

Grade 8 Foundation Workbook

25 lessons · printable · answer key at the back

Name _____

Date _____

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Exponent Rules

WORKED EXAMPLE

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

1. Laws of exponents

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

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

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

3. Laws of exponents

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

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

Estimating Roots

WORKED EXAMPLE

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

$$9^2 = 81$$

$$10^2 = 100$$

$$81 < 83 < 100$$

$$\sqrt{83} \text{ is between } 9 \text{ and } 10$$

$$\sqrt{83} > 9$$

4. Between which whole numbers

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

1 $\sqrt{165} > \underline{\quad}$

2 $\sqrt{41} > \underline{\quad}$

3 $\sqrt{260} > \underline{\quad}$

4 $\sqrt{56} > \underline{\quad}$

5 $\sqrt{79} > \underline{\quad}$

6 $\sqrt{59} > \underline{\quad}$

7 $\sqrt{299} > \underline{\quad}$

8 $\sqrt{136} > \underline{\quad}$

9 $\sqrt{14} > \underline{\quad}$

10 $\sqrt{135} > \underline{\quad}$

11 $\sqrt{267} > \underline{\quad}$

12 $\sqrt{5} > \underline{\quad}$

13 $\sqrt{154} > \underline{\quad}$

14 $\sqrt{232} > \underline{\quad}$

15 $\sqrt{42} > \underline{\quad}$

4. Between which whole numbers (continued)

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

16 $\sqrt{137} > \underline{\hspace{1cm}}$

17 $\sqrt{112} > \underline{\hspace{1cm}}$

18 $\sqrt{197} > \underline{\hspace{1cm}}$

19 $\sqrt{105} > \underline{\hspace{1cm}}$

20 $\sqrt{94} > \underline{\hspace{1cm}}$

21 $\sqrt{258} > \underline{\hspace{1cm}}$

5. To the nearest whole number

Round each root to the nearest whole number.

22 $\sqrt{123} \approx \underline{\hspace{1cm}}$

23 $\sqrt{179} \approx \underline{\hspace{1cm}}$

24 $\sqrt{300} \approx \underline{\hspace{1cm}}$

25 $\sqrt{155} \approx \underline{\hspace{1cm}}$

26 $\sqrt{112} \approx \underline{\hspace{1cm}}$

27 $\sqrt{11} \approx \underline{\hspace{1cm}}$

28 $\sqrt{246} \approx \underline{\hspace{1cm}}$

29 $\sqrt{189} \approx \underline{\hspace{1cm}}$

30 $\sqrt{5} \approx \underline{\hspace{1cm}}$

5. To the nearest whole number (continued)

Round each root to the nearest whole number.

31 $\sqrt{52} \approx \underline{\hspace{1cm}}$

32 $\sqrt{354} \approx \underline{\hspace{1cm}}$

33 $\sqrt{96} \approx \underline{\hspace{1cm}}$

34 $\sqrt{190} \approx \underline{\hspace{1cm}}$

35 $\sqrt{224} \approx \underline{\hspace{1cm}}$

36 $\sqrt{85} \approx \underline{\hspace{1cm}}$

37 $\sqrt{53} \approx \underline{\hspace{1cm}}$

38 $\sqrt{147} \approx \underline{\hspace{1cm}}$

39 $\sqrt{292} \approx \underline{\hspace{1cm}}$

40 $\sqrt{177} \approx \underline{\hspace{1cm}}$

41 $\sqrt{12} \approx \underline{\hspace{1cm}}$

42 $\sqrt{222} \approx \underline{\hspace{1cm}}$

6. To the nearest tenth

Round each root to one decimal place.

43 $\sqrt{293} \approx \underline{\hspace{1cm}}$

44 $\sqrt{497} \approx \underline{\hspace{1cm}}$

45 $\sqrt{90} \approx \underline{\hspace{1cm}}$

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

3 $\sqrt{67}$ Rational / Irrational

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

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

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

11 $\sqrt{100}$ Rational / Irrational

13 $\sqrt{142}$ Rational / Irrational

15 $\sqrt{118}$ Rational / Irrational

17 $\sqrt{66}$ Rational / Irrational

19 $\sqrt{13}$ Rational / Irrational

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

23 $\sqrt{170}$ Rational / Irrational

25 $\sqrt{628}$ Rational / Irrational

27 $\sqrt{528}$ Rational / Irrational

29 $\sqrt{439}$ Rational / Irrational

31 $\sqrt{36}$ Rational / Irrational

33 $\sqrt{167}$ Rational / Irrational

35 $\sqrt{225}$ Rational / Irrational

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

2 $\sqrt{28}$ Rational / Irrational

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

6 $\sqrt{121}$ Rational / Irrational

8 $\sqrt{25}$ Rational / Irrational

10 $\sqrt{4}$ Rational / Irrational

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

14 $\sqrt{50}$ Rational / Irrational

16 $\sqrt{9}$ Rational / Irrational

18 $\sqrt{49}$ Rational / Irrational

20 $\sqrt{101}$ Rational / Irrational

22 $\sqrt{102}$ Rational / Irrational

24 $\sqrt{33}$ Rational / Irrational

26 $\sqrt{624}$ Rational / Irrational

28 $\sqrt{361}$ Rational / Irrational

30 $\sqrt{625}$ Rational / Irrational

32 $\sqrt{529}$ Rational / Irrational

34 $\sqrt{83}$ Rational / Irrational

36 $\sqrt{34}$ Rational / Irrational

8. Laws of exponents

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

38 $2^{12} \times 2^7 = 2^n$, $n = \underline{\hspace{2cm}}$

39 $12^8 \times 12^4 = 12^n$, $n = \underline{\hspace{2cm}}$

40 $5^2 \times 5^4 = 5^n$, $n = \underline{\hspace{2cm}}$

41 $6^9 \times 6^{10} = 6^n$, $n = \underline{\hspace{2cm}}$

42 $10^3 \times 10^3 = 10^n$, $n = \underline{\hspace{2cm}}$

43 $9^5 \times 9^1 = 9^n$, $n = \underline{\hspace{2cm}}$

8. Laws of exponents (continued)

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

44 $6^{11} \times 6^3 = 6^n$, $n = \underline{\hspace{2cm}}$

45 $4^2 \times 4^9 = 4^n$, $n = \underline{\hspace{2cm}}$

46 $5^5 \times 5^4 = 5^n$, $n = \underline{\hspace{2cm}}$

47 $6^{12} \times 6^3 = 6^n$, $n = \underline{\hspace{2cm}}$

Scientific Notation

WORKED EXAMPLE

$$4.4 \times 10^4 = \underline{44000}$$

9. Writing numbers in full

Write each number in standard form.

- | | | |
|------------------------------|------------------------------|------------------------------|
| 1 $4.6 \times 10^3 =$ _____ | 2 $6.9 \times 10^4 =$ _____ | 3 $7.5 \times 10^6 =$ _____ |
| 4 $3.4 \times 10^3 =$ _____ | 5 $3.5 \times 10^2 =$ _____ | 6 $2.1 \times 10^2 =$ _____ |
| 7 $3.4 \times 10^6 =$ _____ | 8 $6.6 \times 10^4 =$ _____ | 9 $3.1 \times 10^2 =$ _____ |
| 10 $2.4 \times 10^4 =$ _____ | 11 $9.2 \times 10^5 =$ _____ | 12 $4.7 \times 10^3 =$ _____ |
| 13 $7.8 \times 10^3 =$ _____ | 14 $6.9 \times 10^5 =$ _____ | 15 $8.9 \times 10^4 =$ _____ |
| 16 $9.9 \times 10^3 =$ _____ | 17 $5.4 \times 10^3 =$ _____ | 18 $3.3 \times 10^6 =$ _____ |
| 19 $5.8 \times 10^4 =$ _____ | 20 $3.9 \times 10^2 =$ _____ | 21 $4.5 \times 10^6 =$ _____ |
| 22 $7.9 \times 10^4 =$ _____ | 23 $2.7 \times 10^3 =$ _____ | 24 $3.5 \times 10^3 =$ _____ |

10. Numbers smaller than one

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

- | | | |
|---------------------------------|---------------------------------|---------------------------------|
| 25 $3 \times 10^{-1} =$ _____ | 26 $2.8 \times 10^{-1} =$ _____ | 27 $2.4 \times 10^{-4} =$ _____ |
| 28 $8.7 \times 10^{-2} =$ _____ | 29 $1.8 \times 10^{-1} =$ _____ | 30 $6.7 \times 10^{-1} =$ _____ |
| 31 $2.6 \times 10^{-3} =$ _____ | 32 $4 \times 10^{-2} =$ _____ | 33 $3.5 \times 10^{-2} =$ _____ |
| 34 $2.2 \times 10^{-2} =$ _____ | 35 $9.3 \times 10^{-3} =$ _____ | 36 $7.4 \times 10^{-2} =$ _____ |
| 37 $7.8 \times 10^{-1} =$ _____ | 38 $6.9 \times 10^{-3} =$ _____ | 39 $5.7 \times 10^{-1} =$ _____ |
| 40 $2.1 \times 10^{-2} =$ _____ | 41 $3.8 \times 10^{-2} =$ _____ | 42 $8.9 \times 10^{-4} =$ _____ |
| 43 $9.1 \times 10^{-2} =$ _____ | 44 $7.8 \times 10^{-2} =$ _____ | 45 $3.1 \times 10^{-3} =$ _____ |
| 46 $6.9 \times 10^{-2} =$ _____ | 47 $7.2 \times 10^{-2} =$ _____ | 48 $1.9 \times 10^{-1} =$ _____ |

11. Square and cube roots

Find each root. Check the symbol before you answer.

- | | | | | |
|------------------------|------------------------|------------------------|-----------------------|------------------------|
| 49 $\sqrt{169} =$ ____ | 50 $\sqrt{144} =$ ____ | 51 $\sqrt{256} =$ ____ | 52 $\sqrt{9} =$ ____ | 53 $\sqrt{121} =$ ____ |
| 54 $\sqrt{49} =$ ____ | 55 $\sqrt{361} =$ ____ | 56 $\sqrt{81} =$ ____ | 57 $\sqrt{36} =$ ____ | 58 $\sqrt{4} =$ ____ |

Working in Scientific Notation

WORKED EXAMPLE

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

$$7.5 \div 2.5 = 3$$

$$4 - 5 = -1$$

$$3 \times 10^{-1}$$

$$1 \leq 3 < 10$$

12. Multiplying and dividing in scientific notation

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

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

2 $(6 \times 10^{-4}) \div (5 \times 10^{-2})$

3 $(4 \times 10^8) \times (2.5 \times 10^{-1})$

4 $(1.5 \times 10^{-2}) \times (6 \times 10^{-1})$

5 $(3 \times 10^8) \div (2.5 \times 10^{-4})$

6 $(5 \times 10^{-3}) \div (2.5 \times 10^5)$

7 $(2.5 \times 10^3) \times (6 \times 10^3)$

8 $(4 \times 10^5) \times (2 \times 10^5)$

9 $(6 \times 10^{-4}) \div (2.5 \times 10^3)$

10 $(1.5 \times 10^3) \times (6 \times 10^3)$

11 $(2 \times 10^4) \times (5 \times 10^{-3})$

12 $(7.5 \times 10^8) \div (5 \times 10^{-1})$

13 $(4.5 \times 10^4) \div (1.5 \times 10^4)$

14 $(7.5 \times 10^7) \times (6 \times 10^{-1})$

15 $(5 \times 10^5) \times (1.2 \times 10^{-5})$

12. Multiplying and dividing in scientific notation (continued)

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

16 $(1.5 \times 10^8) \times (1.2 \times 10^3)$ 17 $(4 \times 10^{-2}) \times (1.2 \times 10^{-4})$ 18 $(4 \times 10^5) \times (2.5 \times 10^5)$

19 $(2 \times 10^8) \times (3 \times 10^{-1})$ 20 $(1.5 \times 10^2) \times (5 \times 10^7)$ 21 $(6 \times 10^{-2}) \times (4.5 \times 10^8)$

22 $(2 \times 10^{-3}) \times (4.5 \times 10^2)$ 23 $(5 \times 10^5) \div (2 \times 10^{-3})$ 24 $(5 \times 10^8) \div (2 \times 10^4)$

13. Between which whole numbers

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

25 $\sqrt{164} > \underline{\hspace{1cm}}$ 26 $\sqrt{137} > \underline{\hspace{1cm}}$ 27 $\sqrt{335} > \underline{\hspace{1cm}}$

28 $\sqrt{139} > \underline{\hspace{1cm}}$ 29 $\sqrt{79} > \underline{\hspace{1cm}}$ 30 $\sqrt{85} > \underline{\hspace{1cm}}$

31 $\sqrt{260} > \underline{\hspace{1cm}}$ 32 $\sqrt{115} > \underline{\hspace{1cm}}$ 33 $\sqrt{142} > \underline{\hspace{1cm}}$

34 $\sqrt{70} > \underline{\hspace{1cm}}$

Solving Equations

WORKED EXAMPLE

$$7x + 7 = 12x + 2 \quad \underline{1}$$

14. Solving equations

Solve each equation for x .

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

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 $8.3 \times 10^4 =$ _____

26 $4.7 \times 10^3 =$ _____

27 $6.3 \times 10^6 =$ _____

28 $1.2 \times 10^2 =$ _____

29 $5.4 \times 10^3 =$ _____

30 $7.4 \times 10^2 =$ _____

31 $7.3 \times 10^6 =$ _____

32 $6.8 \times 10^3 =$ _____

33 $8.4 \times 10^2 =$ _____

34 $8.5 \times 10^2 =$ _____

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 $(6 \times 10^{-4}) \div (1.5 \times 10^4)$

22 $(4 \times 10^5) \div (2.5 \times 10^{-5})$

23 $(4.5 \times 10^{-5}) \times (4 \times 10^{-1})$

24 $(7.5 \times 10^4) \times (1.2 \times 10^{-5})$

25 $(1.5 \times 10^{-4}) \times (3 \times 10^6)$

26 $(7.5 \times 10^8) \div (5 \times 10^{-1})$

27 $(8 \times 10^7) \times (5 \times 10^{-1})$

28 $(1.2 \times 10^{-2}) \times (7.5 \times 10^5)$

29 $(4 \times 10^2) \div (2.5 \times 10^6)$

30 $(1.2 \times 10^2) \times (2 \times 10^5)$

WORKED EXAMPLE

$$y = 5x + 37 \quad m = \underline{5}$$

20. Finding the slope

Write the slope of each line.

1 $y = 10x + 28 \quad m = \underline{\hspace{2cm}}$

3 $y = 8x + 22 \quad m = \underline{\hspace{2cm}}$

5 $y = -6x - 17 \quad m = \underline{\hspace{2cm}}$

7 $y = x + 5 \quad m = \underline{\hspace{2cm}}$

9 $y = -2x - 2 \quad m = \underline{\hspace{2cm}}$

11 $y = 10x + 38 \quad m = \underline{\hspace{2cm}}$

13 $y = -4x - 23 \quad m = \underline{\hspace{2cm}}$

15 $y = 6x - 7 \quad m = \underline{\hspace{2cm}}$

17 $y = x - 22 \quad m = \underline{\hspace{2cm}}$

19 $y = -11x - 19 \quad m = \underline{\hspace{2cm}}$

21 $y = 11x + 25 \quad m = \underline{\hspace{2cm}}$

23 $y = 4x - 22 \quad m = \underline{\hspace{2cm}}$

2 $y = 12x + 1 \quad m = \underline{\hspace{2cm}}$

4 $y = -4x - 25 \quad m = \underline{\hspace{2cm}}$

6 $y = 8x - 28 \quad m = \underline{\hspace{2cm}}$

8 $y = -10x - 20 \quad m = \underline{\hspace{2cm}}$

10 $y = x + 26 \quad m = \underline{\hspace{2cm}}$

12 $y = -12x - 24 \quad m = \underline{\hspace{2cm}}$

14 $y = -6x - 24 \quad m = \underline{\hspace{2cm}}$

16 $y = -21 \quad m = \underline{\hspace{2cm}}$

18 $y = 6x + 37 \quad m = \underline{\hspace{2cm}}$

20 $y = -6x - 29 \quad m = \underline{\hspace{2cm}}$

22 $y = x + 10 \quad m = \underline{\hspace{2cm}}$

24 $y = 11x + 24 \quad m = \underline{\hspace{2cm}}$

21. Finding the y-intercept

Write the y-intercept of each line.

25 $y = -11x - 17 \quad b = \underline{\hspace{2cm}}$

27 $y = -2x - 26 \quad b = \underline{\hspace{2cm}}$

29 $y = -6x - 22 \quad b = \underline{\hspace{2cm}}$

31 $y = 3x - 25 \quad b = \underline{\hspace{2cm}}$

33 $y = 6x + 40 \quad b = \underline{\hspace{2cm}}$

35 $y = -9x - 21 \quad b = \underline{\hspace{2cm}}$

37 $y = -x - 4 \quad b = \underline{\hspace{2cm}}$

39 $y = -11x + 17 \quad b = \underline{\hspace{2cm}}$

41 $y = 11x + 19 \quad b = \underline{\hspace{2cm}}$

43 $y = -6x + 36 \quad b = \underline{\hspace{2cm}}$

45 $y = 6x + 2 \quad b = \underline{\hspace{2cm}}$

47 $y = 3x - 15 \quad b = \underline{\hspace{2cm}}$

26 $y = -6x - 24 \quad b = \underline{\hspace{2cm}}$

28 $y = -10x - 27 \quad b = \underline{\hspace{2cm}}$

30 $y = 5x - 26 \quad b = \underline{\hspace{2cm}}$

32 $y = 9x - 9 \quad b = \underline{\hspace{2cm}}$

34 $y = 3x - 23 \quad b = \underline{\hspace{2cm}}$

36 $y = 5x + 3 \quad b = \underline{\hspace{2cm}}$

38 $y = -7x + 38 \quad b = \underline{\hspace{2cm}}$

40 $y = -5x - 18 \quad b = \underline{\hspace{2cm}}$

42 $y = 11x + 33 \quad b = \underline{\hspace{2cm}}$

44 $y = -7x - 12 \quad b = \underline{\hspace{2cm}}$

46 $y = 12x - 14 \quad b = \underline{\hspace{2cm}}$

48 $y = -4x + 33 \quad b = \underline{\hspace{2cm}}$

22. Solving equations

Solve each equation for x .

49 $4x + 37 = 10x + 13$

52 $7x + 16 = 9x + 12$

55 $4x + 40 = 9x + 15$

58 $7x + 12 = 10x + 6$

50 $8x + 10 = 6x + 12$

53 $5x + 12 = 3x + 18$

56 $5x + 8 = x + 16$

51 $12x + 2 = 6x + 32$

54 $4x + 7 = 6x + 5$

57 $3x + 20 = 8x + 5$

Rate of Change

WORKED EXAMPLE

x	5	6	7	8
y	29	24	19	14

rate $\rightarrow$ -5

y step = -5, x step = 1

$-5 \div 1 = -5$

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	2	3	4
y	42	33	24	15

rate $\rightarrow$ ____

2

x	3	4	5	6
y	35	32	29	26

rate $\rightarrow$ ____

3

x	1	4	7	10
y	33	48	63	78

rate $\rightarrow$ ____

4

x	2	3	4	5
y	51	57	63	69

rate $\rightarrow$ ____

5

x	6	7	8	9
y	55	47	39	31

rate $\rightarrow$ ____

6

x	3	4	5	6
y	18	12	6	0

rate $\rightarrow$ ____

7

x	7	11	15	19
y	39	47	55	63

rate $\rightarrow$ ____

8

x	4	5	6	7
y	59	65	71	77

rate $\rightarrow$ ____

23. Rate of change from a table (continued)

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

9

x	9	10	11	12
y	58	52	46	40

rate $\rightarrow$ ____

10

x	6	7	8	9
y	61	65	69	73

rate $\rightarrow$ ____

11

x	9	13	17	21
y	37	41	45	49

rate $\rightarrow$ ____

12

x	6	7	8	9
y	20	17	14	11

rate $\rightarrow$ ____

13

x	2	3	4	5
y	42	44	46	48

rate $\rightarrow$ ____

14

x	6	10	14	18
y	59	83	107	131

rate $\rightarrow$ ____

15

x	1	2	3	4
y	48	56	64	72

rate $\rightarrow$ ____

16

x	3	4	5	6
y	46	49	52	55

rate $\rightarrow$ ____

17

x	6	7	8	9
y	86	94	102	110

rate $\rightarrow$ ____

18

x	4	8	12	16
y	49	89	129	169

rate $\rightarrow$ ____

19

x	8	9	10	11
y	26	23	20	17

rate $\rightarrow$ ____

20

x	5	6	7	8
y	47	42	37	32

rate $\rightarrow$ ____

23. Rate of change from a table (continued)

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

21

x	2	8	14	20
y	21	81	141	201

rate $\rightarrow$ ____

22

x	6	7	8	9
y	34	36	38	40

rate $\rightarrow$ ____

23

x	4	5	6	7
y	25	28	31	34

rate $\rightarrow$ ____

24

x	6	7	8	9
y	67	74	81	88

rate $\rightarrow$ ____

24. Systems of equations

Solve each pair by adding the two equations.

25
$$\begin{aligned} 11x + 9y &= -4 \\ -8x - 9y &= -29 \end{aligned}$$

26
$$\begin{aligned} 3x + 6y &= -18 \\ 4x - 6y &= 18 \end{aligned}$$

27
$$\begin{aligned} -10x + 2y &= 0 \\ 4x - 2y &= -6 \end{aligned}$$

28
$$\begin{aligned} 7x + 11y &= 42 \\ 6x - 11y &= 36 \end{aligned}$$

29
$$\begin{aligned} -8x + 6y &= -52 \\ 5x - 6y &= 46 \end{aligned}$$

30
$$\begin{aligned} -10x + 6y &= -54 \\ -5x - 6y &= 54 \end{aligned}$$

31
$$\begin{aligned} 8x + 4y &= 32 \\ -3x - 4y &= 8 \end{aligned}$$

32
$$\begin{aligned} -2x + 6y &= 60 \\ 10x - 6y &= 36 \end{aligned}$$

33
$$\begin{aligned} 10x + 8y &= 56 \\ 5x - 8y &= 4 \end{aligned}$$

34
$$\begin{aligned} 6x + 9y &= 36 \\ 4x - 9y &= -36 \end{aligned}$$

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 $y = 6x - 38$ Linear / Nonlinear

3 $y = 7x^2 + 33$ Linear / Nonlinear

5 $y = 11x - 31$ Linear / Nonlinear

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

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

11 $y = 4x^2 + 33$ Linear / Nonlinear

13 $y = 13x - 42$ Linear / Nonlinear

15 $y = 17x - 32$ Linear / Nonlinear

17 $y = 18x - 30$ Linear / Nonlinear

19 $y = 18x - 32$ Linear / Nonlinear

21 $y = 4x^2 + 22$ Linear / Nonlinear

23 $y = x/9 + 23$ Linear / Nonlinear

2 $y = 19x - 20$ Linear / Nonlinear

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

6 $y = 22x - 45$ Linear / Nonlinear

8 $y = 18x + 4$ Linear / Nonlinear

10 $y = x/2 + 28$ Linear / Nonlinear

12 $y = 18x - 28$ Linear / Nonlinear

14 $y = 4x^2 + 25$ Linear / Nonlinear

16 $y = 3x - 17$ Linear / Nonlinear

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

20 $y = 23x + 15$ Linear / Nonlinear

22 $y = 23x - 22$ Linear / Nonlinear

24 $y = 4x - 4$ Linear / Nonlinear

28. Finding the slope

Write the slope of each line.

25 $y = -x - 27$ $m = \underline{\hspace{1cm}}$

27 $y = 12x - 6$ $m = \underline{\hspace{1cm}}$

29 $y = -3x + 29$ $m = \underline{\hspace{1cm}}$

31 $y = -2x - 22$ $m = \underline{\hspace{1cm}}$

33 $y = 10x + 32$ $m = \underline{\hspace{1cm}}$

35 $y = -10x - 20$ $m = \underline{\hspace{1cm}}$

37 $y = -6x - 19$ $m = \underline{\hspace{1cm}}$

39 $y = 9x + 9$ $m = \underline{\hspace{1cm}}$

41 $y = 8x + 31$ $m = \underline{\hspace{1cm}}$

43 $y = 4x - 27$ $m = \underline{\hspace{1cm}}$

26 $y = 12x + 1$ $m = \underline{\hspace{1cm}}$

28 $y = 8x + 35$ $m = \underline{\hspace{1cm}}$

30 $y = -19$ $m = \underline{\hspace{1cm}}$

32 $y = 10x - 20$ $m = \underline{\hspace{1cm}}$

34 $y = -12x + 40$ $m = \underline{\hspace{1cm}}$

36 $y = -2x - 2$ $m = \underline{\hspace{1cm}}$

38 $y = -x - 10$ $m = \underline{\hspace{1cm}}$

40 $y = 9x + 19$ $m = \underline{\hspace{1cm}}$

42 $y = 11x - 17$ $m = \underline{\hspace{1cm}}$

44 $y = 10x + 24$ $m = \underline{\hspace{1cm}}$

Is It a Function?

WORKED EXAMPLE

x	4	6	15	6
y	58	38	32	49

$6 \rightarrow 38$ and $6 \rightarrow 49$

Not a function

29. Is it a function?

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

1

x	10	15	14	15
y	40	52	33	56

2

x	8	16	24	8
y	22	49	24	17

3

x	16	9	21	10
y	46	16	22	22

4

x	5	15	12	22
y	42	28	6	60

5

x	5	19	5	12
y	48	27	14	33

6

x	17	2	11	9
y	18	51	41	38

7

x	10	3	6	21
y	42	42	23	43

8

x	2	15	20	20
y	18	16	13	29

9

x	22	22	13	19
y	57	26	30	60

10

x	13	22	1	1
y	16	8	25	5

11

x	23	17	10	18
y	40	11	36	40

12

x	7	17	12	19
y	55	18	8	32

13

x	21	20	8	21
y	3	25	1	13

14

x	2	22	6	14
y	45	17	31	31

30. Finding the slope

Write the slope of each line.

15 $y = -3x + 30$ $m = \underline{\hspace{2cm}}$

17 $y = 12x - 6$ $m = \underline{\hspace{2cm}}$

19 $y = -19$ $m = \underline{\hspace{2cm}}$

21 $y = -6x + 9$ $m = \underline{\hspace{2cm}}$

23 $y = -8x + 35$ $m = \underline{\hspace{2cm}}$

16 $y = 12x + 1$ $m = \underline{\hspace{2cm}}$

18 $y = -4x - 17$ $m = \underline{\hspace{2cm}}$

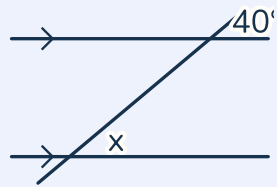
20 $y = -12x + 34$ $m = \underline{\hspace{2cm}}$

22 $y = 12x + 36$ $m = \underline{\hspace{2cm}}$

24 $y = 9x + 9$ $m = \underline{\hspace{2cm}}$

Angles in Parallel Lines

WORKED EXAMPLE

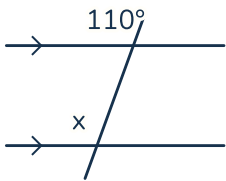


40

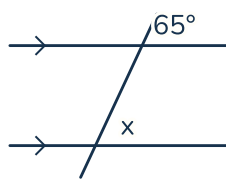
31. Angles in parallel lines

The two lines are parallel. Find x .

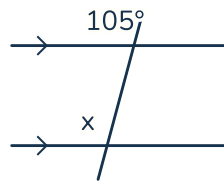
1



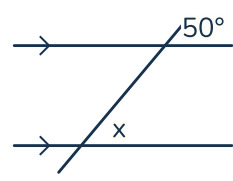
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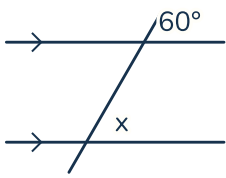
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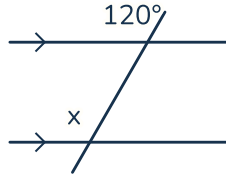
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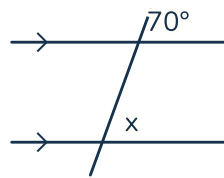
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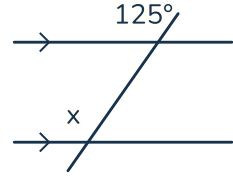
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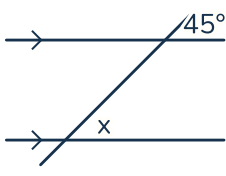
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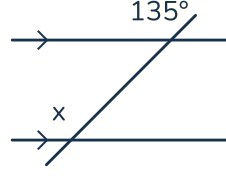
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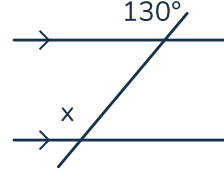
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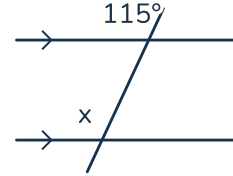
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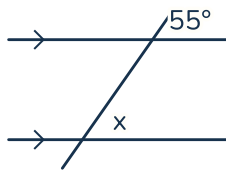
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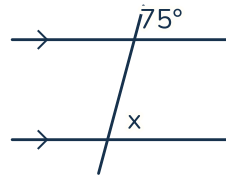
12



13



14



32. Rate of change from a table

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

15

x	9	10	11	12
y	43	42	41	40

rate $\rightarrow$ ____

16

x	1	2	3	4
y	15	17	19	21

rate $\rightarrow$ ____

17

x	4	8	12	16
y	56	100	144	188

rate $\rightarrow$ ____

18

x	6	7	8	9
y	93	102	111	120

rate $\rightarrow$ ____

19

x	7	8	9	10
y	27	23	19	15

rate $\rightarrow$ ____

20

x	3	4	5	6
y	33	40	47	54

rate $\rightarrow$ ____

21

x	5	8	11	14
y	29	44	59	74

rate $\rightarrow$ ____

22

x	2	3	4	5
y	27	22	17	12

rate $\rightarrow$ ____

23

x	9	10	11	12
y	25	22	19	16

rate $\rightarrow$ ____

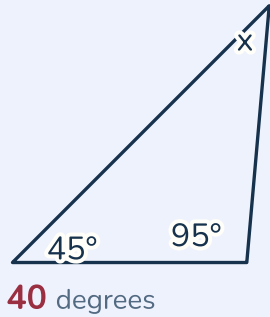
24

x	1	2	3	4
y	48	56	64	72

rate $\rightarrow$ ____

Angles in a Triangle

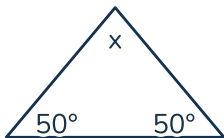
WORKED EXAMPLE



33. The third angle of a triangle

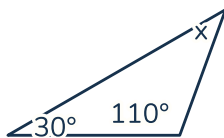
Find the angle marked x . Give each answer in degrees.

1



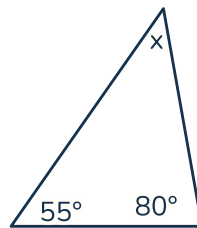
_____ degrees

2



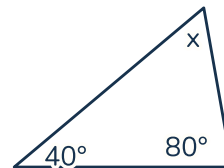
_____ degrees

3



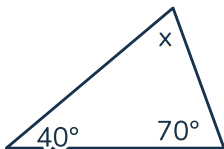
_____ degrees

4



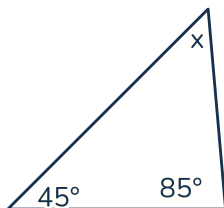
_____ degrees

5



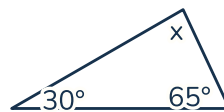
_____ degrees

6



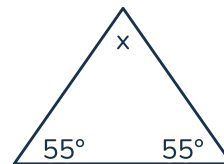
_____ degrees

7



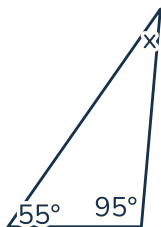
_____ degrees

8



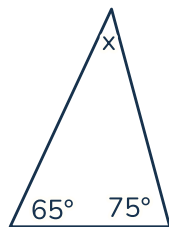
_____ degrees

9



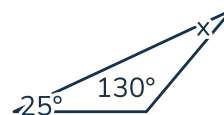
_____ degrees

10



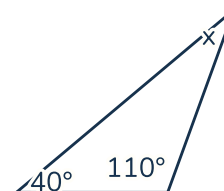
_____ degrees

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

A / B

B 42 pages in 7 days

14 A 84 km in 7 hours

A / B

B $y = 6x$, y km and x hours

15 A $y = 11x$, y km and x hours

A / B

B 28 km in 7 hours

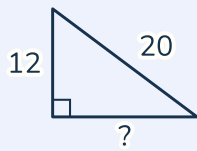
34. Which rate is greater? (continued)

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

- 16 A 56 dollars in 7 weeks A / B
B $y = 14x$, y dollars and x weeks
- 17 A $y = 9x$, y km and x hours A / B
B 64 km in 8 hours
- 18 A $y = 11x$, y words and x minutes A / B
B 20 words in 5 minutes
- 19 A 40 meters in 5 seconds A / B
B $y = 11x$, y meters and x seconds
- 20 A 88 km in 8 hours A / B
B $y = 8x$, y km and x hours
- 21 A $y = 2x$, y words and x minutes A / B
B 60 words in 5 minutes
- 22 A $y = 8x$, y km and x hours A / B
B 12 km in 6 hours

Pythagoras

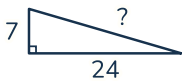
WORKED EXAMPLE

**16** cm

35. Pythagorean theorem

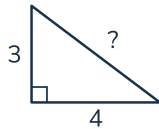
Find the missing side. All lengths are in centimeters.

1



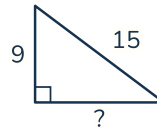
_____ cm

2



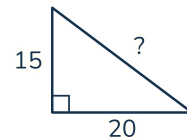
_____ cm

3



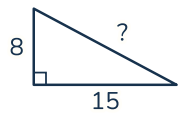
_____ cm

4



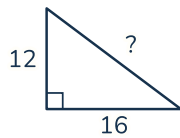
_____ cm

5



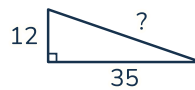
_____ cm

6



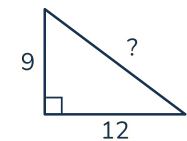
_____ cm

7



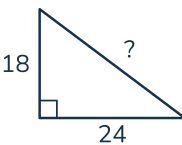
_____ cm

8



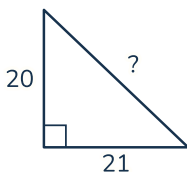
_____ cm

9



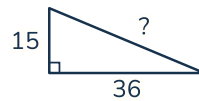
_____ cm

10



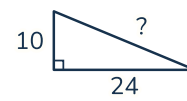
_____ cm

11



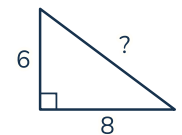
_____ cm

12



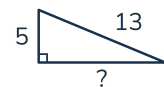
_____ cm

13



_____ cm

14



_____ cm

36. Linear or nonlinear

Is each equation linear or nonlinear? Circle one.

¹⁵ $y = 24x - 16$ Linear / Nonlinear

¹⁷ $y = 4x^2 + 19$ Linear / Nonlinear

¹⁹ $y = 24x + 34$ Linear / Nonlinear

²¹ $y = 8x^2 + 2$ Linear / Nonlinear

²³ $y = 12x + 20$ Linear / Nonlinear

¹⁶ $y = x/15 + 17$ Linear / Nonlinear

¹⁸ $y = x/14 + 6$ Linear / Nonlinear

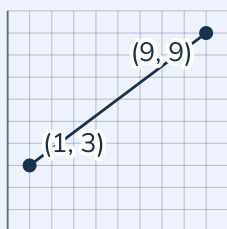
²⁰ $y = x/3 + 20$ Linear / Nonlinear

²² $y = 18x$ Linear / Nonlinear

²⁴ $y = 18x - 28$ Linear / Nonlinear

Distance Between Points

WORKED EXAMPLE

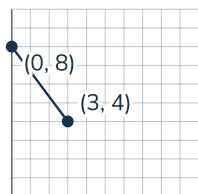


10 units

37. Distance between two points

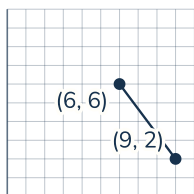
Find the distance between the two points.

1



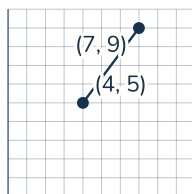
_____ units

2



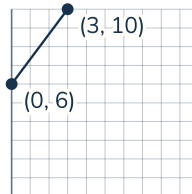
_____ units

3



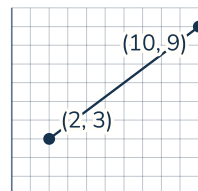
_____ units

4



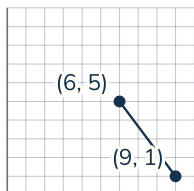
_____ units

5



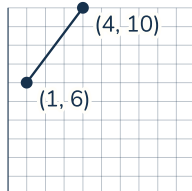
_____ units

6



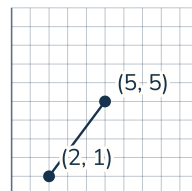
_____ units

7



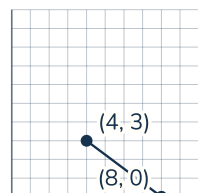
_____ units

8



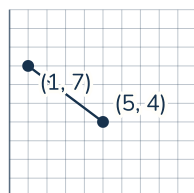
_____ units

9



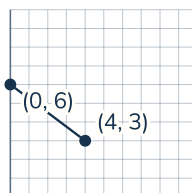
_____ units

10



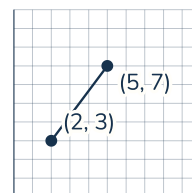
_____ units

11



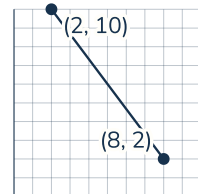
_____ units

12



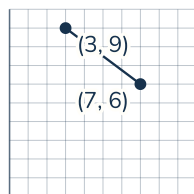
_____ units

13



_____ units

14



_____ units

38. Is it a function?

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

15

x	13	10	7	10
y	45	7	4	26

16

x	11	21	13	11
y	32	33	25	43

17

x	10	9	19	11
y	9	16	16	58

18

x	5	5	24	10
y	14	25	23	39

19

x	17	8	19	19
y	44	5	57	14

20

x	22	22	15	4
y	43	22	6	19

21

x	11	16	10	7
y	52	47	10	52

22

x	14	23	14	0
y	42	12	23	41

23

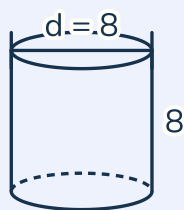
x	19	4	8	10
y	42	10	12	33

24

x	7	3	22	3
y	59	23	11	38

Volume of Cylinders

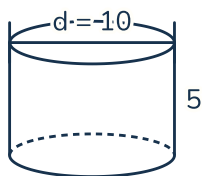
WORKED EXAMPLE

**401.92**

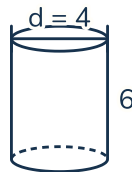
39. Volume of a cylinder

Find the volume of each cylinder. Use $\pi = 3.14$.

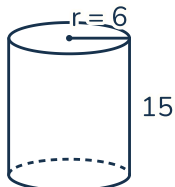
1



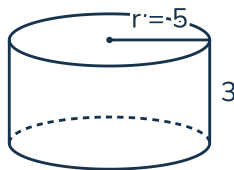
2



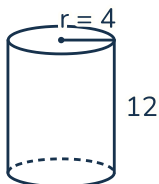
3



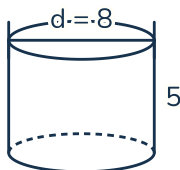
4



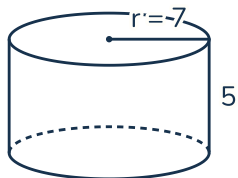
5



6



7



40. Laws of exponents

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

8 $2^{12} \times 2^7 = 2^n$, $n = \underline{\hspace{2cm}}$

9 $2^8 \times 2^4 = 2^n$, $n = \underline{\hspace{2cm}}$

10 $12^8 \times 12^4 = 12^n$, $n = \underline{\hspace{2cm}}$

11 $4^{12} \times 4^4 = 4^n$, $n = \underline{\hspace{2cm}}$

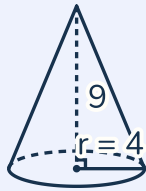
12 $8^9 \times 8^{10} = 8^n$, $n = \underline{\hspace{2cm}}$

13 $4^1 \times 4^3 = 4^n$, $n = \underline{\hspace{2cm}}$

14 $3^{13} \times 3^5 = 3^n$, $n = \underline{\hspace{2cm}}$

Volume of Cones

WORKED EXAMPLE

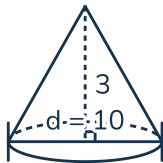


150.72

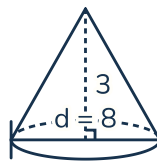
41. Volume of a cone

Find the volume of each cone. Use $\pi = 3.14$.

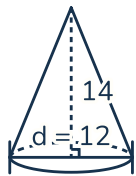
1



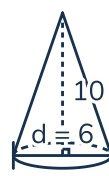
2



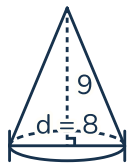
3



4



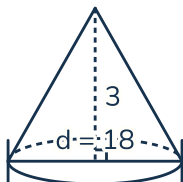
5



6



7



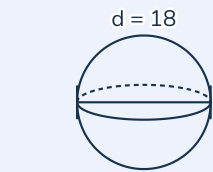
42. Square and cube roots

Find each root. Check the symbol before you answer.

8 $\sqrt{196} = \underline{\hspace{1cm}}$ 9 $\sqrt{4} = \underline{\hspace{1cm}}$ 10 $\sqrt{441} = \underline{\hspace{1cm}}$ 11 $\sqrt{49} = \underline{\hspace{1cm}}$ 12 $\sqrt{64} = \underline{\hspace{1cm}}$
13 $\sqrt{144} = \underline{\hspace{1cm}}$ 14 $\sqrt{484} = \underline{\hspace{1cm}}$

Volume of Spheres

WORKED EXAMPLE

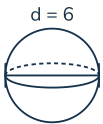


3052.08

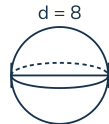
43. Volume of a sphere

Find the volume of each sphere. Use $\pi = 3.14$. Round to the hundredth.

1



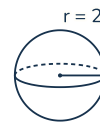
2



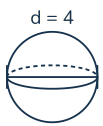
3



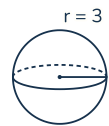
4



5



6



7



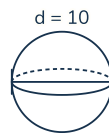
8



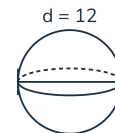
9



10



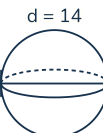
11



12



13



14



15



16



44. Between which whole numbers

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

17 $\sqrt{128} > \underline{\hspace{1cm}}$

18 $\sqrt{108} > \underline{\hspace{1cm}}$

19 $\sqrt{227} > \underline{\hspace{1cm}}$

20 $\sqrt{98} > \underline{\hspace{1cm}}$

21 $\sqrt{24} > \underline{\hspace{1cm}}$

22 $\sqrt{39} > \underline{\hspace{1cm}}$

23 $\sqrt{291} > \underline{\hspace{1cm}}$

24 $\sqrt{142} > \underline{\hspace{1cm}}$

25 $\sqrt{62} > \underline{\hspace{1cm}}$

26 $\sqrt{59} > \underline{\hspace{1cm}}$

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

¹¹ $\sqrt{441}$ Rational / Irrational

¹³ $\sqrt{222}$ Rational / Irrational

¹⁵ $\sqrt{481}$ Rational / Irrational

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

¹² $\sqrt{289}$ Rational / Irrational

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

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

WORKED EXAMPLE

Walking and steps taken



Is the association positive, negative or none?

positive

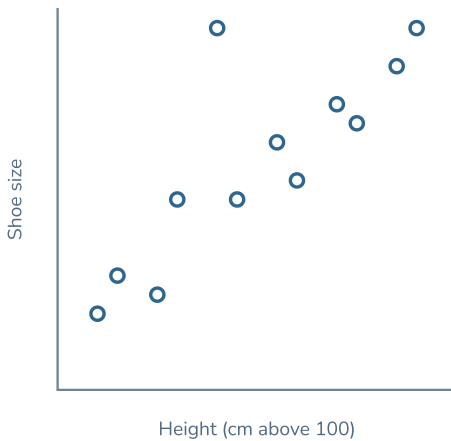
negative

none

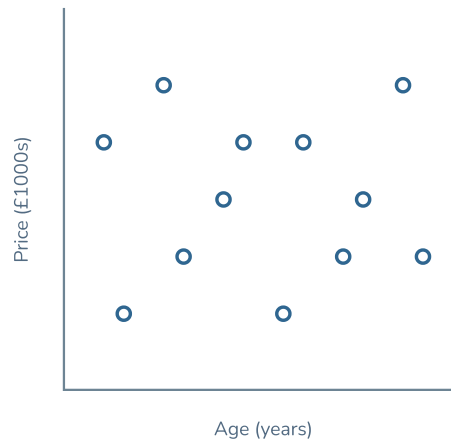
47. Scatter plots

Read each scatter plot and circle the answer.

Height and shoe size



Age and price of a used car



- 1 Is the association positive, negative or none?

positive negative none

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

along a line spread out

- 2 Is the pattern linear or nonlinear?

linear nonlinear

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

yes no

48. Writing numbers in full

Write each number in standard form.

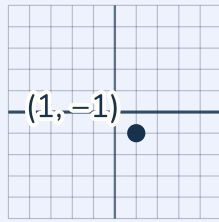
5 $7.6 \times 10^2 =$ _____

6 $2.4 \times 10^3 =$ _____

7 $1.1 \times 10^6 =$ _____

8 $3.5 \times 10^3 =$ _____

WORKED EXAMPLE



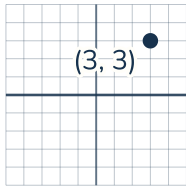
in the x-axis

(1 , 1)

49. Transformations on a grid

Move each point as described. Write where it lands.

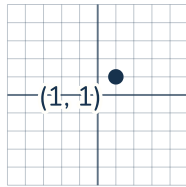
1



in the x-axis

(_____ , _____)

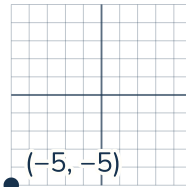
2



5 left and 3 up

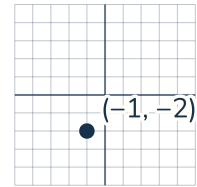
(_____ , _____)

3

 180° about O

(_____ , _____)

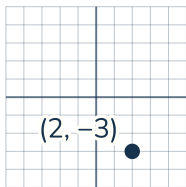
4



2 right and 4 up

(_____ , _____)

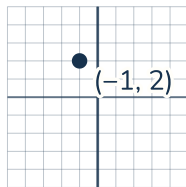
5



2 down

(_____ , _____)

6



in the y-axis

(_____ , _____)

50. Multiplying and dividing in scientific notation

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

7 $(6 \times 10^{-4}) \div (5 \times 10^{-2})$

8 $(2 \times 10^{-2}) \times (4.5 \times 10^{-1})$

9 $(8 \times 10^{-1}) \times (7.5 \times 10^7)$

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

11 $(3 \times 10^{-4}) \times (1.5 \times 10^7)$

12 $(8 \times 10^{-3}) \div (5 \times 10^2)$

Check the Powers

51. Check the powers

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

- 1 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?

- 2 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?

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

☐ x^6 ☐ x^8 ☐ x^{18} ☐ x^9

Why?

- 4 Priya's answer to $x^5 \cdot x^3 \div x^4$ is x^4 . Which is correct?

☐ x^6 ☐ x^{11} ☐ x^{12} ☐ x^4

Why?

- 5 On Priya's paper: $x^3 \cdot x^3 \div x^4 = x^4$. Which line should replace it?

☐ x^{10} ☐ x^5 ☐ x^4 ☐ x^2

Why?

- 6 Theo says $x^4 \cdot x^4 \div x^3$ comes to x^5 . Which is correct?

☐ x^{13} ☐ x^5 ☐ x^{11} ☐ x^3

Why?

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

☐ x^{18} ☐ x^{32} ☐ x^{10} ☐ x^{16}

Why?

- 8 On Priya's paper: $x^3 \cdot x^3 \div x^2 = x^2$. Which line should replace it?

☐ x^2 ☐ x^4 ☐ x^7 ☐ x^8

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

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. $\sqrt{165}$ 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
6. $\sqrt{59}$ is between 7 and 8: 7
7. $\sqrt{299}$ is between 17 and 18: 17
8. $\sqrt{136}$ is between 11 and 12: 11
9. $\sqrt{14}$ is between 3 and 4: 3
10. $\sqrt{135}$ is between 11 and 12: 11
11. $\sqrt{267}$ is between 16 and 17: 16
12. $\sqrt{5}$ is between 2 and 3: 2
13. $\sqrt{154}$ is between 12 and 13: 12
14. $\sqrt{232}$ is between 15 and 16: 15
15. $\sqrt{42}$ is between 6 and 7: 6
16. $\sqrt{137}$ is between 11 and 12: 11
17. $\sqrt{112}$ is between 10 and 11: 10
18. $\sqrt{197}$ is between 14 and 15: 14
19. $\sqrt{105}$ is between 10 and 11: 10
20. $\sqrt{94}$ is between 9 and 10: 9
21. $\sqrt{258}$ is between 16 and 17: 16

To the nearest whole number

22. $\sqrt{123}$ is between 11 and 12: 11
23. $\sqrt{179}$ is between 13 and 14: 13
24. $\sqrt{300}$ is between 17 and 18: 17
25. $\sqrt{155}$ is between 12 and 13: 12
26. $\sqrt{112}$ is between 10 and 11: 11
27. $\sqrt{11}$ is between 3 and 4: 3
28. $\sqrt{246}$ is between 15 and 16: 16
29. $\sqrt{189}$ is between 13 and 14: 14

Estimating Roots (continued)

To the nearest whole number (continued)

30. $\sqrt{5}$ is between 2 and 3: 2
31. $\sqrt{52}$ is between 7 and 8: 7
32. $\sqrt{354}$ is between 18 and 19: 19
33. $\sqrt{96}$ is between 9 and 10: 10
34. $\sqrt{190}$ is between 13 and 14: 14
35. $\sqrt{224}$ is between 14 and 15: 15
36. $\sqrt{85}$ is between 9 and 10: 9
37. $\sqrt{53}$ is between 7 and 8: 7
38. $\sqrt{147}$ is between 12 and 13: 12
39. $\sqrt{292}$ is between 17 and 18: 17
40. $\sqrt{177}$ is between 13 and 14: 13
41. $\sqrt{12}$ is between 3 and 4: 3
42. $\sqrt{222}$ is between 14 and 15: 15

To the nearest tenth

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

Rational and Irrational Numbers

Rational or irrational

1. $\sqrt{484}$: rational — it is exactly 22, and any whole number counts as a fraction over one
2. $\sqrt{28}$: irrational — 28 is not a perfect square, so its root never ends and never repeats
3. $\sqrt{67}$: 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. $\sqrt{121}$: 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. $4.6 \times 10^3 = 4600$
2. $6.9 \times 10^4 = 69000$
3. $7.5 \times 10^6 = 7500000$
4. $3.4 \times 10^3 = 3400$
5. $3.5 \times 10^2 = 350$
6. $2.1 \times 10^2 = 210$
7. $3.4 \times 10^6 = 3400000$
8. $6.6 \times 10^4 = 66000$
9. $3.1 \times 10^2 = 310$
10. $2.4 \times 10^4 = 24000$
11. $9.2 \times 10^5 = 920000$
12. $4.7 \times 10^3 = 4700$
13. $7.8 \times 10^3 = 7800$
14. $6.9 \times 10^5 = 690000$
15. $8.9 \times 10^4 = 89000$
16. $9.9 \times 10^3 = 9900$
17. $5.4 \times 10^3 = 5400$
18. $3.3 \times 10^6 = 3300000$
19. $5.8 \times 10^4 = 58000$
20. $3.9 \times 10^2 = 390$
21. $4.5 \times 10^6 = 4500000$
22. $7.9 \times 10^4 = 79000$
23. $2.7 \times 10^3 = 2700$

Answer Key (4 of 12)

Scientific Notation (continued)

Writing numbers in full (continued)

24. $3.5 \times 10^3 = 3500$

Numbers smaller than one

25. $3 \times 10^{-1} = 0.3$

26. $2.8 \times 10^{-1} = 0.28$

27. $2.4 \times 10^{-4} = 0.00024$

28. $8.7 \times 10^{-2} = 0.087$

29. $1.8 \times 10^{-1} = 0.18$

30. $6.7 \times 10^{-1} = 0.67$

31. $2.6 \times 10^{-3} = 0.0026$

32. $4 \times 10^{-2} = 0.04$

33. $3.5 \times 10^{-2} = 0.035$

34. $2.2 \times 10^{-2} = 0.022$

35. $9.3 \times 10^{-3} = 0.0093$

36. $7.4 \times 10^{-2} = 0.074$

37. $7.8 \times 10^{-1} = 0.78$

38. $6.9 \times 10^{-3} = 0.0069$

39. $5.7 \times 10^{-1} = 0.57$

40. $2.1 \times 10^{-2} = 0.021$

41. $3.8 \times 10^{-2} = 0.038$

42. $8.9 \times 10^{-4} = 0.00089$

43. $9.1 \times 10^{-2} = 0.091$

44. $7.8 \times 10^{-2} = 0.078$

45. $3.1 \times 10^{-3} = 0.0031$

46. $6.9 \times 10^{-2} = 0.069$

47. $7.2 \times 10^{-2} = 0.072$

48. $1.9 \times 10^{-1} = 0.19$

Square and cube roots

49. $\sqrt{169} = 13$

50. $\sqrt{144} = 12$

51. $\sqrt{256} = 16$

52. $\sqrt{9} = 3$

53. $\sqrt{121} = 11$

54. $\sqrt{49} = 7$

55. $\sqrt{361} = 19$

56. $\sqrt{81} = 9$

57. $\sqrt{36} = 6$

58. $\sqrt{4} = 2$

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. $(6 \times 10^{-4}) \div (5 \times 10^{-2}) = 1.2 \times 10^{-2}$

3. $(4 \times 10^8) \times (2.5 \times 10^{-1}) = 1 \times 10^8$

4. $(1.5 \times 10^{-2}) \times (6 \times 10^{-1}) = 9 \times 10^{-3}$

5. $(3 \times 10^8) \div (2.5 \times 10^{-4}) = 1.2 \times 10^{12}$

6. $(5 \times 10^{-3}) \div (2.5 \times 10^5) = 2 \times 10^{-8}$

Working in Scientific Notation (continued)

Multiplying and dividing in scientific notation (continued)

7. $(2.5 \times 10^3) \times (6 \times 10^3) = 1.5 \times 10^7$

8. $(4 \times 10^5) \times (2 \times 10^5) = 8 \times 10^{10}$

9. $(6 \times 10^{-4}) \div (2.5 \times 10^3) = 2.4 \times 10^{-7}$

10. $(1.5 \times 10^3) \times (6 \times 10^3) = 9 \times 10^6$

11. $(2 \times 10^4) \times (5 \times 10^{-3}) = 1 \times 10^2$

12. $(7.5 \times 10^8) \div (5 \times 10^{-1}) = 1.5 \times 10^9$

13. $(4.5 \times 10^4) \div (1.5 \times 10^4) = 3 \times 10^0$

14. $(7.5 \times 10^7) \times (6 \times 10^{-1}) = 4.5 \times 10^7$

15. $(5 \times 10^5) \times (1.2 \times 10^{-5}) = 6 \times 10^0$

16. $(1.5 \times 10^8) \times (1.2 \times 10^3) = 1.8 \times 10^{11}$

17. $(4 \times 10^{-2}) \times (1.2 \times 10^{-4}) = 4.8 \times 10^{-6}$

18. $(4 \times 10^5) \times (2.5 \times 10^5) = 1 \times 10^{11}$

19. $(2 \times 10^8) \times (3 \times 10^{-1}) = 6 \times 10^7$

20. $(1.5 \times 10^2) \times (5 \times 10^7) = 7.5 \times 10^9$

21. $(6 \times 10^{-2}) \times (4.5 \times 10^8) = 2.7 \times 10^7$

22. $(2 \times 10^{-3}) \times (4.5 \times 10^2) = 9 \times 10^{-1}$

23. $(5 \times 10^5) \div (2 \times 10^{-3}) = 2.5 \times 10^8$

24. $(5 \times 10^8) \div (2 \times 10^4) = 2.5 \times 10^4$

Between which whole numbers

25. $\sqrt{164}$ is between 12 and 13: 12

26. $\sqrt{137}$ is between 11 and 12: 11

27. $\sqrt{335}$ is between 18 and 19: 18

28. $\sqrt{139}$ is between 11 and 12: 11

29. $\sqrt{79}$ is between 8 and 9: 8

30. $\sqrt{85}$ is between 9 and 10: 9

31. $\sqrt{260}$ is between 16 and 17: 16

32. $\sqrt{115}$ is between 10 and 11: 10

33. $\sqrt{142}$ is between 11 and 12: 11

34. $\sqrt{70}$ is between 8 and 9: 8

Solving Equations

Solving equations

1. $7x + 3 = 2x + 8 \rightarrow x = 1$

2. $11x + 13 = 3x + 37 \rightarrow x = 3$

3. $8x + 15 = 5x + 30 \rightarrow x = 5$

4. $5x + 4 = 6x + 3 \rightarrow x = 1$

5. $x + 23 = 11x + 3 \rightarrow x = 2$

6. $9x + 10 = 11x + 6 \rightarrow x = 2$

7. $9x + 14 = 6x + 32 \rightarrow x = 6$

8. $10x + 15 = 9x + 18 \rightarrow x = 3$

9. $9x + 8 = 5x + 12 \rightarrow x = 1$

10. $3x + 17 = 10x + 3 \rightarrow x = 2$

11. $11x + 20 = 12x + 15 \rightarrow x = 5$

12. $8x + 9 = 6x + 17 \rightarrow x = 4$

13. $11x + 1 = 5x + 25 \rightarrow x = 4$

14. $5x + 38 = 9x + 14 \rightarrow x = 6$

Answer Key (5 of 12)

Solving Equations (continued)

Solving equations (continued)

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

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. $8.3 \times 10^4 = 83000$
26. $4.7 \times 10^3 = 4700$
27. $6.3 \times 10^6 = 6300000$
28. $1.2 \times 10^2 = 120$
29. $5.4 \times 10^3 = 5400$
30. $7.4 \times 10^2 = 740$
31. $7.3 \times 10^6 = 7300000$
32. $6.8 \times 10^3 = 6800$
33. $8.4 \times 10^2 = 840$
34. $8.5 \times 10^2 = 850$

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. $(6 \times 10^{-4}) \div (1.5 \times 10^4) = 4 \times 10^{-8}$
22. $(4 \times 10^5) \div (2.5 \times 10^{-5}) = 1.6 \times 10^{10}$
23. $(4.5 \times 10^{-5}) \times (4 \times 10^{-1}) = 1.8 \times 10^{-5}$
24. $(7.5 \times 10^4) \times (1.2 \times 10^{-5}) = 9 \times 10^{-1}$
25. $(1.5 \times 10^{-4}) \times (3 \times 10^6) = 4.5 \times 10^2$
26. $(7.5 \times 10^8) \div (5 \times 10^{-1}) = 1.5 \times 10^9$
27. $(8 \times 10^7) \times (5 \times 10^{-1}) = 4 \times 10^7$
28. $(1.2 \times 10^{-2}) \times (7.5 \times 10^5) = 9 \times 10^3$
29. $(4 \times 10^2) \div (2.5 \times 10^6) = 1.6 \times 10^{-4}$
30. $(1.2 \times 10^2) \times (2 \times 10^5) = 2.4 \times 10^7$

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. $4x + 37 = 10x + 13 \rightarrow x = 4$
50. $8x + 10 = 6x + 12 \rightarrow x = 1$
51. $12x + 2 = 6x + 32 \rightarrow x = 5$
52. $7x + 16 = 9x + 12 \rightarrow x = 2$
53. $5x + 12 = 3x + 18 \rightarrow x = 3$
54. $4x + 7 = 6x + 5 \rightarrow x = 1$
55. $4x + 40 = 9x + 15 \rightarrow x = 5$
56. $5x + 8 = x + 16 \rightarrow x = 2$
57. $3x + 20 = 8x + 5 \rightarrow x = 3$

Answer Key (7 of 12)

Slope (continued)

Solving equations (continued)

58. $7x + 12 = 10x + 6 \rightarrow x = 2$

Rate of Change

Rate of change from a table

1. $x: 1, 2, 3, 4$; $y: 42, 33, 24, 15 \rightarrow -9$ (y moves -9 while x moves 1 , and $-9 \div 1 = -9$)
2. $x: 3, 4, 5, 6$; $y: 35, 32, 29, 26 \rightarrow -3$ (y moves -3 while x moves 1 , and $-3 \div 1 = -3$)
3. $x: 1, 4, 7, 10$; $y: 33, 48, 63, 78 \rightarrow 5$ (y moves 15 while x moves 3 , and $15 \div 3 = 5$)
4. $x: 2, 3, 4, 5$; $y: 51, 57, 63, 69 \rightarrow 6$ (y moves 6 while x moves 1 , and $6 \div 1 = 6$)
5. $x: 6, 7, 8, 9$; $y: 55, 47, 39, 31 \rightarrow -8$ (y moves -8 while x moves 1 , and $-8 \div 1 = -8$)
6. $x: 3, 4, 5, 6$; $y: 18, 12, 6, 0 \rightarrow -6$ (y moves -6 while x moves 1 , and $-6 \div 1 = -6$)
7. $x: 7, 11, 15, 19$; $y: 39, 47, 55, 63 \rightarrow 2$ (y moves 8 while x moves 4 , and $8 \div 4 = 2$)
8. $x: 4, 5, 6, 7$; $y: 59, 65, 71, 77 \rightarrow 6$ (y moves 6 while x moves 1 , and $6 \div 1 = 6$)
9. $x: 9, 10, 11, 12$; $y: 58, 52, 46, 40 \rightarrow -6$ (y moves -6 while x moves 1 , and $-6 \div 1 = -6$)
10. $x: 6, 7, 8, 9$; $y: 61, 65, 69, 73 \rightarrow 4$ (y moves 4 while x moves 1 , and $4 \div 1 = 4$)
11. $x: 9, 13, 17, 21$; $y: 37, 41, 45, 49 \rightarrow 1$ (y moves 4 while x moves 4 , and $4 \div 4 = 1$)
12. $x: 6, 7, 8, 9$; $y: 20, 17, 14, 11 \rightarrow -3$ (y moves -3 while x moves 1 , and $-3 \div 1 = -3$)
13. $x: 2, 3, 4, 5$; $y: 42, 44, 46, 48 \rightarrow 2$ (y moves 2 while x moves 1 , and $2 \div 1 = 2$)
14. $x: 6, 10, 14, 18$; $y: 59, 83, 107, 131 \rightarrow 6$ (y moves 24 while x moves 4 , and $24 \div 4 = 6$)
15. $x: 1, 2, 3, 4$; $y: 48, 56, 64, 72 \rightarrow 8$ (y moves 8 while x moves 1 , and $8 \div 1 = 8$)
16. $x: 3, 4, 5, 6$; $y: 46, 49, 52, 55 \rightarrow 3$ (y moves 3 while x moves 1 , and $3 \div 1 = 3$)
17. $x: 6, 7, 8, 9$; $y: 86, 94, 102, 110 \rightarrow 8$ (y moves 8 while x moves 1 , and $8 \div 1 = 8$)
18. $x: 4, 8, 12, 16$; $y: 49, 89, 129, 169 \rightarrow 10$ (y moves 40 while x moves 4 , and $40 \div 4 = 10$)
19. $x: 8, 9, 10, 11$; $y: 26, 23, 20, 17 \rightarrow -3$ (y moves -3 while x moves 1 , and $-3 \div 1 = -3$)
20. $x: 5, 6, 7, 8$; $y: 47, 42, 37, 32 \rightarrow -5$ (y moves -5 while x moves 1 , and $-5 \div 1 = -5$)
21. $x: 2, 8, 14, 20$; $y: 21, 81, 141, 201 \rightarrow 10$ (y moves 60 while x moves 6 , and $60 \div 6 = 10$)
22. $x: 6, 7, 8, 9$; $y: 34, 36, 38, 40 \rightarrow 2$ (y moves 2 while x moves 1 , and $2 \div 1 = 2$)
23. $x: 4, 5, 6, 7$; $y: 25, 28, 31, 34 \rightarrow 3$ (y moves 3 while x moves 1 , and $3 \div 1 = 3$)

Rate of Change (continued)

Rate of change from a table (continued)

24. $x: 6, 7, 8, 9$; $y: 67, 74, 81, 88 \rightarrow 7$ (y moves 7 while x moves 1 , and $7 \div 1 = 7$)

Systems of equations

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

Comparing Rates

Which rate is greater?

1. $A y = 10x$, y meters and x seconds B 39 meters in 3 seconds $\rightarrow B$ (A is 10 and B is 13 per second)
2. A 84 km in 7 hours $B y = 6x$, y km and x hours $\rightarrow A$ (A is 12 and B is 6 per hour)
3. A 12 km in 2 hours $B y = 13x$, y km and x hours $\rightarrow B$ (A is 6 and B is 13 per hour)
4. $A y = 11x$, y km and x hours B 28 km in 7 hours $\rightarrow A$ (A is 11 and B is 4 per hour)
5. $A y = 12x$, y meters and x seconds B 49 meters in 7 seconds $\rightarrow A$ (A is 12 and B is 7 per second)
6. A 35 km in 7 hours $B y = 10x$, y km and x hours $\rightarrow B$ (A is 5 and B is 10 per hour)
7. A 84 km in 7 hours $B y = 10x$, y km and x hours $\rightarrow A$ (A is 12 and B is 10 per hour)
8. A 40 dollars in 5 weeks $B y = 5x$, y dollars and x weeks $\rightarrow A$ (A is 8 and B is 5 per week)
9. $A y = 2x$, y meters and x seconds B 12 meters in 4 seconds $\rightarrow B$ (A is 2 and B is 3 per second)
10. $A y = 9x$, y km and x hours B 64 km in 8 hours $\rightarrow A$ (A is 9 and B is 8 per hour)
11. $A y = 13x$, y meters and x seconds B 49 meters in 7 seconds $\rightarrow A$ (A is 13 and B is 7 per second)
12. $A y = 13x$, y words and x minutes B 66 words in 6 minutes $\rightarrow A$ (A is 13 and B is 11 per minute)
13. $A y = 4x$, y km and x hours B 30 km in 3 hours $\rightarrow B$ (A is 4 and B is 10 per hour)
14. $A y = 13x$, y pages and x days B 18 pages in 2 days $\rightarrow A$ (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. $y = 6x - 38$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
2. $y = 19x - 20$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
3. $y = 7x^2 + 33$: Nonlinear — x is squared, so the steps in y grow as x grows
4. $y = x/4 + 9$: Linear — dividing by 4 is multiplying by a number, so the steps in y stay equal
5. $y = 11x - 31$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
6. $y = 22x - 45$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
7. $y = 7x^3 + 39$: Nonlinear — x is cubed, so the steps in y grow as x grows
8. $y = 18x + 4$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
9. $y = 9x + 13$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
10. $y = x/2 + 28$: Linear — dividing by 2 is multiplying by a number, so the steps in y stay equal
11. $y = 4x^2 + 33$: Nonlinear — x is squared, so the steps in y grow as x grows
12. $y = 18x - 28$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
13. $y = 13x - 42$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
14. $y = 4x^2 + 25$: Nonlinear — x is squared, so the steps in y grow as x grows
15. $y = 17x - 32$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
16. $y = 3x - 17$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
17. $y = 18x - 30$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
18. $y = 5x^2 + 18$: Nonlinear — x is squared, so the steps in y grow as x grows
19. $y = 18x - 32$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
20. $y = 23x + 15$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y

Is It Linear? (continued)

Linear or nonlinear (continued)

21. $y = 4x^2 + 22$: Nonlinear — x is squared, so the steps in y grow as x grows
22. $y = 23x - 22$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
23. $y = x/9 + 23$: Linear — dividing by 9 is multiplying by a number, so the steps in y stay equal
24. $y = 4x - 4$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y

Finding the slope

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

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. (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
3. (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
4. (5, 42) (15, 28) (12, 6) (22, 60): Yes — every input appears once, so no input can go to two places
5. (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
6. (17, 18) (2, 51) (11, 41) (9, 38): Yes — every input appears once, so no input can go to two places

Answer Key (9 of 12)

Is It a Function? (continued)

Is it a function? (continued)

7. (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
8. (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
9. (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
10. (13, 16) (22, 8) (1, 25) (1, 5): No — the input 1 goes to 25 and also to 5, and one input may only go to one place
11. (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
12. (7, 55) (17, 18) (12, 8) (19, 32): Yes — every input appears once, so no input can go to two places
13. (21, 3) (20, 25) (8, 1) (21, 13): No — the input 21 goes to 3 and also to 13, and one input may only go to one place
14. (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

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

Angles in Parallel Lines (continued)

Angles in parallel lines (continued)

14. corresponding, 75° : 75°

Rate of change from a table

15. x: 9, 10, 11, 12 y: 43, 42, 41, 40 $\rightarrow -1$ (y moves -1 while x moves 1, and $-1 \div 1 = -1$)
16. x: 1, 2, 3, 4 y: 15, 17, 19, 21 $\rightarrow 2$ (y moves 2 while x moves 1, and $2 \div 1 = 2$)
17. x: 4, 8, 12, 16 y: 56, 100, 144, 188 $\rightarrow 11$ (y moves 44 while x moves 4, and $44 \div 4 = 11$)
18. x: 6, 7, 8, 9 y: 93, 102, 111, 120 $\rightarrow 9$ (y moves 9 while x moves 1, and $9 \div 1 = 9$)
19. x: 7, 8, 9, 10 y: 27, 23, 19, 15 $\rightarrow -4$ (y moves -4 while x moves 1, and $-4 \div 1 = -4$)
20. x: 3, 4, 5, 6 y: 33, 40, 47, 54 $\rightarrow 7$ (y moves 7 while x moves 1, and $7 \div 1 = 7$)
21. x: 5, 8, 11, 14 y: 29, 44, 59, 74 $\rightarrow 15$ (y moves 15 while x moves 3, and $15 \div 3 = 5$)
22. x: 2, 3, 4, 5 y: 27, 22, 17, 12 $\rightarrow -5$ (y moves -5 while x moves 1, and $-5 \div 1 = -5$)
23. x: 9, 10, 11, 12 y: 25, 22, 19, 16 $\rightarrow -3$ (y moves -3 while x moves 1, and $-3 \div 1 = -3$)
24. x: 1, 2, 3, 4 y: 48, 56, 64, 72 $\rightarrow 8$ (y moves 8 while x moves 1, and $8 \div 1 = 8$)

Angles in a Triangle

The third angle of a triangle

1. $50^\circ + 50^\circ = 100^\circ$: 80°
2. $30^\circ + 110^\circ = 140^\circ$: 40°
3. $55^\circ + 80^\circ = 135^\circ$: 45°
4. $40^\circ + 80^\circ = 120^\circ$: 60°
5. $40^\circ + 70^\circ = 110^\circ$: 70°
6. $45^\circ + 85^\circ = 130^\circ$: 50°
7. $30^\circ + 65^\circ = 95^\circ$: 85°
8. $55^\circ + 55^\circ = 110^\circ$: 70°
9. $55^\circ + 95^\circ = 150^\circ$: 30°
10. $65^\circ + 75^\circ = 140^\circ$: 40°
11. $25^\circ + 130^\circ = 155^\circ$: 25°
12. $40^\circ + 110^\circ = 150^\circ$: 30°

Which rate is greater?

13. A $y = 2x$, y pages and x days B 42 pages in 7 days $\rightarrow$ 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 $\rightarrow$ A (A is 12 and B is 6 per hour)
15. A $y = 11x$, y km and x hours B 28 km in 7 hours $\rightarrow$ 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 $\rightarrow$ 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 $\rightarrow$ A (A is 9 and B is 8 per hour)

Answer Key (10 of 12)

Angles in a Triangle (continued)

Which rate is greater? (continued)

18. $A y = 11x$, y words and x minutes B 20 words in 5 minutes $\rightarrow$ 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 $\rightarrow$ 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 $\rightarrow$ 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 $\rightarrow$ 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 $\rightarrow$ A (A is 8 and B is 2 per hour)

Pythagoras

Pythagorean theorem

1. 7, 24, 25 — hypotenuse: 25 cm
2. 3, 4, 5 — hypotenuse: 5 cm
3. 9, 12, 15 — leg: 12 cm
4. 15, 20, 25 — hypotenuse: 25 cm
5. 8, 15, 17 — hypotenuse: 17 cm
6. 12, 16, 20 — hypotenuse: 20 cm
7. 12, 35, 37 — hypotenuse: 37 cm
8. 9, 12, 15 — hypotenuse: 15 cm
9. 18, 24, 30 — hypotenuse: 30 cm
10. 20, 21, 29 — hypotenuse: 29 cm
11. 15, 36, 39 — hypotenuse: 39 cm
12. 10, 24, 26 — hypotenuse: 26 cm
13. 6, 8, 10 — hypotenuse: 10 cm
14. 5, 12, 13 — leg: 12 cm

Linear or nonlinear

15. $y = 24x - 16$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
16. $y = x/15 + 17$: Linear — dividing by 15 is multiplying by a number, so the steps in y stay equal
17. $y = 4x^2 + 19$: Nonlinear — x is squared, so the steps in y grow as x grows
18. $y = x/14 + 6$: Linear — dividing by 14 is multiplying by a number, so the steps in y stay equal
19. $y = 24x + 34$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
20. $y = x/3 + 20$: Linear — dividing by 3 is multiplying by a number, so the steps in y stay equal
21. $y = 8x^2 + 2$: Nonlinear — x is squared, so the steps in y grow as x grows
22. $y = 18x$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
23. $y = 12x + 20$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y
24. $y = 18x - 28$: Linear — x is only multiplied by a number and added to, so equal steps in x give equal steps in y

Distance Between Points

Distance between two points

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

Is it a function?

15. (13, 45) (10, 7) (7, 4) (10, 26): No — the input 10 goes to 7 and also to 26, and one input may only go to one place
16. (11, 32) (21, 33) (13, 25) (11, 43): No — the input 11 goes to 32 and also to 43, and one input may only go to one place
17. (10, 9) (9, 16) (19, 16) (11, 58): Yes — every input appears once — 16 turns up twice, but that is an output, and two inputs may land on the same one
18. (5, 14) (5, 25) (24, 23) (10, 39): No — the input 5 goes to 14 and also to 25, and one input may only go to one place
19. (17, 44) (8, 5) (19, 57) (19, 14): No — the input 19 goes to 57 and also to 14, and one input may only go to one place
20. (22, 43) (22, 22) (15, 6) (4, 19): No — the input 22 goes to 43 and also to 22, and one input may only go to one place
21. (11, 52) (16, 47) (10, 10) (7, 52): Yes — every input appears once — 52 turns up twice, but that is an output, and two inputs may land on the same one
22. (14, 42) (23, 12) (14, 23) (0, 41): No — the input 14 goes to 42 and also to 23, and one input may only go to one place
23. (19, 42) (4, 10) (8, 12) (10, 33): Yes — every input appears once, so no input can go to two places
24. (7, 59) (3, 23) (22, 11) (3, 38): No — the input 3 goes to 23 and also to 38, and one input may only go to one place

Volume of Cylinders

Volume of a cylinder

1. $d = 10$, $h = 5$: 392.5 cm^3
2. $d = 4$, $h = 6$: 75.36 cm^3
3. $r = 6$, $h = 15$: 1695.6 cm^3
4. $r = 5$, $h = 3$: 235.5 cm^3
5. $r = 4$, $h = 12$: 602.88 cm^3

Answer Key (11 of 12)

Volume of Cylinders (continued)

Volume of a cylinder (continued)

6. $d = 8, h = 5$: 251.2 cm^3
7. $r = 7, h = 5$: 769.3 cm^3

Laws of exponents

8. $2^{12} \times 2^7 = 2^{19}$
9. $2^8 \times 2^4 = 2^{12}$
10. $12^8 \times 12^4 = 12^{12}$
11. $4^{12} \times 4^4 = 4^{16}$
12. $8^9 \times 8^{10} = 8^{19}$
13. $4^1 \times 4^3 = 4^4$
14. $3^{13} \times 3^5 = 3^{18}$

Volume of Cones

Volume of a cone

1. $d = 10, h = 3$: 78.5 cm^3
2. $d = 8, h = 3$: 50.24 cm^3
3. $d = 12, h = 14$: 527.52 cm^3
4. $d = 6, h = 10$: 94.2 cm^3
5. $d = 8, h = 9$: 150.72 cm^3
6. $r = 3, h = 9$: 84.78 cm^3
7. $d = 18, h = 3$: 254.34 cm^3

Square and cube roots

8. $\sqrt{196} = 14$
9. $\sqrt{4} = 2$
10. $\sqrt{441} = 21$
11. $\sqrt{49} = 7$
12. $\sqrt{64} = 8$
13. $\sqrt{144} = 12$
14. $\sqrt{484} = 22$

Volume of Spheres

Volume of a sphere

1. $d = 6$: 113.04 cm^3
2. $d = 8$: 267.95 cm^3
3. $r = 7$: 1436.03 cm^3
4. $r = 2$: 33.49 cm^3
5. $d = 4$: 33.49 cm^3
6. $r = 3$: 113.04 cm^3
7. $r = 8$: 2143.57 cm^3
8. $r = 4$: 267.95 cm^3
9. $r = 5$: 523.33 cm^3
10. $d = 10$: 523.33 cm^3
11. $d = 12$: 904.32 cm^3
12. $r = 10$: 4186.67 cm^3
13. $d = 14$: 1436.03 cm^3
14. $d = 16$: 2143.57 cm^3
15. $r = 9$: 3052.08 cm^3

Volume of Spheres (continued)

Volume of a sphere (continued)

16. $r = 6$: 904.32 cm^3

Between which whole numbers

17. $\sqrt{128}$ is between 11 and 12: 11
18. $\sqrt{108}$ is between 10 and 11: 10
19. $\sqrt{227}$ is between 15 and 16: 15
20. $\sqrt{98}$ is between 9 and 10: 9
21. $\sqrt{24}$ is between 4 and 5: 4
22. $\sqrt{39}$ is between 6 and 7: 6
23. $\sqrt{291}$ is between 17 and 18: 17
24. $\sqrt{142}$ is between 11 and 12: 11
25. $\sqrt{62}$ is between 7 and 8: 7
26. $\sqrt{59}$ is between 7 and 8: 7

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
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

Answer Key (12 of 12)

Scatter Plots (continued)

Scatter plots (continued)

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. $7.6 \times 10^2 = 760$
6. $2.4 \times 10^3 = 2400$
7. $1.1 \times 10^6 = 1100000$
8. $3.5 \times 10^3 = 3500$

Transformations

Transformations on a grid

1. (3, 3) in the x-axis: (3, -3)
2. (1, 1) 5 left and 3 up: (-4, 4)
3. (-5, -5) 180° about O: (5, 5)
4. (-1, -2) 2 right and 4 up: (1, 2)
5. (2, -3) 2 down: (2, -5)
6. (-1, 2) in the y-axis: (1, 2)

Multiplying and dividing in scientific notation

7. $(6 \times 10^{-4}) \div (5 \times 10^{-2}) = 1.2 \times 10^{-2}$
8. $(2 \times 10^{-2}) \times (4.5 \times 10^{-1}) = 9 \times 10^{-3}$
9. $(8 \times 10^{-1}) \times (7.5 \times 10^7) = 6 \times 10^7$
10. $(7.5 \times 10^{-2}) \div (3 \times 10^3) = 2.5 \times 10^{-5}$
11. $(3 \times 10^{-4}) \times (1.5 \times 10^7) = 4.5 \times 10^3$
12. $(8 \times 10^{-3}) \div (5 \times 10^2) = 1.6 \times 10^{-5}$

Check the Powers

Check the powers

1. $x^4 \cdot x^3 \div x^2 = x^5$, not x^9 (the dividing step added its power instead of taking it away)
2. $x^3 \cdot x^4 \div x^3 = x^4$, not x^2 (the second power was taken away and the third one added)
3. $(x^3)^2 \cdot x^3 = x^9$, not x^{18} (the last power was multiplied in as well as the first two)
4. $x^5 \cdot x^3 \div x^4 = x^4$, which is what was written — this line is correct
5. $x^3 \cdot x^3 \div x^4 = x^2$, not x^4 (the second power was taken away and the third one added)
6. $x^4 \cdot x^4 \div x^3 = x^5$, which is what was written — this line is correct
7. $(x^4)^4 \cdot x^2 = x^{18}$, not x^{32} (the last power was multiplied in as well as the first two)
8. $x^3 \cdot x^3 \div x^2 = x^4$, not x^2 (the second power was taken away and the third one added)

Solutions (1 of 28)

Exponent Rules

Laws of exponents

1. $2^8 \times 2^4 = 2^n$, $n = \underline{\hspace{1cm}}$

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

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. $9^7 \times 9^3 = 9^n$, $n = \underline{\hspace{1cm}}$

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

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. $\sqrt{196} = \underline{\hspace{1cm}}$

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

$\sqrt{\hspace{1cm}}$ 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: $14 \times 14 = 196$. So $\sqrt{196} = 14$.

Solutions (2 of 28)

Square and Cube Roots (continued)

Square and cube roots (continued)

2. $\sqrt{169} = \underline{\hspace{1cm}}$

$$\begin{array}{rcl} 13 \times 13 & = & 169 \\ \sqrt{169} & = & \mathbf{13} \end{array}$$

$\sqrt{\hspace{1cm}}$ 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

Between which whole numbers

1. $\sqrt{165} > \underline{\hspace{1cm}}$

$$\sqrt{165} > \mathbf{12}$$

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.

Solutions (3 of 28)

Estimating Roots (continued)

Between which whole numbers (continued)

2. $\sqrt{41} > \underline{\hspace{1cm}}$

$$\sqrt{41} > 6$$

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

$$\sqrt{484} \text{ is } \text{rational}$$

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

$$\sqrt{28} \text{ is } \text{irrational}$$

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. $4.6 \times 10^3 =$ _____

$$\begin{array}{r} 4.6 \\ 46 \\ 460 \\ 4600 \\ 4.6 \times 10^3 = 4600 \end{array}$$

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: $4.6 \rightarrow 46 \rightarrow 460 \rightarrow 4600$. So $4.6 \times 10^3 = 4600$.

2. $6.9 \times 10^4 =$ _____

$$\begin{array}{r} 6.9 \\ 69 \\ 690 \\ 6900 \\ 69000 \\ 6.9 \times 10^4 = 69000 \end{array}$$

10^4 is 4 tens multiplied together, which is 10000. So this asks for 6.9 lots of 10000.

Multiplying by ten moves every digit up one place, which shows up as the point moving one place right. There are 4 of them here, so the point moves 4 places right.

Following it the whole way: $6.9 \rightarrow 69 \rightarrow 690 \rightarrow 6900 \rightarrow 69000$. So $6.9 \times 10^4 = 69000$.

Solutions (5 of 28)

Working in Scientific Notation

Multiplying and dividing in scientific notation

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

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

$$2 \times 10^9$$

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 .

Solutions (6 of 28)

Working in Scientific Notation (continued)

Multiplying and dividing in scientific notation (continued)

2. $(6 \times 10^{-4}) \div (5 \times 10^{-2})$

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

$$1.2 \times 10^{-2}$$

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: $6 \div 5 = 1.2$.

Now the powers. Dividing powers of the same base SUBTRACTS the exponents: $-4 - -2 = -2$. So the powers give 10^{-2} .

Put them together: 1.2×10^{-2} . Now CHECK it — a coefficient has to be at least 1 and less than 10, and 1.2 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 1.2×10^{-2} — $6 \div 5 = 1.2$ and the powers give 10^{-2} .

Solutions (7 of 28)

Solving Equations

Solving equations

1. $7x + 3 = 2x + 8$

$$7x + 3 = 2x + 8$$

$$10 = 10 \quad \checkmark$$

This one has x on BOTH sides, so nothing can be undone yet — subtracting 3 would still leave an x on the right. Collect the x terms first.

Take $2x$ off BOTH sides. That clears x from the right, leaving $5x + 3 = 8$. That is an equation you have already met.

Two things were done to x : multiplied by 5, 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. $8 - 3 = 5$.

That leaves $5x$, which means 5 lots of x . Divide both sides by 5: $5 \div 5 = 1$.

Check by putting it back into the ORIGINAL, both sides: $7(1) + 3 = 10$, and $2(1) + 8 = 10$ — both 10, so $x = 1$.

2. $11x + 13 = 3x + 37$

$$11x + 13 = 3x + 37$$

$$46 = 46 \quad \checkmark$$

This one has x on BOTH sides, so nothing can be undone yet — subtracting 13 would still leave an x on the right. Collect the x terms first.

Take $3x$ off BOTH sides. That clears x from the right, leaving $8x + 13 = 37$. That is an equation you have already met.

Two things were done to x : multiplied by 8, then 13 added. Undo them in the REVERSE order — whatever happened last comes off first.

The 13 went on last, so it comes off first — and off BOTH sides, or the two halves stop being equal. $37 - 13 = 24$.

That leaves $8x$, which means 8 lots of x . Divide both sides by 8: $24 \div 8 = 3$.

Check by putting it back into the ORIGINAL, both sides: $11(3) + 13 = 46$, and $3(3) + 37 = 46$ — both 46, so $x = 3$.

Solutions (8 of 28)

Systems of Equations

Systems of equations

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

$$\begin{array}{rcl} x & = & 0 \\ y & = & -1 \end{array}$$

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

$$\begin{array}{rcl} x & = & 4 \\ y & = & -7 \end{array}$$

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. $-72 \div (-18) = 4$, 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. $6x - 29 = 6x - 26$

$$\begin{array}{l} -29 = -26 \quad \text{is false} \\ \text{no solution} \end{array}$$

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. $y = 10x + 28$ $m = \underline{\hspace{1cm}}$

$$y = 10x + 28$$
$$m = 10$$

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. $y = 12x + 1$ $m = \underline{\hspace{1cm}}$

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

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	2	3	4
y	42	33	24	15

rate $\rightarrow$ ____

rate of change = **-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.

Written out, that is one step of each: y moved -9 while x moved 1. Those two numbers are the whole of the division below.

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 $-9 \div 1 = -9$.

Solutions (12 of 28)

Rate of Change (continued)

Rate of change from a table (continued)

2.

x	3	4	5	6
y	35	32	29	26

rate $\rightarrow$ ____

rate of change = **-3**

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 -3 , -3 , -3 . 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 -3 while x moved 1. Those two numbers are the whole of the division below.

Now divide: $-3 \div 1 = -3$. 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 -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

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: $39 \div 3 = 13$. 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: $84 \div 7 = 12$. 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. $y = 19x - 20$ 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.

Solutions (14 of 28)

Is It a Function?

Is it a function?

1.

x	10	15	14	15
y	40	52	33	56

$15 \rightarrow 52$ and $15 \rightarrow 56$

Not 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, 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	8	16	24	8
y	22	49	24	17

$8 \rightarrow 22$ and $8 \rightarrow 17$

Not 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: 8, 16, 24, 8. Nothing about the outputs matters yet.

8 is in that list twice, and the two pairs it belongs to do not agree: the input 8 goes to 22 and also to 17, and one input may only go to one place.

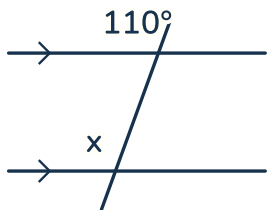
One input, two different outputs. That is the one thing a function is not allowed to do, so this relation is not a function.

Solutions (15 of 28)

Angles in Parallel Lines

Angles in parallel lines

1.



$$110^\circ = x$$

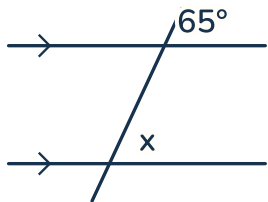
$$x = 110^\circ$$

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. $x = 110^\circ$. Nothing to work out — but only once you have seen which pair it is.

2.



$$65^\circ = x$$

$$x = 65^\circ$$

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.

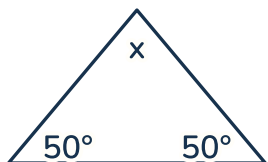
Corresponding angles are equal, so x is the same as the angle already marked. $x = 65^\circ$. Nothing to work out — but only once you have seen which pair it is.

Solutions (16 of 28)

Angles in a Triangle

The third angle of a triangle

1.



— degrees

$$50 + 50 = 100$$

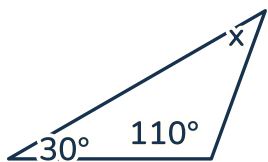
$$180 - 100 = 80^\circ$$

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: 50 and 50, which is 100 between them.

So the third takes up what is left of the 180: $180 - 100 = 80^\circ$.

2.



— degrees

$$30 + 110 = 140$$

$$180 - 140 = 40^\circ$$

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 110, which is 140 between them.

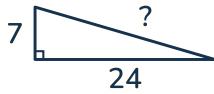
So the third takes up what is left of the 180: $180 - 140 = 40^\circ$.

Solutions (17 of 28)

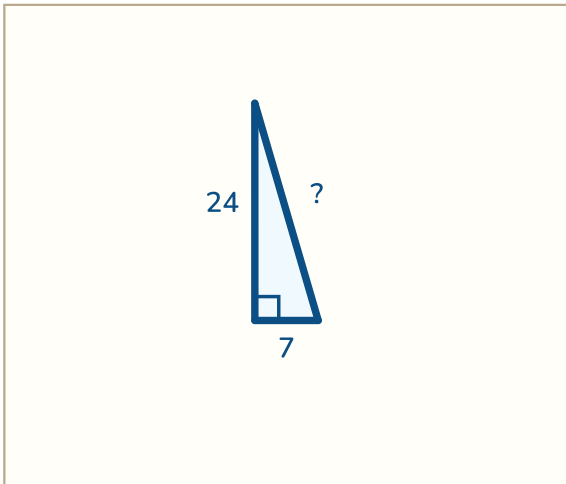
Pythagoras

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.

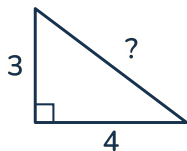
Here the hypotenuse is the missing one, so the two given sides are both legs: 7 and 24.

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

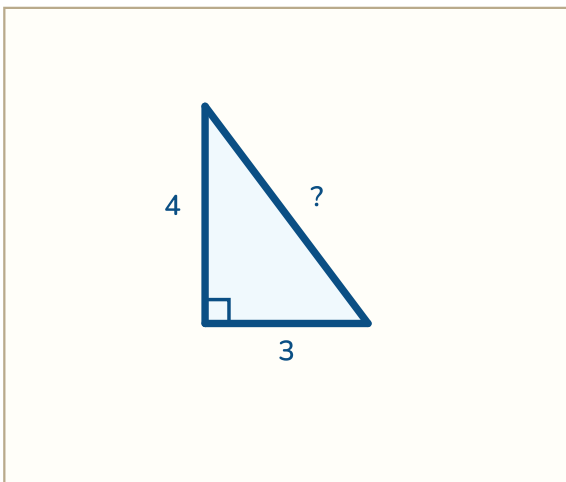
The two squares ADD to the square on the hypotenuse: $49 + 576 = 625$.

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 the missing one, so the two given sides are both legs: 3 and 4.

Square the two you have: $3^2 = 9$ and $4^2 = 16$.

The two squares ADD to the square on the hypotenuse: $9 + 16 = 25$.

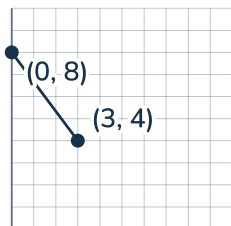
That is the square, not the side. Take the square root: $\sqrt{25} = 5$ cm.

Solutions (18 of 28)

Distance Between Points

Distance between two points

1.



— units

$$3^2 + 4^2 = 25$$
$$\text{distance} = \mathbf{5 \text{ units}}$$

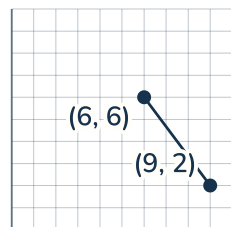
There is no new formula here. Draw the horizontal and vertical steps between the two points and they make a right triangle — the line you were given is its longest side.

Across: $3 - 0 = 3$, so that side is 3 long. Up: $4 - 8 = -4$, 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

$$3^2 + 4^2 = 25$$
$$\text{distance} = \mathbf{5 \text{ units}}$$

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: $9 - 6 = 3$, so that side is 3 long. Up: $2 - 6 = -4$, so that side is 4. A length has no sign, so take both as positive.

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

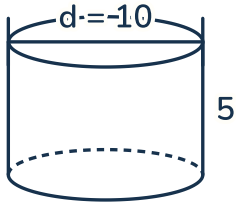
The distance is the square root of that: $\sqrt{25} = 5$. So the two points are 5 units apart.

Solutions (19 of 28)

Volume of Cylinders

Volume of a cylinder

1.



base: 78.5

$$78.5 \times 5 = 392.5$$

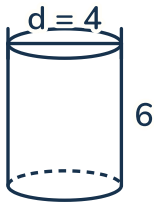
The 10 cm goes right across, so it is the diameter. Halve it first: the radius is 5. Every one of these formulas SQUARES the radius, so getting this wrong is out by a factor of four, not two.

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 $\pi \times r \times r = 3.14 \times 5 \times 5 = 78.5$ square cm.

Times the height: $78.5 \times 5 = 392.5$ cubic cm.

2.



base: 12.56

$$12.56 \times 6 = 75.36$$

The 4 cm goes right across, so it is the diameter. Halve it first: the radius is 2. 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 $\pi \times r \times r = 3.14 \times 2 \times 2 = 12.56$ square cm.

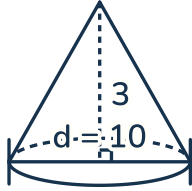
Times the height: $12.56 \times 6 = 75.36$ cubic cm.

Solutions (20 of 28)

Volume of Cones

Volume of a cone

1.



cylinder: 235.5

3 cones fill 1 cylinder

$235.5 \div 3 =$ **78.5 cubic cm**

The 10 cm goes right across, so it is the diameter. Halve it first: the radius is 5. 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 $\pi \times r \times r = 3.14 \times 5 \times 5 = 78.5$ square cm.

Times the height: $78.5 \times 3 = 235.5$ cubic cm. That is the CYLINDER it fits inside, not the cone yet.

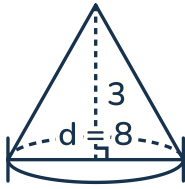
Now the part that gets forgotten. Exactly THREE cones fill the cylinder they sit inside — it is a fact about cones, not a number bolted onto a formula. So take a third: $235.5 \div 3 = 78.5$ cubic cm.

Solutions (21 of 28)

Volume of Cones (continued)

Volume of a cone (continued)

2.



cylinder: 150.72

3 cones fill 1 cylinder

$$150.72 \div 3 =$$

50.24 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: $50.24 \times 3 = 150.72$ 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: $150.72 \div 3 = 50.24$ cubic cm.

Solutions (22 of 28)

Volume of Spheres

Volume of a sphere

1.



diameter: 6 cm

$$6 \div 2 = 3$$

$$3 \times 3 \times 3 = 27$$

$$\frac{4}{3} \times 3.14 \times 27 =$$

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 : $\frac{4}{3} \times 3.14 \times 27 = 113.04$.

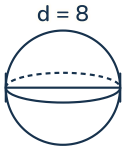
So the volume is 113.04 cubic cm. Cubic, not square — a volume fills a space, and the unit is the quickest way to notice you have answered a surface-area question instead.

Solutions (23 of 28)

Volume of Spheres (continued)

Volume of a sphere (continued)

2.



diameter: 8 cm

$$8 \div 2 = 4$$

$$4 \times 4 \times 4 = 64$$

$$\frac{4}{3} \times 3.14 \times 64 \approx$$

267.95

267.95 cm³

The 8 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 8 is 4, so $r = 4$ cm.

Cube the radius on a line of its own. r^3 means $r \times r \times r$, not $r \times 3$: $4 \times 4 \times 4 = 64$.

Then four-thirds of that, times π : $\frac{4}{3} \times 3.14 \times 64$ comes to 267.9467..., which is 267.95 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 267.95 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 $20 - 14 = 6$.

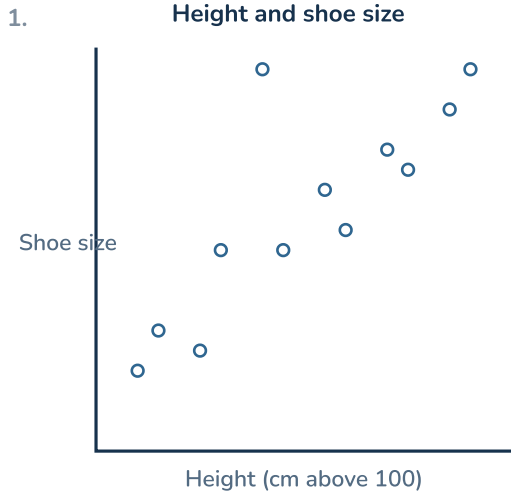
Down the column as a check. The None column adds up to 20, and the other number in it is 14: $20 - 14 = 6$. The same 6, which is what says the table hangs together.

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

Solutions (25 of 28)

Scatter Plots

Scatter plots



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.

Solutions (26 of 28)

Scatter Plots (continued)

Scatter plots (continued)



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.

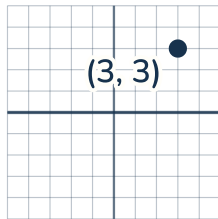
So the answer is "linear". Say what that means for the two things rather than for the graph — and remember it is not a claim that one CAUSES the other. Two measurements can move together for a reason that is nothing to do with either of them.

Solutions (27 of 28)

Transformations

Transformations on a grid

1.



in the x-axis

(—, —)

(3, 3)

3 above → 3 below

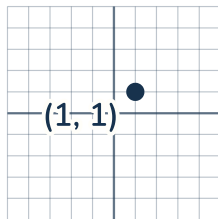
(3, 3) → (3, -3)

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.

2.



5 left and 3 up

(—, —)

(1, 1)

across = -4

up = 4

(1, 1) → (-4, 4)

Start where the point is: (1, 1). The move is 5 left and 3 up, and the question is only where those two numbers end up.

Sliding changes each coordinate on its own. Across, it moves 5 left: $1 - 5 = -4$. Up, it moves 3 up: $1 + 3 = 4$.

So it lands on (-4, 4).

Solutions (28 of 28)

Check the Powers

Check the powers

1. 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?

$$x^4 \cdot x^3 \div x^2 = x^5$$

they wrote: x^9

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: $x^4 \cdot x^3 \div x^2$ becomes $x^{(4 + 3 - 2)}$.

Tidy that up and it is x^5 .

Now compare. They wrote x^9 , and the dividing step added its power instead of taking it away — so the correct answer is x^5 .

2. 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?

$$x^3 \cdot x^4 \div x^3 = x^4$$

they wrote: x^2

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: $x^3 \cdot x^4 \div x^3$ becomes $x^{(3 + 4 - 3)}$.

Tidy that up and it is x^4 .

Now compare. They wrote x^2 , and the second power was taken away and the third one added — so the correct answer is x^4 .