Grade 8 Math Workbook

21 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 $\sqrt[3]{64} = \underline{4}$

2. Square and cube roots

Find each root. Check the symbol before you answer.

1 $\sqrt{196} =$ ___	2 $\sqrt{169} =$ ___	3 $\sqrt{729} =$ ___	4 $\sqrt{25} =$ ___
5 $\sqrt{49} =$ ___	6 $\sqrt{676} =$ ___	7 $\sqrt{4} =$ ___	8 $\sqrt[3]{1000} =$ ___
9 $\sqrt{9} =$ ___	10 $\sqrt{100} =$ ___	11 $\sqrt{400} =$ ___	12 $\sqrt{225} =$ ___
13 $\sqrt{144} =$ ___	14 $\sqrt{576} =$ ___	15 $\sqrt{36} =$ ___	16 $\sqrt[3]{27} =$ ___
17 $\sqrt{16} =$ ___	18 $\sqrt{625} =$ ___	19 $\sqrt{81} =$ ___	20 $\sqrt{64} =$ ___
21 $\sqrt{256} =$ ___	22 $\sqrt{121} =$ ___	23 $\sqrt{484} =$ ___	24 $\sqrt[3]{125} =$ ___
25 $\sqrt{324} =$ ___	26 $\sqrt[3]{1728} =$ ___	27 $\sqrt{529} =$ ___	28 $\sqrt[3]{343} =$ ___
29 $\sqrt{441} =$ ___	30 $\sqrt{361} =$ ___	31 $\sqrt[3]{216} =$ ___	32 $\sqrt{784} =$ ___
33 $\sqrt{841} =$ ___	34 $\sqrt{289} =$ ___	35 $\sqrt{900} =$ ___	36 $\sqrt[3]{512} =$ ___
37 $\sqrt[3]{1331} =$ ___	38 $\sqrt[3]{729} =$ ___		

Estimating Roots

WORKED EXAMPLE $\sqrt{83} > \underline{9}$

3. Estimating square roots

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

1 $\sqrt{165} >$ ___
2 $\sqrt{41} >$ ___
3 $\sqrt{260} >$ ___
4 $\sqrt{56} >$ ___
5 $\sqrt{79} >$ ___
6 $\sqrt{299} >$ ___
7 $\sqrt{59} >$ ___
8 $\sqrt{419} >$ ___
9 $\sqrt{136} >$ ___
10 $\sqrt{267} >$ ___
11 $\sqrt{14} >$ ___
12 $\sqrt{135} >$ ___
13 $\sqrt{232} >$ ___
14 $\sqrt{5} >$ ___
15 $\sqrt{471} >$ ___
16 $\sqrt{154} >$ ___

4. Estimating square roots

Round each root to the nearest whole number.

17 $\sqrt{123} \approx$ ___
18 $\sqrt{179} \approx$ ___
19 $\sqrt{300} \approx$ ___
20 $\sqrt{155} \approx$ ___
21 $\sqrt{112} \approx$ ___
22 $\sqrt{246} \approx$ ___
23 $\sqrt{11} \approx$ ___
24 $\sqrt{416} \approx$ ___
25 $\sqrt{189} \approx$ ___
26 $\sqrt{354} \approx$ ___
27 $\sqrt{5} \approx$ ___
28 $\sqrt{52} \approx$ ___
29 $\sqrt{224} \approx$ ___
30 $\sqrt{96} \approx$ ___
31 $\sqrt{485} \approx$ ___
32 $\sqrt{190} \approx$ ___

5. Estimating square roots

Round each root to one decimal place.

33 $\sqrt{293} \approx$ ______
34 $\sqrt{497} \approx$ ______
35 $\sqrt{90} \approx$ ______
36 $\sqrt{317} \approx$ ______
37 $\sqrt{175} \approx$ ______
38 $\sqrt{424} \approx$ ______
39 $\sqrt{374} \approx$ ______
40 $\sqrt{268} \approx$ ______
41 $\sqrt{113} \approx$ ______
42 $\sqrt{407} \approx$ ______
43 $\sqrt{362} \approx$ ______
44 $\sqrt{19} \approx$ ______

Rational and Irrational Numbers

WORKED EXAMPLE $\sqrt{576}$ Rational / Irrational

6. 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

Scientific Notation

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

7. Scientific notation

Write each number in standard form.

1 $4.6 \times 10^3 =$ ______
2 $7.5 \times 10^6 =$ ______
3 $6.9 \times 10^4 =$ ______
4 $3.4 \times 10^3 =$ ______
5 $5.2 \times 10^7 =$ ______
6 $3.5 \times 10^2 =$ ______
7 $3.4 \times 10^6 =$ ______
8 $2.1 \times 10^2 =$ ______
9 $6.6 \times 10^4 =$ ______
10 $9.2 \times 10^5 =$ ______
11 $3.1 \times 10^2 =$ ______
12 $4.8 \times 10^8 =$ ______
13 $2.4 \times 10^4 =$ ______
14 $6.9 \times 10^5 =$ ______
15 $4.7 \times 10^3 =$ ______
16 $3.3 \times 10^6 =$ ______
17 $7.8 \times 10^3 =$ ______
18 $9.1 \times 10^7 =$ ______
19 $8.9 \times 10^4 =$ ______
20 $4.5 \times 10^6 =$ ______
21 $9.9 \times 10^3 =$ ______
22 $5.4 \times 10^3 =$ ______

8. Scientific notation

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

23 $3 \times 10^{-1} =$ ______
24 $2.4 \times 10^{-4} =$ ______
25 $2.8 \times 10^{-1} =$ ______
26 $8.7 \times 10^{-2} =$ ______
27 $9.6 \times 10^{-5} =$ ______
28 $1.8 \times 10^{-1} =$ ______
29 $2.6 \times 10^{-3} =$ ______
30 $6.7 \times 10^{-1} =$ ______
31 $4 \times 10^{-2} =$ ______
32 $9.3 \times 10^{-3} =$ ______
33 $3.5 \times 10^{-2} =$ ______
34 $6.6 \times 10^{-5} =$ ______
35 $2.2 \times 10^{-2} =$ ______
36 $6.9 \times 10^{-3} =$ ______
37 $7.4 \times 10^{-2} =$ ______
38 $8.9 \times 10^{-4} =$ ______
39 $7.8 \times 10^{-1} =$ ______
40 $1.5 \times 10^{-5} =$ ______
41 $5.7 \times 10^{-1} =$ ______
42 $3.1 \times 10^{-3} =$ ______
43 $2.1 \times 10^{-2} =$ ______
44 $3.8 \times 10^{-2} =$ ______

Working in Scientific Notation

WORKED EXAMPLE

$(7.5 \times 10^{4}) \div (2.5 \times 10^{5}) = c \times 10^{n}$

c = 3 n = −1

9. Multiplying and dividing in scientific notation

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

1 $(5 \times 10^{7}) \div (2.5 \times 10^{-2}) = c \times 10^{n}$
c = _____ n = _____

2 $(4 \times 10^{8}) \times (2.5 \times 10^{-1}) = c \times 10^{n}$
c = _____ n = _____

3 $(6 \times 10^{-4}) \div (5 \times 10^{-2}) = c \times 10^{n}$
c = _____ n = _____

4 $(1.5 \times 10^{-2}) \times (6 \times 10^{-1}) = c \times 10^{n}$
c = _____ n = _____

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

6 $(3 \times 10^{8}) \div (2.5 \times 10^{-4}) = c \times 10^{n}$
c = _____ n = _____

7 $(2.5 \times 10^{3}) \times (6 \times 10^{3}) = c \times 10^{n}$
c = _____ n = _____

8 $(5 \times 10^{-3}) \div (2.5 \times 10^{5}) = c \times 10^{n}$
c = _____ n = _____

9 $(2 \times 10^{4}) \times (5 \times 10^{-3}) = c \times 10^{n}$
c = _____ n = _____

10 $(4 \times 10^{5}) \times (2 \times 10^{5}) = c \times 10^{n}$
c = _____ n = _____

11 $(3 \times 10^{7}) \div (5 \times 10^{2}) = c \times 10^{n}$
c = _____ n = _____

12 $(6 \times 10^{-4}) \div (2.5 \times 10^{3}) = c \times 10^{n}$
c = _____ n = _____

13 $(7.5 \times 10^{7}) \times (6 \times 10^{-1}) = c \times 10^{n}$
c = _____ n = _____

14 $(1.5 \times 10^{3}) \times (6 \times 10^{3}) = c \times 10^{n}$
c = _____ n = _____

15 $(7.5 \times 10^{8}) \div (5 \times 10^{-1}) = c \times 10^{n}$
c = _____ n = _____

16 $(6 \times 10^{-3}) \div (7.5 \times 10^{5}) = c \times 10^{n}$
c = _____ n = _____

17 $(4 \times 10^{5}) \times (2.5 \times 10^{5}) = c \times 10^{n}$
c = _____ n = _____

18 $(4.5 \times 10^{4}) \div (1.5 \times 10^{4}) = c \times 10^{n}$
c = _____ n = _____

19 $(5 \times 10^{5}) \times (1.2 \times 10^{-5}) = c \times 10^{n}$
c = _____ n = _____

20 $(6 \times 10^{-2}) \times (4.5 \times 10^{8}) = c \times 10^{n}$
c = _____ n = _____

21 $(3 \times 10^{-4}) \div (5 \times 10^{-5}) = c \times 10^{n}$
c = _____ n = _____

22 $(1.5 \times 10^{8}) \times (1.2 \times 10^{3}) = c \times 10^{n}$
c = _____ n = _____

23 $(4.5 \times 10^{3}) \times (8 \times 10^{8}) = c \times 10^{n}$
c = _____ n = _____

2-1

Solving Equations

WORKED EXAMPLE

$8x + 15 = 11x + 9$ 2

10. Solving equations

Solve each equation for x.

1 $2x + 16 = 5x + 10$ ___

2 $4x + 35 = 10x + 11$ ___

3 $12x + 8 = 11x + 9$ ___

4 $4x + 5 = 6x + 1$ ___

5 $10x + 24 = 12x + 10$ ___

6 $11x + 15 = 12x + 14$ ___

7 $4x + 17 = 6x + 7$ ___

8 $4x + 18 = 6x + 14$ ___

9 $6x + 6 = 7x + 2$ ___

10 $8x + 3 = 5x + 6$ ___

11 $7x + 12 = 4x + 36$ ___

12 $8x + 9 = 11x + 3$ ___

13 $x + 27 = 6x + 2$ ___

14 $2x + 7 = 4x + 5$ ___

15 $x + 37 = 4x + 10$ ___

16 $11x + 10 = 3x + 34$ ___

17 $12x + 7 = 11x + 12$ ___

18 $4x + 21 = 10x + 9$ ___

19 $4x + 38 = 8x + 2$ ___

20 $7x + 10 = x + 40$ ___

21 $11x + 14 = 2x + 32$ ___

22 $12x + 6 = 10x + 8$ ___

23 $9x + 8 = 6x + 23$ ___

24 $7x + 9 = 5x + 29$ ___

25 $2x + 31 = 12x + 1$ ___

26 $10x + 5 = 11x + 1$ ___

27 $4x + 7 = 5x + 4$ ___

28 $8x + 42 = 12x + 10$ ___

29 $12x + 11 = 11x + 13$ ___

30 $4x + 32 = 9x + 2$ ___

31 $2x + 26 = 10x + 2$ ___

32 $10x + 4 = 5x + 44$ ___

33 $3x + 5 = 2x + 11$ ___

34 $8x + 9 = 9x + 7$ ___

35 $6x + 15 = 9x + 9$ ___

36 $8x + 36 = 12x + 8$ ___

37 $10x + 21 = 12x + 9$ ___

38 $x + 17 = 2x + 15$ ___

39 $10x + 14 = 7x + 26$ ___

40 $7x + 16 = 9x + 10$ ___

41 $4x + 30 = 7x + 3$ ___

42 $x + 20 = 5x + 12$ ___

43 $9x + 8 = 3x + 44$ ___

44 $2x + 13 = 7x + 3$ ___

Systems of Equations

WORKED EXAMPLE

$-9x + 9y = -36$ x = $\underline{-3}$
$x - 9y = 60$ y = $\underline{-7}$

11. Systems of equations

Solve each pair by adding the two equations. Give x and y.

1 $11x + 9y = -4$, $-8x - 9y = -29$ x = ____ y = ____

2 $9x + 8y = -8$, $6x - 8y = 8$ x = ____ y = ____

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

4 $3x + 10y = 18$, $-4x - 10y = -24$ x = ____ y = ____

5 $-2x + 3y = -2$, $6x - 3y = 6$ x = ____ y = ____

6 $9x + 4y = 42$, $10x - 4y = -4$ x = ____ y = ____

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

8 $x + 2y = 6$, $11x - 2y = 18$ x = ____ y = ____

9 $-11x + 12y = -9$, $12x - 12y = 24$ x = ____ y = ____

10 $-10x + 6y = -54$, $-5x - 6y = 54$ x = ____ y = ____

11 $-4x + 2y = 30$, $7x - 2y = -33$ x = ____ y = ____

12 $-6x + y = -4$, $-2x - y = -4$ x = ____ y = ____

13 $10x + 8y = 56$, $5x - 8y = 4$ x = ____ y = ____

14 $-8x + 10y = -20$, $10x - 10y = 30$ x = ____ y = ____

15 $2x + 5y = -37$, $11x - 5y = 24$ x = ____ y = ____

16 $-6x + 8y = -46$, $-10x - 8y = 30$ x = ____ y = ____

17 $12x + 2y = 54$, $12x - 2y = -6$ x = ____ y = ____

18 $-7x + 7y = 21$, $2x - 7y = 39$ x = ____ y = ____

19 $-9x + 10y = -7$, $7x - 10y = 21$ x = ____ y = ____

20 $-4x + 7y = -12$, $-12x - 7y = -36$ x = ____ y = ____

21 $5x + 2y = 27$, $-8x - 2y = -36$ x = ____ y = ____

22 $-12x + 2y = 40$, $-10x - 2y = -18$ x = ____ y = ____

Slope

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

12. Slope and y-intercept

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 $y = x + 10$ $m =$ ____

13. Slope and y-intercept

Write the y-intercept of each line.

23 $y = -11x - 17$ $b =$ ____

24 $y = -6x - 24$ $b =$ ____

25 $y = -2x - 26$ $b =$ ____

26 $y = -10x - 27$ $b =$ ____

27 $y = -6x - 22$ $b =$ ____

28 $y = 5x - 26$ $b =$ ____

29 $y = 3x - 25$ $b =$ ____

30 $y = 9x - 9$ $b =$ ____

31 $y = 6x + 40$ $b =$ ____

32 $y = 3x - 23$ $b =$ ____

33 $y = -9x - 21$ $b =$ ____

34 $y = 5x + 3$ $b =$ ____

35 $y = -x - 4$ $b =$ ____

36 $y = -7x + 38$ $b =$ ____

37 $y = -11x + 17$ $b =$ ____

38 $y = -5x - 18$ $b =$ ____

39 $y = 11x + 19$ $b =$ ____

40 $y = 11x + 33$ $b =$ ____

41 $y = -6x + 36$ $b =$ ____

42 $y = -7x - 12$ $b =$ ____

43 $y = 6x + 2$ $b =$ ____

44 $y = 12x - 14$ $b =$ ____

Rate of Change

WORKED EXAMPLE

x	5	6	7	8
y	29	24	19	14

rate → −5

14. Rate of change from a table

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

1

x	1	2	3	4
y	42	33	24	15

rate → ___

2

x	1	4	7	10
y	33	48	63	78

rate → ___

3

x	3	4	5	6
y	35	32	29	26

rate → ___

4

x	2	3	4	5
y	51	57	63	69

rate → ___

5

x	7	11	15	19
y	39	47	55	63

rate → ___

6

x	6	7	8	9
y	55	47	39	31

rate → ___

7

x	9	13	17	21
y	37	41	45	49

rate → ___

8

x	3	4	5	6
y	18	12	6	0

rate → ___

9

x	6	10	14	18
y	59	83	107	131

rate → ___

10

x	4	5	6	7
y	59	65	71	77

rate → ___

11

x	9	10	11	12
y	58	52	46	40

rate → ___

12

x	4	8	12	16
y	49	89	129	169

rate → ___

13

x	6	7	8	9
y	61	65	69	73

rate → ___

14

x	2	8	14	20
y	21	81	141	201

rate → ___

15

x	6	7	8	9
y	20	17	14	11

rate → ___

16

x	2	7	12	17
y	154	109	64	19

rate → ___

17

x	2	3	4	5
y	42	44	46	48

rate → ___

18

x	3	5	7	9
y	50	34	18	2

rate → ___

19

x	1	2	3	4
y	48	56	64	72

rate → ___

20

x	3	4	5	6
y	46	49	52	55

rate → ___

21

x	2	7	12	17
y	38	48	58	68

rate → ___

22

x	6	7	8	9
y	86	94	102	110

rate → ___

23

x	7	10	13	16
y	51	36	21	6

rate → ___

24

x	8	9	10	11
y	26	23	20	17

rate → ___

Comparing Rates

WORKED EXAMPLE

A 24 meters in 4 seconds
B $y = 14x$, y meters and x seconds
A / B

15. 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

3-4

Is It Linear?

WORKED EXAMPLE $y = 13x + 17$ Linear / Nonlinear

16. Linear or nonlinear

Is each equation linear or nonlinear? Circle one.

1 $y = 6x - 38$ Linear / Nonlinear

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

3 $y = 19x - 20$ Linear / Nonlinear

4 $y = 25/x$ Linear / Nonlinear

5 $y = x/4 + 9$ Linear / Nonlinear

6 $y = 7x^3 + 39$ Linear / Nonlinear

7 $y = 11x - 31$ Linear / Nonlinear

8 $y = 92$ Linear / Nonlinear

9 $y = 4x^2 + 33$ Linear / Nonlinear

10 $y = 22x - 45$ Linear / Nonlinear

11 $y = 54/x$ Linear / Nonlinear

12 $y = 4x^2 + 25$ Linear / Nonlinear

13 $y = 18x + 4$ Linear / Nonlinear

14 $y = 61/x$ Linear / Nonlinear

15 $y = 5x^2 + 18$ Linear / Nonlinear

16 $y = 9x + 13$ Linear / Nonlinear

17 $y = 43/x$ Linear / Nonlinear

18 $y = x/2 + 28$ Linear / Nonlinear

Is It a Function?

WORKED EXAMPLE

x	4	6	15	6
y	58	38	32	49

Yes / No

17. Is it a function?

Does each table show a function? Circle one.

1

x	10	15	14	15
y	40	52	33	56

Yes / No

2

x	16	9	21	10
y	46	16	22	22

Yes / No

3

x	8	16	24	8
y	22	49	24	17

Yes / No

4

x	10	3	6	21
y	42	42	23	43

Yes / No

5

x	5	15	12	22
y	42	28	6	60

Yes / No

6

x	23	17	10	18
y	40	11	36	40

Yes / No

7

x	5	19	5	12
y	48	27	14	33

Yes / No

8

x	17	2	11	9
y	18	51	41	38

Yes / No

9

x	2	22	6	14
y	45	17	31	31

Yes / No

10

x	2	15	20	20
y	18	16	13	29

Yes / No

11

x	2	9	8	0
y	21	21	1	32

Yes / No

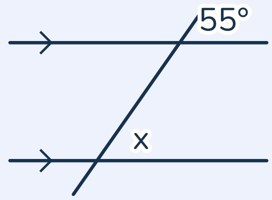
12

x	22	22	13	19
y	57	26	30	60

Yes / No

Angles in Parallel Lines

WORKED EXAMPLE

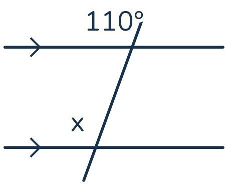


55

18. Angles in parallel lines

The two lines are parallel. Find x.

1



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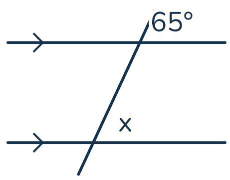

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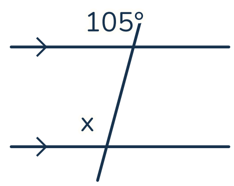

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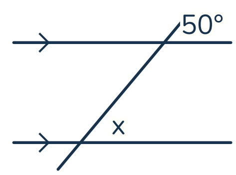

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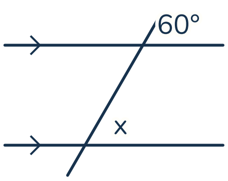

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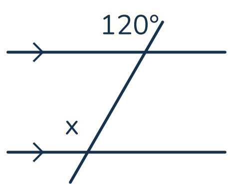

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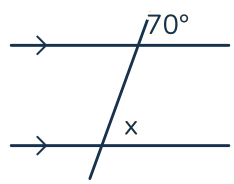

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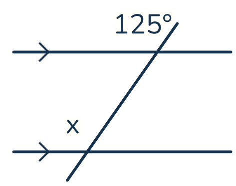

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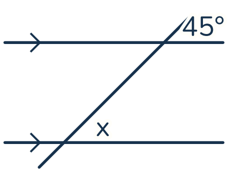

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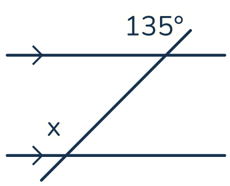

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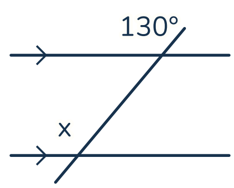
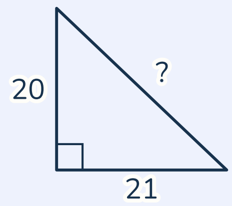


Pythagoras

WORKED EXAMPLE

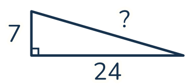


29 cm

19. Pythagorean theorem

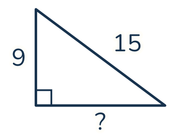
Find the missing side. All lengths are in centimeters.

1



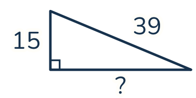
________ cm

2



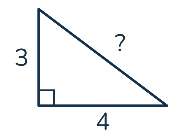
________ cm

3



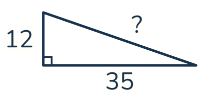
________ cm

4



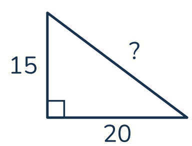
________ cm

5



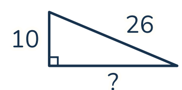
________ cm

6



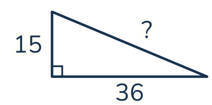
________ cm

7



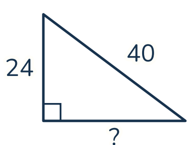
________ cm

8



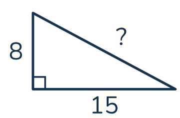
________ cm

9



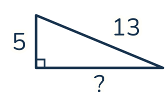
________ cm

10



________ cm

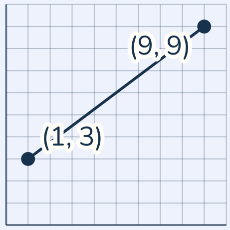
11



________ cm

Distance Between Points

WORKED EXAMPLE

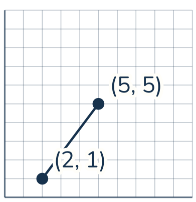


10 units

20. Distance between two points

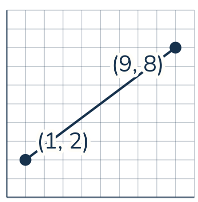
Find the distance between the two points.

1



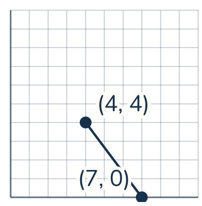
______________ units

2



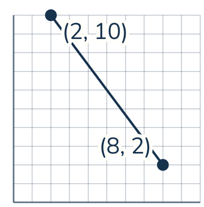
______________ units

3



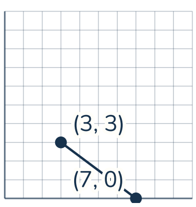
______________ units

4



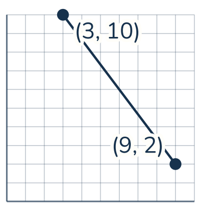
______________ units

5



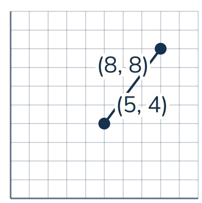
______________ units

6



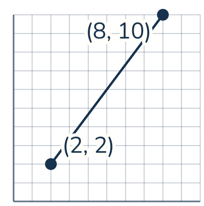
______________ units

7



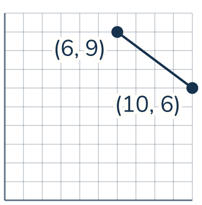
______________ units

8



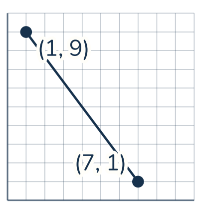
______________ units

9



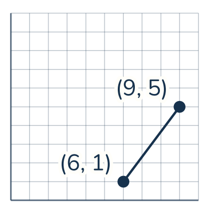
______________ units

10



______________ units

11

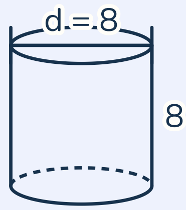


______________ units

4-4

Volume of Cylinders

WORKED EXAMPLE

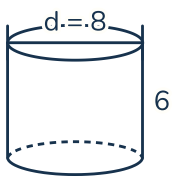


401.92

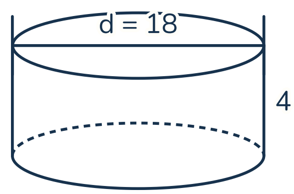
21. Volume of a cylinder

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

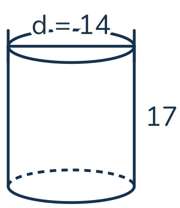
1



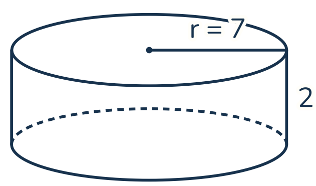
2



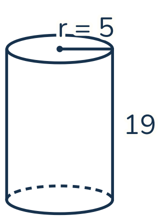
3



4



5



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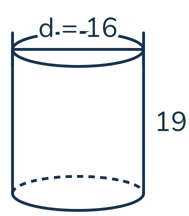
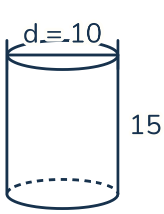
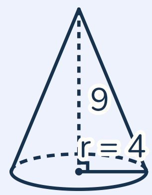


7



Volume of Cones

WORKED EXAMPLE

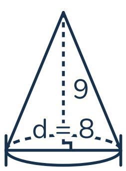


150.72

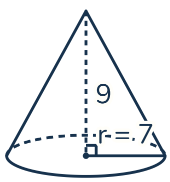
22. Volume of a cone

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

1



2



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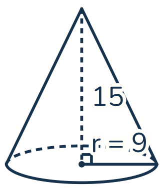

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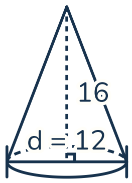

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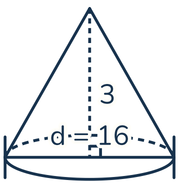

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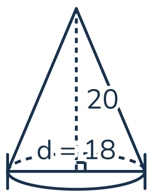

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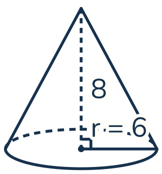
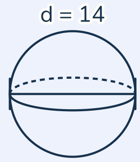


Volume of Spheres

WORKED EXAMPLE

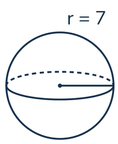


1436.03

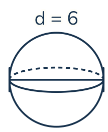
23. Volume of a sphere

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

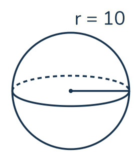
1



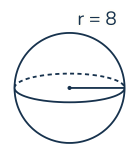
2



3



4



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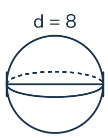

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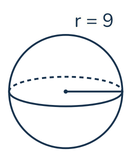

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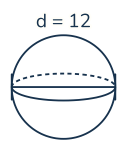


5-1

Two-Way Tables

WORKED EXAMPLE

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

24. 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

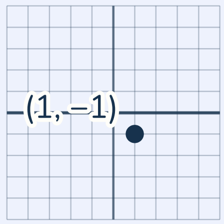
	CASH	CARD	TOTAL
WEEKDAY	7	___	25
WEEKEND	7	24	31
TOTAL	14	42	56

8

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

Transformations

WORKED EXAMPLE



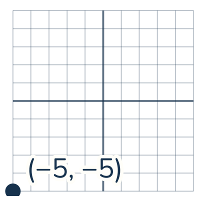
in the x-axis

(1 , 1)

25. Transformations on a grid

Move each point as described. Write where it lands.

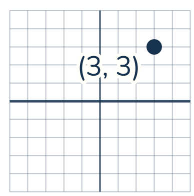
1



180° about O

(______ , ______)

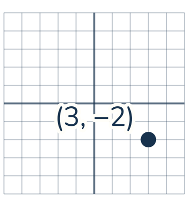
2



in the x-axis

(______ , ______)

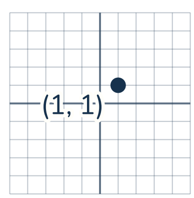
3



90° counterclockwise about O

(______ , ______)

4



5 left and 3 up

(______ , ______)

Answer Key (1 of 7)

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. $\sqrt{196} = 14$
2. $\sqrt{169} = 13$
3. $\sqrt{729} = 27$
4. $\sqrt{25} = 5$
5. $\sqrt{49} = 7$
6. $\sqrt{676} = 26$
7. $\sqrt{4} = 2$
8. $\sqrt[3]{1000} = 10$
9. $\sqrt{9} = 3$
10. $\sqrt{100} = 10$
11. $\sqrt{400} = 20$
12. $\sqrt{225} = 15$
13. $\sqrt{144} = 12$
14. $\sqrt{576} = 24$
15. $\sqrt{36} = 6$
16. $\sqrt[3]{27} = 3$
17. $\sqrt{16} = 4$
18. $\sqrt{625} = 25$
19. $\sqrt{81} = 9$
20. $\sqrt{64} = 8$
21. $\sqrt{256} = 16$
22. $\sqrt{121} = 11$
23. $\sqrt{484} = 22$
24. $\sqrt[3]{125} = 5$
25. $\sqrt{324} = 18$
26. $\sqrt[3]{1728} = 12$
27. $\sqrt{529} = 23$
28. $\sqrt[3]{343} = 7$
29. $\sqrt{441} = 21$
30. $\sqrt{361} = 19$
31. $\sqrt[3]{216} = 6$
32. $\sqrt{784} = 28$
33. $\sqrt{841} = 29$
34. $\sqrt{289} = 17$
35. $\sqrt{900} = 30$
36. $\sqrt[3]{512} = 8$
37. $\sqrt[3]{1331} = 11$
38. $\sqrt[3]{729} = 9$

Estimating Roots

Estimating square roots

1. $\sqrt{165}$ is between 12 and 13: 12
2. $\sqrt{41}$ is between 6 and 7: 6
3. $\sqrt{260}$ is between 16 and 17: 16
4. $\sqrt{56}$ is between 7 and 8: 7
5. $\sqrt{79}$ is between 8 and 9: 8

Estimating Roots (continued)

Estimating square roots (continued)

6. √299 is between 17 and 18: 17
7. √59 is between 7 and 8: 7
8. √419 is between 20 and 21: 20
9. √136 is between 11 and 12: 11
10. √267 is between 16 and 17: 16
11. √14 is between 3 and 4: 3
12. √135 is between 11 and 12: 11
13. √232 is between 15 and 16: 15
14. √5 is between 2 and 3: 2
15. √471 is between 21 and 22: 21
16. √154 is between 12 and 13: 12

Estimating square roots

17. √123 is between 11 and 12: 11
18. √179 is between 13 and 14: 13
19. √300 is between 17 and 18: 17
20. √155 is between 12 and 13: 12
21. √112 is between 10 and 11: 11
22. √246 is between 15 and 16: 16
23. √11 is between 3 and 4: 3
24. √416 is between 20 and 21: 20
25. √189 is between 13 and 14: 14
26. √354 is between 18 and 19: 19
27. √5 is between 2 and 3: 2
28. √52 is between 7 and 8: 7
29. √224 is between 14 and 15: 15
30. √96 is between 9 and 10: 10
31. √485 is between 22 and 23: 22
32. √190 is between 13 and 14: 14

Estimating square roots

33. √293 is between 17 and 18: 17.1
34. √497 is between 22 and 23: 22.3
35. √90 is between 9 and 10: 9.5
36. √317 is between 17 and 18: 17.8
37. √175 is between 13 and 14: 13.2
38. √424 is between 20 and 21: 20.6
39. √374 is between 19 and 20: 19.3
40. √268 is between 16 and 17: 16.4
41. √113 is between 10 and 11: 10.6
42. √407 is between 20 and 21: 20.2
43. √362 is between 19 and 20: 19
44. √19 is between 4 and 5: 4.4

Rational and Irrational Numbers

Rational or irrational

1. √484: rational — it is exactly 22, and any whole number counts as a fraction over one

Rational and Irrational Numbers (continued)

Rational or irrational (continued)

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. ∛729: rational — it is exactly 9, and any whole number counts as a fraction over one
5. ∛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. ∛1000: rational — it is exactly 10, and any whole number counts as a fraction over one
8. √25: rational — it is exactly 5, and any whole number counts as a fraction over one
9. ∛512: rational — it is exactly 8, and any whole number counts as a fraction over one
10. √4: rational — it is exactly 2, and any whole number counts as a fraction over one
11. √100: rational — it is exactly 10, and any whole number counts as a fraction over one
12. ∛1728: rational — it is exactly 12, and any whole number counts as a fraction over one
13. √142: irrational — 142 is not a perfect square, so its root never ends and never repeats
14. √50: irrational — 50 is not a perfect square, so its root never ends and never repeats
15. √118: irrational — 118 is not a perfect square, so its root never ends and never repeats
16. √9: rational — it is exactly 3, and any whole number counts as a fraction over one
17. √66: irrational — 66 is not a perfect square, so its root never ends and never repeats
18. √49: rational — it is exactly 7, and any whole number counts as a fraction over one
19. √13: irrational — 13 is not a perfect square, so its root never ends and never repeats
20. √101: irrational — 101 is not a perfect square, so its root never ends and never repeats
21. ∛343: rational — it is exactly 7, and any whole number counts as a fraction over one
22. √102: irrational — 102 is not a perfect square, so its root never ends and never repeats
23. √170: irrational — 170 is not a perfect square, so its root never ends and never repeats
24. √33: irrational — 33 is not a perfect square, so its root never ends and never repeats
25. √628: irrational — 628 is not a perfect square, so its root never ends and never repeats
26. √624: irrational — 624 is not a perfect square, so its root never ends and never repeats

Answer Key (3 of 7)

Rational and Irrational Numbers (continued)

Rational or irrational (continued)

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
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

Scientific Notation

Scientific notation

1. $4.6 \times 10^3 = 4600$
2. $7.5 \times 10^6 = 7500000$
3. $6.9 \times 10^4 = 69000$
4. $3.4 \times 10^3 = 3400$
5. $5.2 \times 10^7 = 52000000$
6. $3.5 \times 10^2 = 350$
7. $3.4 \times 10^6 = 3400000$
8. $2.1 \times 10^2 = 210$
9. $6.6 \times 10^4 = 66000$
10. $9.2 \times 10^5 = 920000$
11. $3.1 \times 10^2 = 310$
12. $4.8 \times 10^8 = 480000000$
13. $2.4 \times 10^4 = 24000$
14. $6.9 \times 10^5 = 690000$
15. $4.7 \times 10^3 = 4700$
16. $3.3 \times 10^6 = 3300000$
17. $7.8 \times 10^3 = 7800$
18. $9.1 \times 10^7 = 91000000$
19. $8.9 \times 10^4 = 89000$
20. $4.5 \times 10^6 = 4500000$
21. $9.9 \times 10^3 = 9900$
22. $5.4 \times 10^3 = 5400$

Scientific Notation (continued)

Scientific notation

23. $3 \times 10^{-1} = 0.3$
24. $2.4 \times 10^{-4} = 0.00024$
25. $2.8 \times 10^{-1} = 0.28$
26. $8.7 \times 10^{-2} = 0.087$
27. $9.6 \times 10^{-5} = 0.000096$
28. $1.8 \times 10^{-1} = 0.18$
29. $2.6 \times 10^{-3} = 0.0026$
30. $6.7 \times 10^{-1} = 0.67$
31. $4 \times 10^{-2} = 0.04$
32. $9.3 \times 10^{-3} = 0.0093$
33. $3.5 \times 10^{-2} = 0.035$
34. $6.6 \times 10^{-5} = 0.000066$
35. $2.2 \times 10^{-2} = 0.022$
36. $6.9 \times 10^{-3} = 0.0069$
37. $7.4 \times 10^{-2} = 0.074$
38. $8.9 \times 10^{-4} = 0.00089$
39. $7.8 \times 10^{-1} = 0.78$
40. $1.5 \times 10^{-5} = 0.000015$
41. $5.7 \times 10^{-1} = 0.57$
42. $3.1 \times 10^{-3} = 0.0031$
43. $2.1 \times 10^{-2} = 0.021$
44. $3.8 \times 10^{-2} = 0.038$

Working in Scientific Notation

Multiplying and dividing in scientific notation

1. $(5 \times 10^7) \div (2.5 \times 10^{-2}) = 2 \times 10^9$
2. $(4 \times 10^8) \times (2.5 \times 10^{-1}) = 1 \times 10^8$
3. $(6 \times 10^{-4}) \div (5 \times 10^{-2}) = 1.2 \times 10^{-2}$
4. $(1.5 \times 10^{-2}) \times (6 \times 10^{-1}) = 9 \times 10^{-3}$
5. $(2 \times 10^{-2}) \div (5 \times 10^8) = 4 \times 10^{-11}$
6. $(3 \times 10^8) \div (2.5 \times 10^{-4}) = 1.2 \times 10^{12}$
7. $(2.5 \times 10^3) \times (6 \times 10^3) = 1.5 \times 10^7$
8. $(5 \times 10^{-3}) \div (2.5 \times 10^5) = 2 \times 10^{-8}$
9. $(2 \times 10^4) \times (5 \times 10^{-3}) = 1 \times 10^2$
10. $(4 \times 10^5) \times (2 \times 10^5) = 8 \times 10^{10}$
11. $(3 \times 10^7) \div (5 \times 10^2) = 6 \times 10^4$
12. $(6 \times 10^{-4}) \div (2.5 \times 10^3) = 2.4 \times 10^{-7}$
13. $(7.5 \times 10^7) \times (6 \times 10^{-1}) = 4.5 \times 10^7$
14. $(1.5 \times 10^3) \times (6 \times 10^3) = 9 \times 10^6$
15. $(7.5 \times 10^8) \div (5 \times 10^{-1}) = 1.5 \times 10^9$
16. $(6 \times 10^{-3}) \div (7.5 \times 10^5) = 8 \times 10^{-9}$
17. $(4 \times 10^5) \times (2.5 \times 10^5) = 1 \times 10^{11}$
18. $(4.5 \times 10^4) \div (1.5 \times 10^4) = 3 \times 10^0$
19. $(5 \times 10^5) \times (1.2 \times 10^{-5}) = 6 \times 10^0$
20. $(6 \times 10^{-2}) \times (4.5 \times 10^8) = 2.7 \times 10^7$
21. $(3 \times 10^{-4}) \div (5 \times 10^{-5}) = 6 \times 10^0$

Working in Scientific Notation (continued)

Multiplying and dividing in scientific notation (continued)

22. $(1.5 \times 10^8) \times (1.2 \times 10^3) = 1.8 \times 10^{11}$
23. $(4.5 \times 10^3) \times (8 \times 10^8) = 3.6 \times 10^{12}$

Solving Equations

Solving equations

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

Solving Equations (continued)

Solving equations (continued)

42. x + 20 = 5x + 12 → x = 2
43. 9x + 8 = 3x + 44 → x = 6
44. 2x + 13 = 7x + 3 → x = 2

Systems of Equations

Systems of equations

1. 11x + 9y = −4, −8x − 9y = −29 → (−11, 13)
2. 9x + 8y = −8, 6x − 8y = 8 → (0, −1)
3. −2x + 6y = −10, 11x − 6y = 55 → (5, 0)
4. 3x + 10y = 18, −4x − 10y = −24 → (6, 0)
5. −2x + 3y = −2, 6x − 3y = 6 → (1, 0)
6. 9x + 4y = 42, 10x − 4y = −4 → (2, 6)
7. 7x + 11y = 42, 6x − 11y = 36 → (6, 0)
8. x + 2y = 6, 11x − 2y = 18 → (2, 2)
9. −11x + 12y = −9, 12x − 12y = 24 → (15, 13)
10. −10x + 6y = −54, −5x − 6y = 54 → (0, −9)
11. −4x + 2y = 30, 7x − 2y = −33 → (−1, 13)
12. −6x + y = −4, −2x − y = −4 → (1, 2)
13. 10x + 8y = 56, 5x − 8y = 4 → (4, 2)
14. −8x + 10y = −20, 10x − 10y = 30 → (5, 2)
15. 2x + 5y = −37, 11x − 5y = 24 → (−1, −7)
16. −6x + 8y = −46, −10x − 8y = 30 → (1, −5)
17. 12x + 2y = 54, 12x − 2y = −6 → (2, 15)
18. −7x + 7y = 21, 2x − 7y = 39 → (−12, −9)
19. −9x + 10y = −7, 7x − 10y = 21 → (−7, −7)
20. −4x + 7y = −12, −12x − 7y = −36 → (3, 0)
21. 5x + 2y = 27, −8x − 2y = −36 → (3, 6)
22. −12x + 2y = 40, −10x − 2y = −18 → (−1, 14)

Slope

Slope and y-intercept

1. y = 10x + 28 → m = 10
2. y = 12x + 1 → m = 12
3. y = 8x + 22 → m = 8
4. y = −4x − 25 → m = −4
5. y = −6x − 17 → m = −6
6. y = 8x − 28 → m = 8
7. y = x + 5 → m = 1
8. y = −10x − 20 → m = −10
9. y = −2x − 2 → m = −2
10. y = x + 26 → m = 1
11. y = 10x + 38 → m = 10
12. y = −12x − 24 → m = −12
13. y = −4x − 23 → m = −4
14. y = −6x − 24 → m = −6
15. y = 6x − 7 → m = 6

Answer Key (5 of 7)

Slope (continued)

Slope and y-intercept (continued)

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. $y = x + 10 \rightarrow m = 1$

Slope and y-intercept

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

Rate of Change

Rate of change from a table

1. x: 1, 2, 3, 4 y: 42, 33, 24, 15 → −9 (y moves −9 while x moves 1, and $-9 \div 1 = -9$)
2. x: 1, 4, 7, 10 y: 33, 48, 63, 78 → 5 (y moves 15 while x moves 3, and $15 \div 3 = 5$)
3. x: 3, 4, 5, 6 y: 35, 32, 29, 26 → −3 (y moves −3 while x moves 1, and $-3 \div 1 = -3$)
4. x: 2, 3, 4, 5 y: 51, 57, 63, 69 → 6 (y moves 6 while x moves 1, and $6 \div 1 = 6$)
5. x: 7, 11, 15, 19 y: 39, 47, 55, 63 → 2 (y moves 8 while x moves 4, and $8 \div 4 = 2$)
6. x: 6, 7, 8, 9 y: 55, 47, 39, 31 → −8 (y moves −8 while x moves 1, and $-8 \div 1 = -8$)
7. x: 9, 13, 17, 21 y: 37, 41, 45, 49 → 1 (y moves 4 while x moves 4, and $4 \div 4 = 1$)

Rate of Change (continued)

Rate of change from a table (continued)

8. x: 3, 4, 5, 6 y: 18, 12, 6, 0 → −6 (y moves −6 while x moves 1, and $-6 \div 1 = -6$)
9. x: 6, 10, 14, 18 y: 59, 83, 107, 131 → 6 (y moves 24 while x moves 4, and $24 \div 4 = 6$)
10. x: 4, 5, 6, 7 y: 59, 65, 71, 77 → 6 (y moves 6 while x moves 1, and $6 \div 1 = 6$)
11. x: 9, 10, 11, 12 y: 58, 52, 46, 40 → −6 (y moves −6 while x moves 1, and $-6 \div 1 = -6$)
12. x: 4, 8, 12, 16 y: 49, 89, 129, 169 → 10 (y moves 40 while x moves 4, and $40 \div 4 = 10$)
13. x: 6, 7, 8, 9 y: 61, 65, 69, 73 → 4 (y moves 4 while x moves 1, and $4 \div 1 = 4$)
14. x: 2, 8, 14, 20 y: 21, 81, 141, 201 → 10 (y moves 60 while x moves 6, and $60 \div 6 = 10$)
15. x: 6, 7, 8, 9 y: 20, 17, 14, 11 → −3 (y moves −3 while x moves 1, and $-3 \div 1 = -3$)
16. x: 2, 7, 12, 17 y: 154, 109, 64, 19 → −9 (y moves −45 while x moves 5, and $-45 \div 5 = -9$)
17. x: 2, 3, 4, 5 y: 42, 44, 46, 48 → 2 (y moves 2 while x moves 1, and $2 \div 1 = 2$)
18. x: 3, 5, 7, 9 y: 50, 34, 18, 2 → −8 (y moves −16 while x moves 2, and $-16 \div 2 = -8$)
19. x: 1, 2, 3, 4 y: 48, 56, 64, 72 → 8 (y moves 8 while x moves 1, and $8 \div 1 = 8$)
20. x: 3, 4, 5, 6 y: 46, 49, 52, 55 → 3 (y moves 3 while x moves 1, and $3 \div 1 = 3$)
21. x: 2, 7, 12, 17 y: 38, 48, 58, 68 → 2 (y moves 10 while x moves 5, and $10 \div 5 = 2$)
22. x: 6, 7, 8, 9 y: 86, 94, 102, 110 → 8 (y moves 8 while x moves 1, and $8 \div 1 = 8$)
23. x: 7, 10, 13, 16 y: 51, 36, 21, 6 → −5 (y moves −15 while x moves 3, and $-15 \div 3 = -5$)
24. x: 8, 9, 10, 11 y: 26, 23, 20, 17 → −3 (y moves −3 while x moves 1, and $-3 \div 1 = -3$)

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)

Answer Key (6 of 7)

Comparing Rates (continued)

Which rate is greater? (continued)

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)

Is It Linear?

Linear or nonlinear

1. $y = 6x - 38$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
2. $y = 7x^2 + 33$: Nonlinear — x is squared, so the steps in y grow as x grows
3. $y = 19x - 20$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
4. $y = 25/x$: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again
5. $y = x/4 + 9$: Linear — dividing by 4 is multiplying by a number, so the steps in y stay equal
6. $y = 7x^3 + 39$: Nonlinear — x is cubed, so the steps in y grow as x grows
7. $y = 11x - 31$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
8. $y = 92$: 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
9. $y = 4x^2 + 33$: Nonlinear — x is squared, so the steps in y grow as x grows
10. $y = 22x - 45$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
11. $y = 54/x$: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again
12. $y = 4x^2 + 25$: Nonlinear — x is squared, so the steps in y grow as x grows
13. $y = 18x + 4$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
14. $y = 61/x$: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again
15. $y = 5x^2 + 18$: Nonlinear — x is squared, so the steps in y grow as x grows
16. $y = 9x + 13$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
17. $y = 43/x$: Nonlinear — x is underneath, so doubling x halves y instead of adding the same amount again

Is It Linear? (continued)

Linear or nonlinear (continued)

18. $y = x/2 + 28$: Linear — dividing by 2 is multiplying by a number, so the steps in y stay equal

Is It a Function?

Is it a function?

1. (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
2. (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
3. (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
4. (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
5. (5, 42) (15, 28) (12, 6) (22, 60): Yes — every input appears once, so no input can go to two places
6. (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
7. (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
8. (17, 18) (2, 51) (11, 41) (9, 38): Yes — every input appears once, so no input can go to two places
9. (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
10. (2, 18) (15, 16) (20, 13) (20, 29): No — the input 20 goes to 13 and also to 29, and one input may only go to one place
11. (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
12. (22, 57) (22, 26) (13, 30) (19, 60): No — the input 22 goes to 57 and also to 26, and one input may only go to one place

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°
9. corresponding, 45°: 45°
10. corresponding, 135°: 135°

Answer Key (7 of 7)

Angles in Parallel Lines (continued)

Angles in parallel lines (continued)

11. corresponding, 130°: 130°

Pythagoras

Pythagorean theorem

1. 7, 24, 25 — hypotenuse: 25 cm
2. 9, 12, 15 — leg: 12 cm
3. 15, 36, 39 — leg: 36 cm
4. 3, 4, 5 — hypotenuse: 5 cm
5. 12, 35, 37 — hypotenuse: 37 cm
6. 15, 20, 25 — hypotenuse: 25 cm
7. 10, 24, 26 — leg: 24 cm
8. 15, 36, 39 — hypotenuse: 39 cm
9. 24, 32, 40 — leg: 32 cm
10. 8, 15, 17 — hypotenuse: 17 cm
11. 5, 12, 13 — leg: 12 cm

Distance Between Points

Distance between two points

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

Volume of Cylinders

Volume of a cylinder

1. d = 8, h = 6: 301.44 cm^3
2. d = 18, h = 4: 1017.36 cm^3
3. d = 14, h = 17: 2615.62 cm^3
4. r = 7, h = 2: 307.72 cm^3
5. r = 5, h = 19: 1491.5 cm^3
6. d = 16, h = 19: 3818.24 cm^3
7. d = 10, h = 15: 1177.5 cm^3

Volume of Cones

Volume of a cone

1. d = 8, h = 9: 150.72 cm^3
2. r = 7, h = 9: 461.58 cm^3
3. r = 9, h = 15: 1271.7 cm^3

Volume of Cones (continued)

Volume of a cone (continued)

4. d = 12, h = 16: 602.88 cm^3
5. d = 16, h = 3: 200.96 cm^3
6. d = 18, h = 20: 1695.6 cm^3
7. r = 6, h = 8: 301.44 cm^3

Volume of Spheres

Volume of a sphere

1. r = 7: 1436.03 cm^3
2. d = 6: 113.04 cm^3
3. r = 10: 4186.67 cm^3
4. r = 8: 2143.57 cm^3
5. d = 8: 267.95 cm^3
6. r = 9: 3052.08 cm^3
7. d = 12: 904.32 cm^3

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

Transformations

Transformations on a grid

1. (−5, −5) 180° about O: (5, 5)
2. (3, 3) in the x-axis: (3, −3)
3. (3, −2) 90° counterclockwise about O: (2, 3)
4. (1, 1) 5 left and 3 up: (−4, 4)

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. $\sqrt{196}$ = ___

$$14 \times 14 = 196$$
$$\sqrt{196} = 14$$

√ asks a question: which number times itself gives 196? It is not an instruction to halve 196 — that is the mistake this symbol collects.

Bracket it first. $10^2 = 100$, which is under 196, and $20^2 = 400$, which is over. So the answer is between 10 and 20.

Now the last digit. 196 ends in 6, and the only digits whose square ends in 6 are 4 and 6. Between 10 and 20 that leaves 14 or 16.

Two left, and the bracket picks between them: 196 is nearer 100 than 400, so take the smaller one — 14.

Check it: 14 × 14 = 196. So $\sqrt{196} = 14$.

Square and Cube Roots (continued)

Square and cube roots (continued)

2. $\sqrt{169}$ = ___

$13 \times 13 = 169$

$\sqrt{169} = 13$

√ asks a question: which number times itself gives 169? It is not an instruction to halve 169 — that is the mistake this symbol collects.

Bracket it first. $10^2 = 100$, which is under 169, and $20^2 = 400$, which is over. So the answer is between 10 and 20.

Now the last digit. 169 ends in 9, and the only digits whose square ends in 9 are 3 and 7. Between 10 and 20 that leaves 13 or 17.

Two left, and the bracket picks between them: 169 is nearer 100 than 400, so take the smaller one — 13.

Check it: $13 \times 13 = 169$. So $\sqrt{169} = 13$.

Estimating Roots

Estimating square roots

1. $\sqrt{165}$ > ___

$\sqrt{165} > 12$

Find the perfect squares on either side. 144 is 12^2 and 169 is 13^2, and 165 sits between them.

So the root is between those two whole numbers: $\sqrt{165}$ is between 12 and 13.

The smaller of the two is 12.

2. $\sqrt{41}$ > ___

$\sqrt{41} > 6$

Find the perfect squares on either side. 36 is 6^2 and 49 is 7^2, and 41 sits between them.

So the root is between those two whole numbers: $\sqrt{41}$ is between 6 and 7.

The smaller of the two is 6.

Rational and Irrational Numbers

Rational or irrational

1. $\sqrt{484}$ Rational / Irrational

$\sqrt{484}$ 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. $\sqrt{28}$ Rational / Irrational

$\sqrt{28}$ 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.

Scientific Notation

Scientific notation

1. $4.6 \times 10^3 =$ ______

4.6

46

460

4600

4.6×10^3 = **4600**

10^3 is 3 tens multiplied together, which is 1000. So this asks for 4.6 lots of 1000.

Multiplying by ten moves every digit up one place, which shows up as the point moving one place right. There are 3 of them here, so the point moves 3 places right.

Following it the whole way: 4.6 → 46 → 460 → 4600. So $4.6 \times 10^3 = 4600$.

Scientific Notation (continued)

Scientific notation (continued)

2. $7.5 \times 10^6 =$ ____________

$$7.5$$
$$75$$
$$750$$
$$7500$$
$$75000$$
$$750000$$
$$7500000$$
$$7.5 \times 10^6 = 7500000$$

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 $7.5 \times 10^6 = 7500000$.

Working in Scientific Notation

Multiplying and dividing in scientific notation

1. $(5 \times 10^7) \div (2.5 \times 10^{-2}) = c \times 10^n$

$c =$ ____ $n =$ ____

$$(5 \times 10^7) \div (2.5 \times 10^{-2}) = 2 \times 10^9$$

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: $5 \div 2.5 = 2$.

Now the powers. Dividing powers of the same base SUBTRACTS the exponents: $7 - -2 = 9$. So the powers give 10^9.

Put them together: 2×10^9. Now CHECK it — a coefficient has to be at least 1 and less than 10, and 2 is. Nothing left to do, and it was still worth looking: this is the step that catches the ones that are not.

So the answer is 2×10^9 — $5 \div 2.5 = 2$ and the powers give 10^9.

Working in Scientific Notation (continued)

Multiplying and dividing in scientific notation (continued)

2. **$(4 \times 10^8) \times (2.5 \times 10^{-1}) = c \times 10^n$**

   $c =$ ___ $n =$ ___

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

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.

Solving Equations

Solving equations

1. **$2x + 16 = 5x + 10$** ___

$$2x + 16 = 5x + 10$$

$$\boxed{20 = 20} \quad \checkmark$$

This one has x on BOTH sides, so nothing can be undone yet — subtracting 16 would still leave an x on the right. Collect the x terms first.

Take 2x off BOTH sides. That clears x from the left, leaving $16 = 3x + 10$. An equals sign does not care which side is which, so write it as $3x + 10 = 16$. That is an equation you have already met.

Two things were done to x: multiplied by 3, then 10 added. Undo them in the REVERSE order — whatever happened last comes off first.

The 10 went on last, so it comes off first — and off BOTH sides, or the two halves stop being equal. $16 - 10 = 6$.

That leaves 3x, which means 3 lots of x. Divide both sides by 3: $6 \div 3 = 2$.

Check by putting it back into the ORIGINAL, both sides: $2(2) + 16 = 20$, and $5(2) + 10 = 20$ — both 20, so $x = 2$.

2. **$4x + 35 = 10x + 11$** ___

$$4x + 35 = 10x + 11$$

$$\boxed{51 = 51} \quad \checkmark$$

This one has x on BOTH sides, so nothing can be undone yet — subtracting 35 would still leave an x on the right. Collect the x terms first.

Take 4x off BOTH sides. That clears x from the left, leaving $35 = 6x + 11$. An equals sign does not care which side is which, so write it as $6x + 11 = 35$. That is an equation you have already met.

Two things were done to x: multiplied by 6, then 11 added. Undo them in the REVERSE order — whatever happened last comes off first.

The 11 went on last, so it comes off first — and off BOTH sides, or the two halves stop being equal. $35 - 11 = 24$.

That leaves 6x, which means 6 lots of x. Divide both sides by 6: $24 \div 6 = 4$.

Check by putting it back into the ORIGINAL, both sides: $4(4) + 35 = 51$, and $10(4) + 11 = 51$ — both 51, so $x = 4$.

Systems of Equations

Systems of equations

1. $11x + 9y = -4$ $x =$ ____
   $-8x - 9y = -29$ $y =$ ____

$x = -11$
$y = \boxed{13}$

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: 9y in the first and −9y 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 $3x = -33$.

One letter left. $-33 \div 3 = -11$, so $x = -11$.

Now put x back into either equation to get y — this is the half that gets forgotten. It gives $y = 13$, so the solution is $(-11, 13)$.

2. $9x + 8y = -8$ $x =$ ____
   $6x - 8y = 8$ $y =$ ____

$x = 0$
$y = \boxed{-1}$

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 $(0, -1)$.

Slope

Slope and y-intercept

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

$y = 10x + 28$

$m = \boxed{10}$

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

$y = 12x + 1$

$m = \boxed{12}$

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.

Rate of Change

Rate of change from a table

1.

x	1	2	3	4
y	42	33	24	15

rate → ___

rate of change $\boxed{-9}$

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 1, 1, 1 — the same each time — and y moves −9, −9, −9. They are steady, so this table really does have one rate rather than a different one in every gap.

Now divide: $-9 \div 1 = -9$. Dividing by one changes nothing, which is exactly why it is worth writing down — on a table whose x steps by more, it will not.

So the rate of change is −9: y moves −9 while x moves 1, and $-9 \div 1 = -9$.

Rate of Change (continued)

Rate of change from a table (continued)

2.

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.

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.

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.

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. $y = 6x - 38$ Linear / Nonlinear

Linear or nonlinear? Linear

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 happens to x: it is multiplied by a number, and a number is added or taken away. Nothing else is done to it.

That is exactly the mx + b shape — x is only multiplied by a number and added to, so equal steps in x give equal steps in y. It is a line.

2. $y = 7x^2 + 33$ 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.

Is It a Function?

Is it a function?

1.

x	10	15	14	15
y	40	52	33	56

Yes / No

Is this a function? **No**

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, 15, 14, 15. Nothing about the outputs matters yet.

15 is in that list twice, and the two pairs it belongs to do not agree: the input 15 goes to 52 and also to 56, and one input may only go to one place.

One input, two different outputs. That is the one thing a function is not allowed to do, so this relation is not a function.

2.

x	16	9	21	10
y	46	16	22	22

Yes / No

Is this a function? **Yes**

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.

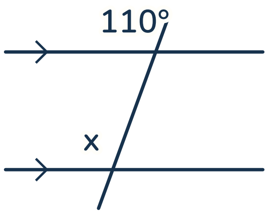
Every input has exactly one output, so this relation is a function.

Solutions (12 of 21)

Angles in Parallel Lines

Angles in parallel lines

1.



___

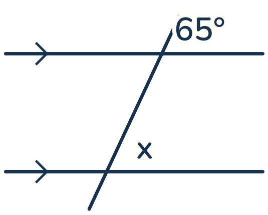
$110° = x$	
$x = 110°$	

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.

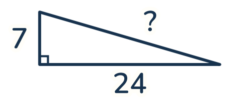
Now find where the two marked angles sit. They are in the same corner at each crossing — both above their line and both on the same side of the slanted one. That makes them corresponding angles.

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.

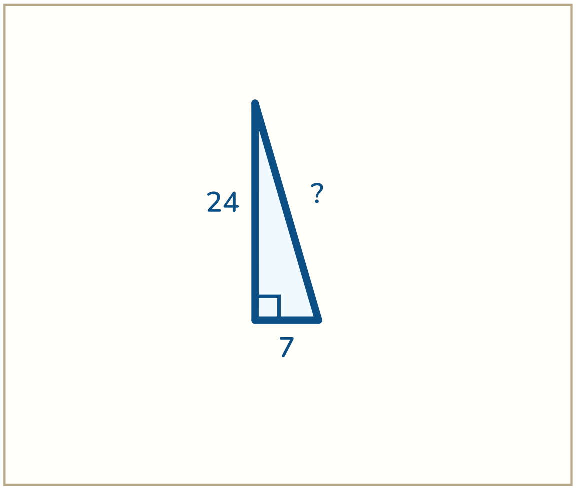
Pythagoras

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.

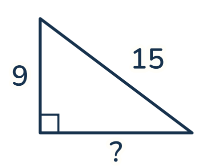
Here the hypotenuse is the missing one, so the two given sides are both legs: 7 and 24.

Square the two you have: $7^2 = 49$ and $24^2 = 576$.

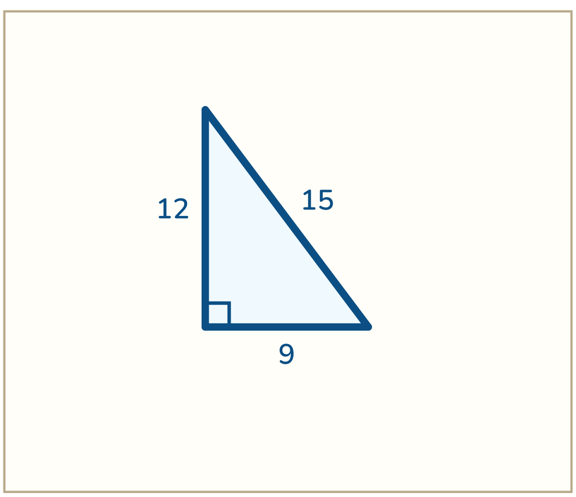
The two squares ADD to the square on the hypotenuse: $49 + 576 = 625$.

That is the square, not the side. Take the square root: $\sqrt{625} = 25$ 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 — 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 $9^2 = 81$.

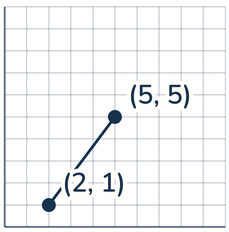
The leg's square is what is LEFT when you take the other leg's square off the hypotenuse's: $225 - 81 = 144$.

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

Distance Between Points

Distance between two points

1.



____ units

$3^2 + 4^2$	=	25
distance	=	**5 units**

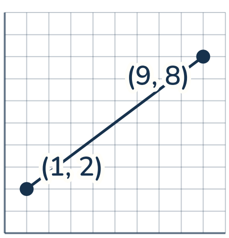
There is no new formula here. Draw the horizontal and vertical steps between the two points and they make a right triangle — the line you were given is its longest side.

Across: 5 – 2 = 3, so that side is 3 long. Up: 5 – 1 = 4, so that side is 4. A length has no sign, so take both as positive.

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

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

2.



____ units

$8^2 + 6^2$	=	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: 9 – 1 = 8, so that side is 8 long. Up: 8 – 2 = 6, so that side is 6. A length has no sign, so take both as positive.

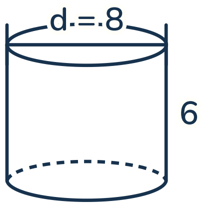
Now it is the theorem you already know: $8^2 + 6^2 = 64 + 36 = 100$.

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

Volume of Cylinders

Volume of a cylinder

1.



base: 50.24

$50.24 \times 6 =$ **301.44**

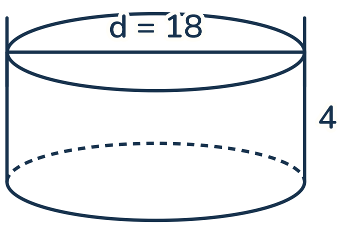
The 8 cm goes right across, so it is the diameter. Halve it first: the radius is 4. Every one of these formulas SQUARES the radius, so getting this wrong is out by a factor of four, not two.

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 $\pi \times r \times r = 3.14 \times 4 \times 4 = 50.24$ square cm.

Times the height: $50.24 \times 6 = 301.44$ cubic cm.

2.



base: 254.34

$254.34 \times 4 =$ **1017.36**

The 18 cm goes right across, so it is the diameter. Halve it first: the radius is 9. Every one of these formulas SQUARES the radius, so getting this wrong is out by a factor of four, not two.

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.

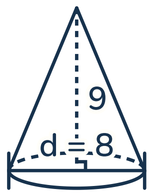
The circle's area is $\pi \times r \times r = 3.14 \times 9 \times 9 = 254.34$ square cm.

Times the height: $254.34 \times 4 = 1017.36$ cubic cm.

Volume of Cones

Volume of a cone

1.



cylinder: 452.16

3 cones fill 1 cylinder

452.16 ÷ 3 =

150.72 cubic cm

The 8 cm goes right across, so it is the diameter. Halve it first: the radius is 4. Every one of these formulas SQUARES the radius, so getting this wrong is out by a factor of four, not two.

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 $\pi \times r \times r = 3.14 \times 4 \times 4 = 50.24$ square cm.

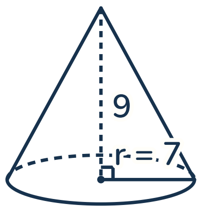
Times the height: $50.24 \times 9 = 452.16$ cubic cm. That is the CYLINDER it fits inside, not the cone yet.

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: $452.16 \div 3 = 150.72$ cubic cm.

Volume of Cones (continued)

Volume of a cone (continued)

2.



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.

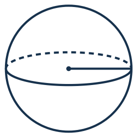
Times the height: 153.86 × 9 = 1384.74 cubic cm. That is the CYLINDER it fits inside, not the cone yet.

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.

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 cm³

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 $r \times 3$: $7 \times 7 \times 7 = 343$.

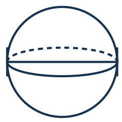
Then four-thirds of that, times π: $4/3 \times 3.14 \times 343$ comes to 1436.0267..., which is 1436.03 to two decimal places. A third rarely lands on a whole number of hundredths, so this kind of answer is usually rounded.

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.



______

diameter: 6 cm

$6 \div 2 = \mathbf{3}$

$3 \times 3 \times 3 = \mathbf{27}$

$4/3 \times 3.14 \times 27 =$ **113.04**

113.04 cm³

The 6 cm marked here goes right ACROSS the sphere — that is the diameter. The formula wants the radius, and using the diameter instead makes the answer EIGHT times too big, because it is cubed.

Half of 6 is 3, so r = 3 cm.

Cube the radius on a line of its own. r^3 means $r \times r \times r$, not $r \times 3$: $3 \times 3 \times 3 = 27$.

Then four-thirds of that, times π: $4/3 \times 3.14 \times 27 = 113.04$.

So the volume is 113.04 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.

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.

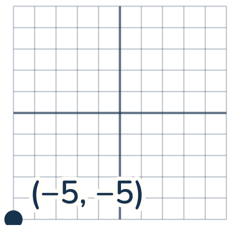
Down the column as a check. The None column adds up to 20, and the other number in it is 14: 20 – 14 = 6. The same 6, which is what says the table hangs together.

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

Transformations

Transformations on a grid

1.



180° about O

(___, ___)

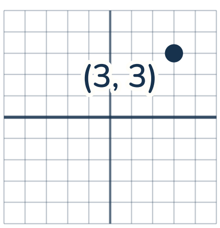
(−5, −5) → **(5, 5)**

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.



in the x-axis

(___, ___)

	(3, 3)	
3 above	→	**3 below**
(3, 3)	→	**(3, −3)**

Start where the point is: (3, 3). The move is in the x-axis, and the question is only where those two numbers end up.

A mirror keeps the distance and swaps the side. This point is 3 above the x-axis, so its image is 3 below it.

Nothing moved sideways, so the x-coordinate stays at 3. The image is (3, −3). Notice which number changed: mirroring in the x-axis changes the y.