AND to a column. The gap is in the Weekend row and the Cash column, so either one of them can find it — and if both give the same answer, it is right.

Along the row first. The Weekend row adds up to 20, and the other number in it is 18. So the gap is 20 − 18 = 2.

Down the column as a check. The Cash column adds up to 20, and the other number in it is 18: 20 − 18 = 2. The same 2, which is what says the table hangs together.

So the missing number is 2 — the Weekend row totals 20, and 20 − 18 = 2.

2.

	HELMET	NONE	TOTAL
BIKES	14	___	20
SCOOTERS	15	14	29
TOTAL	29	20	49

	Helmet	None	Total
Bikes	14	**6**	20
Scooters	15	14	29
Total	29	20	49

Every number in a two-way table belongs to a row AND to a column. The gap is in the Bikes row and the None column, so either one of them can find it — and if both give the same answer, it is right.

Along the row first. The Bikes row adds up to 20, and the other number in it is 14. So the gap is 20 − 14 = 6.

Down the column as a check. The None column adds up to 20, and the other number in it is 14: 20 − 14 = 6. The same 6, which is what says the table hangs together.

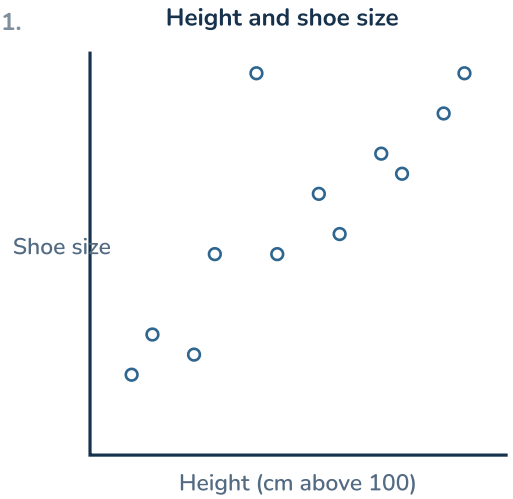
So the missing number is 6 — the Bikes row totals 20, and 20 − 14 = 6.

Solutions (25 of 28)

Scatter Plots

Scatter plots

1.



Is the association positive, negative or none?

positive negative none

positive

A scatter plot puts two measurements against each other: Height (cm above 100) along the bottom, Shoe size up the side, and one dot for each thing measured. There is no single dot to read off — every question here is about what the whole cloud is doing.

Association is about DIRECTION: as you move right, do the points tend to rise or fall? Not every point — the general drift of them.

They drift upwards to the right, so as one measurement grows the other grows with it. That is a POSITIVE association.

So the answer is "positive". Say what that means for the two things rather than for the graph — and remember it is not a claim that one CAUSES the other. Two measurements can move together for a reason that is nothing to do with either of them.

Scatter Plots (continued)

Scatter plots (continued)

2.

Is the pattern linear or nonlinear?

linear nonlinear

linear

A scatter plot puts two measurements against each other: Height (cm above 100) along the bottom, Shoe size up the side, and one dot for each thing measured. There is no single dot to read off — every question here is about what the whole cloud is doing.

Shape is about whether a straight line would follow the points, or whether they bend away from one. Sketch a line through the middle of the cloud with a finger and see.

The points stay close to that straight line all the way along, so the pattern is LINEAR.

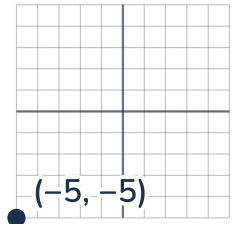
So the answer is "linear". Say what that means for the two things rather than for the graph — and remember it is not a claim that one CAUSES the other. Two measurements can move together for a reason that is nothing to do with either of them.

Solutions (27 of 28)

Transformations

Transformations on a grid

1.



180° about O

(___, ___)

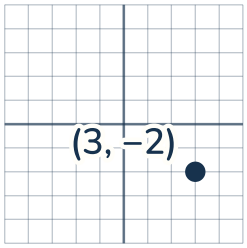
(−5, −5) → **(5, 5)**

Start where the point is: (−5, −5). The move is 180° about O, and the question is only where those two numbers end up.

Half a turn sends every point straight through the origin and out the other side, the same distance away. Both coordinates keep their size and swap sign.

So (−5, −5) lands on (5, 5).

2.



90° counterclockwise about O

(___, ___)

(3, −2)

3, −2 swap **−2, 3**

(3, −2) → **(2, 3)**

Start where the point is: (3, −2). The move is 90° counterclockwise about O, and the question is only where those two numbers end up.

A quarter turn SWAPS the two numbers — going 3 across and −2 up becomes going −2 across and 3 up — and then one of them changes sign, because the turn carries the point into a different quarter of the grid.

Turning counterclockwise, that gives (2, 3).

Solutions (28 of 28)

Check the Powers

Check the powers

1. **Sam wrote $(x^3)^2 \cdot x^3 = x^{18}$. Which is correct?**

   x^6 x^8 x^{18} x^9

   Why?

$(x^3)^2 \cdot x^3$ = **x^9**

they wrote: **x^{18}**

Do not check by reading their line. Somebody else's working is the most persuasive thing on the page, and rereading it is how you end up agreeing with it — do the step yourself first, then compare.

On your own, and writing the step nobody writes down: $(x^3)^2 \cdot x^3$ becomes $x^6 \cdot x^3$.

Tidy that up and it is x^9.

Now compare. They wrote x^{18}, and the last power was multiplied in as well as the first two — so the correct answer is x^9.

2. **Priya wrote $(x^4)^4 \cdot x^2 = x^{32}$. What should it be?**

   x^{18} x^{32} x^{10} x^{16}

   Why?

$(x^4)^4 \cdot x^2$ = **x^{18}**

they wrote: **x^{32}**

Do not check by reading their line. Somebody else's working is the most persuasive thing on the page, and rereading it is how you end up agreeing with it — do the step yourself first, then compare.

On your own, and writing the step nobody writes down: $(x^4)^4 \cdot x^2$ becomes $x^{16} \cdot x^2$.

Tidy that up and it is x^{18}.

Now compare. They wrote x^{32}, and the last power was multiplied in as well as the first two — so the correct answer is x^{18}.