Grade 8 Exponents and Roots Workbook

6 lessons · printable · answer key at the back

Name _____ Date _____

Contents

Exponent Rules

WORKED EXAMPLE

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

1. Laws of exponents

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Square and Cube Roots

WORKED EXAMPLE $\sqrt[3]{64} = 4$

2. Square and cube roots

Find each root. Check the symbol before you answer.

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

Estimating Roots

WORKED EXAMPLE $\sqrt{83} > 9$

3. Estimating square roots

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

1 $\sqrt{165} > \_\_$ 2 $\sqrt{260} > \_\_$ 3 $\sqrt{41} > \_\_$ 4 $\sqrt{419} > \_\_$ 5 $\sqrt{56} > \_\_$

6 $\sqrt{299} > \_\_$ 7 $\sqrt{79} > \_\_$ 8 $\sqrt{59} > \_\_$ 9 $\sqrt{267} > \_\_$ 10 $\sqrt{471} > \_\_$

11 $\sqrt{136} > \_\_$ 12 $\sqrt{232} > \_\_$ 13 $\sqrt{14} > \_\_$ 14 $\sqrt{464} > \_\_$ 15 $\sqrt{135} > \_\_$

16 $\sqrt{197} > \_\_$

4. Estimating square roots

Round each root to the nearest whole number.

17 $\sqrt{123} \approx \_\_$ 18 $\sqrt{300} \approx \_\_$ 19 $\sqrt{179} \approx \_\_$ 20 $\sqrt{416} \approx \_\_$ 21 $\sqrt{155} \approx \_\_$

22 $\sqrt{246} \approx \_\_$ 23 $\sqrt{112} \approx \_\_$ 24 $\sqrt{11} \approx \_\_$ 25 $\sqrt{354} \approx \_\_$ 26 $\sqrt{485} \approx \_\_$

27 $\sqrt{189} \approx \_\_$ 28 $\sqrt{224} \approx \_\_$ 29 $\sqrt{5} \approx \_\_$ 30 $\sqrt{425} \approx \_\_$ 31 $\sqrt{52} \approx \_\_$

32 $\sqrt{292} \approx \_\_$

5. Estimating square roots

Round each root to one decimal place.

33 $\sqrt{293} \approx \_\_\_\_$ 34 $\sqrt{497} \approx \_\_\_\_$ 35 $\sqrt{90} \approx \_\_\_\_$ 36 $\sqrt{317} \approx \_\_\_\_$

37 $\sqrt{175} \approx \_\_\_\_$ 38 $\sqrt{424} \approx \_\_\_\_$ 39 $\sqrt{374} \approx \_\_\_\_$ 40 $\sqrt{268} \approx \_\_\_\_$

41 $\sqrt{113} \approx \_\_\_\_$ 42 $\sqrt{407} \approx \_\_\_\_$ 43 $\sqrt{362} \approx \_\_\_\_$ 44 $\sqrt{19} \approx \_\_\_\_$

Rational and Irrational Numbers

WORKED EXAMPLE

√576 **Rational** / Irrational

6. Rational or irrational

Is each number rational or irrational? Circle one.

1 √484 Rational / Irrational

2 √28 Rational / Irrational

3 √67 Rational / Irrational

4 ∛729 Rational / Irrational

5 ∛1331 Rational / Irrational

6 √121 Rational / Irrational

7 ∛1000 Rational / Irrational

8 √25 Rational / Irrational

9 ∛512 Rational / Irrational

10 √4 Rational / Irrational

11 √100 Rational / Irrational

12 ∛1728 Rational / Irrational

13 √142 Rational / Irrational

14 √50 Rational / Irrational

15 √118 Rational / Irrational

16 √9 Rational / Irrational

17 √66 Rational / Irrational

18 √49 Rational / Irrational

19 √13 Rational / Irrational

20 √101 Rational / Irrational

21 ∛343 Rational / Irrational

22 √102 Rational / Irrational

23 √170 Rational / Irrational

24 √33 Rational / Irrational

25 √628 Rational / Irrational

26 √624 Rational / Irrational

27 √528 Rational / Irrational

28 √361 Rational / Irrational

29 √439 Rational / Irrational

30 √625 Rational / Irrational

31 √36 Rational / Irrational

32 √529 Rational / Irrational

33 √167 Rational / Irrational

34 √83 Rational / Irrational

35 √225 Rational / Irrational

36 √34 Rational / Irrational

37 ∛27 Rational / Irrational

Scientific Notation

WORKED EXAMPLE

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

7. Scientific notation

Write each number in standard form.

1 $4.6 \times 10^{3} =$ _____

2 $7.5 \times 10^{6} =$ _____

3 $5.2 \times 10^{7} =$ _____

4 $6.9 \times 10^{4} =$ _____

5 $3.4 \times 10^{6} =$ _____

6 $4.8 \times 10^{8} =$ _____

7 $9.2 \times 10^{5} =$ _____

8 $3.4 \times 10^{3} =$ _____

9 $9.1 \times 10^{7} =$ _____

10 $6.4 \times 10^{8} =$ _____

11 $6.9 \times 10^{5} =$ _____

12 $3.5 \times 10^{2} =$ _____

13 $3.6 \times 10^{7} =$ _____

14 $3.3 \times 10^{6} =$ _____

15 $6.2 \times 10^{7} =$ _____

16 $2.1 \times 10^{2} =$ _____

17 $8.3 \times 10^{8} =$ _____

18 $4.5 \times 10^{6} =$ _____

19 $5.9 \times 10^{8} =$ _____

20 $7.7 \times 10^{6} =$ _____

21 $6.6 \times 10^{4} =$ _____

22 $3.8 \times 10^{7} =$ _____

8. Scientific notation

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

23 $3 \times 10^{-1} =$ _____

24 $2.4 \times 10^{-4} =$ _____

25 $9.6 \times 10^{-5} =$ _____

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

27 $2.6 \times 10^{-3} =$ _____

28 $6.6 \times 10^{-5} =$ _____

29 $9.3 \times 10^{-3} =$ _____

30 $8.7 \times 10^{-2} =$ _____

31 $1.5 \times 10^{-5} =$ _____

32 $6 \times 10^{-5} =$ _____

33 $6.9 \times 10^{-3} =$ _____

34 $1.8 \times 10^{-1} =$ _____

35 $2 \times 10^{-5} =$ _____

36 $8.9 \times 10^{-4} =$ _____

37 $7.4 \times 10^{-5} =$ _____

38 $6.7 \times 10^{-1} =$ _____

39 $3.8 \times 10^{-5} =$ _____

40 $3.1 \times 10^{-3} =$ _____

41 $2.5 \times 10^{-5} =$ _____

42 $9.2 \times 10^{-4} =$ _____

43 $4 \times 10^{-2} =$ _____

44 $7.5 \times 10^{-5} =$ _____

Working in Scientific Notation

WORKED EXAMPLE

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

$c = 3$ $n = -1$

9. Multiplying and dividing in scientific notation

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

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

$c =$ ____ $n =$ ____

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

$c =$ ____ $n =$ ____

3 $(2 \times 10^{-2}) \div (5 \times 10^8) = c \times 10^n$

$c =$ ____ $n =$ ____

4 $(2.5 \times 10^3) \times (6 \times 10^3) = c \times 10^n$

$c =$ ____ $n =$ ____

5 $(3 \times 10^7) \div (5 \times 10^2) = c \times 10^n$

$c =$ ____ $n =$ ____

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

$c =$ ____ $n =$ ____

7 $(6 \times 10^{-3}) \div (7.5 \times 10^5) = c \times 10^n$

$c =$ ____ $n =$ ____

8 $(6 \times 10^{-4}) \div (5 \times 10^{-2}) = c \times 10^n$

$c =$ ____ $n =$ ____

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

$c =$ ____ $n =$ ____

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

$c =$ ____ $n =$ ____

11 $(1.2 \times 10^{-3}) \div (2 \times 10^7) = c \times 10^n$

$c =$ ____ $n =$ ____

12 $(3 \times 10^{-1}) \div (5 \times 10^8) = c \times 10^n$

$c =$ ____ $n =$ ____

13 $(4 \times 10^5) \times (2.5 \times 10^5) = c \times 10^n$

$c =$ ____ $n =$ ____

14 $(2 \times 10^{-2}) \div (5 \times 10^{-3}) = c \times 10^n$

$c =$ ____ $n =$ ____

15 $(1.5 \times 10^{-2}) \times (6 \times 10^{-1}) = c \times 10^n$

$c =$ ____ $n =$ ____

16 $(3 \times 10^8) \div (6 \times 10^{-3}) = c \times 10^n$

$c =$ ____ $n =$ ____

17 $(6 \times 10^{-2}) \times (4.5 \times 10^8) = c \times 10^n$

$c =$ ____ $n =$ ____

18 $(2.5 \times 10^{-5}) \div (5 \times 10^6) = c \times 10^n$

$c =$ ____ $n =$ ____

19 $(4.5 \times 10^3) \times (8 \times 10^8) = c \times 10^n$

$c =$ ____ $n =$ ____

20 $(1.2 \times 10^2) \div (1.5 \times 10^{-1}) = c \times 10^n$

$c =$ ____ $n =$ ____

21 $(1.2 \times 10^{-4}) \div (6 \times 10^4) = c \times 10^n$

$c =$ ____ $n =$ ____

22 $(7.5 \times 10^{-2}) \times (2 \times 10^3) = c \times 10^n$

$c =$ ____ $n =$ ____

23 $(4 \times 10^7) \div (5 \times 10^{-2}) = c \times 10^n$

$c =$ ____ $n =$ ____

Answer Key (1 of 4)

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

Estimating Roots

Estimating square roots

1. $\sqrt{165}$ is between 12 and 13: 12
2. $\sqrt{260}$ is between 16 and 17: 16
3. $\sqrt{41}$ is between 6 and 7: 6
4. $\sqrt{419}$ is between 20 and 21: 20
5. $\sqrt{56}$ is between 7 and 8: 7

Answer Key (2 of 4)

Estimating Roots (continued)

Estimating square roots (continued)

6. √299 is between 17 and 18: 17
7. √79 is between 8 and 9: 8
8. √59 is between 7 and 8: 7
9. √267 is between 16 and 17: 16
10. √471 is between 21 and 22: 21
11. √136 is between 11 and 12: 11
12. √232 is between 15 and 16: 15
13. √14 is between 3 and 4: 3
14. √464 is between 21 and 22: 21
15. √135 is between 11 and 12: 11
16. √197 is between 14 and 15: 14

Estimating square roots

17. √123 is between 11 and 12: 11
18. √300 is between 17 and 18: 17
19. √179 is between 13 and 14: 13
20. √416 is between 20 and 21: 20
21. √155 is between 12 and 13: 12
22. √246 is between 15 and 16: 16
23. √112 is between 10 and 11: 11
24. √11 is between 3 and 4: 3
25. √354 is between 18 and 19: 19
26. √485 is between 22 and 23: 22
27. √189 is between 13 and 14: 14
28. √224 is between 14 and 15: 15
29. √5 is between 2 and 3: 2
30. √425 is between 20 and 21: 21
31. √52 is between 7 and 8: 7
32. √292 is between 17 and 18: 17

Estimating square roots

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

Rational and Irrational Numbers

Rational or irrational

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

Rational and Irrational Numbers (continued)

Rational or irrational (continued)

2. √28: irrational — 28 is not a perfect square, so its root never ends and never repeats
3. √67: irrational — 67 is not a perfect square, so its root never ends and never repeats
4. $\sqrt[3]{729}$: rational — it is exactly 9, and any whole number counts as a fraction over one
5. $\sqrt[3]{1331}$: rational — it is exactly 11, and any whole number counts as a fraction over one
6. √121: rational — it is exactly 11, and any whole number counts as a fraction over one
7. $\sqrt[3]{1000}$: rational — it is exactly 10, and any whole number counts as a fraction over one
8. √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. √4: rational — it is exactly 2, and any whole number counts as a fraction over one
11. √100: rational — it is exactly 10, and any whole number counts as a fraction over one
12. $\sqrt[3]{1728}$: rational — it is exactly 12, and any whole number counts as a fraction over one
13. √142: irrational — 142 is not a perfect square, so its root never ends and never repeats
14. √50: irrational — 50 is not a perfect square, so its root never ends and never repeats
15. √118: irrational — 118 is not a perfect square, so its root never ends and never repeats
16. √9: rational — it is exactly 3, and any whole number counts as a fraction over one
17. √66: irrational — 66 is not a perfect square, so its root never ends and never repeats
18. √49: rational — it is exactly 7, and any whole number counts as a fraction over one
19. √13: irrational — 13 is not a perfect square, so its root never ends and never repeats
20. √101: irrational — 101 is not a perfect square, so its root never ends and never repeats
21. $\sqrt[3]{343}$: rational — it is exactly 7, and any whole number counts as a fraction over one
22. √102: irrational — 102 is not a perfect square, so its root never ends and never repeats
23. √170: irrational — 170 is not a perfect square, so its root never ends and never repeats
24. √33: irrational — 33 is not a perfect square, so its root never ends and never repeats
25. √628: irrational — 628 is not a perfect square, so its root never ends and never repeats
26. √624: irrational — 624 is not a perfect square, so its root never ends and never repeats

Answer Key (3 of 4)

Rational and Irrational Numbers (continued)

Rational or irrational (continued)

27. $\sqrt{528}$: irrational — 528 is not a perfect square, so its root never ends and never repeats
28. $\sqrt{361}$: rational — it is exactly 19, and any whole number counts as a fraction over one
29. $\sqrt{439}$: irrational — 439 is not a perfect square, so its root never ends and never repeats
30. $\sqrt{625}$: rational — it is exactly 25, and any whole number counts as a fraction over one
31. $\sqrt{36}$: rational — it is exactly 6, and any whole number counts as a fraction over one
32. $\sqrt{529}$: rational — it is exactly 23, and any whole number counts as a fraction over one
33. $\sqrt{167}$: irrational — 167 is not a perfect square, so its root never ends and never repeats
34. $\sqrt{83}$: irrational — 83 is not a perfect square, so its root never ends and never repeats
35. $\sqrt{225}$: rational — it is exactly 15, and any whole number counts as a fraction over one
36. $\sqrt{34}$: irrational — 34 is not a perfect square, so its root never ends and never repeats
37. $\sqrt[3]{27}$: rational — it is exactly 3, and any whole number counts as a fraction over one

Scientific Notation

Scientific notation

1. $4.6 \times 10^{3} = 4600$
2. $7.5 \times 10^{6} = 7500000$
3. $5.2 \times 10^{7} = 52000000$
4. $6.9 \times 10^{4} = 69000$
5. $3.4 \times 10^{6} = 3400000$
6. $4.8 \times 10^{8} = 480000000$
7. $9.2 \times 10^{5} = 920000$
8. $3.4 \times 10^{3} = 3400$
9. $9.1 \times 10^{7} = 91000000$
10. $6.4 \times 10^{8} = 640000000$
11. $6.9 \times 10^{5} = 690000$
12. $3.5 \times 10^{2} = 350$
13. $3.6 \times 10^{7} = 36000000$
14. $3.3 \times 10^{6} = 3300000$
15. $6.2 \times 10^{7} = 62000000$
16. $2.1 \times 10^{2} = 210$
17. $8.3 \times 10^{8} = 830000000$
18. $4.5 \times 10^{6} = 4500000$
19. $5.9 \times 10^{8} = 590000000$
20. $7.7 \times 10^{6} = 7700000$
21. $6.6 \times 10^{4} = 66000$
22. $3.8 \times 10^{7} = 38000000$

Scientific Notation (continued)

Scientific notation

23. $3 \times 10^{-1} = 0.3$
24. $2.4 \times 10^{-4} = 0.00024$
25. $9.6 \times 10^{-5} = 0.000096$
26. $2.8 \times 10^{-1} = 0.28$
27. $2.6 \times 10^{-3} = 0.0026$
28. $6.6 \times 10^{-5} = 0.000066$
29. $9.3 \times 10^{-3} = 0.0093$
30. $8.7 \times 10^{-2} = 0.087$
31. $1.5 \times 10^{-5} = 0.000015$
32. $6 \times 10^{-5} = 0.00006$
33. $6.9 \times 10^{-3} = 0.0069$
34. $1.8 \times 10^{-1} = 0.18$
35. $2 \times 10^{-5} = 0.00002$
36. $8.9 \times 10^{-4} = 0.00089$
37. $7.4 \times 10^{-5} = 0.000074$
38. $6.7 \times 10^{-1} = 0.67$
39. $3.8 \times 10^{-5} = 0.000038$
40. $3.1 \times 10^{-3} = 0.0031$
41. $2.5 \times 10^{-5} = 0.000025$
42. $9.2 \times 10^{-4} = 0.00092$
43. $4 \times 10^{-2} = 0.04$
44. $7.5 \times 10^{-5} = 0.000075$

Working in Scientific Notation

Multiplying and dividing in scientific notation

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

Answer Key (4 of 4)

Working in Scientific Notation (continued)

Multiplying and dividing in scientific notation (continued)

22. $(7.5 \times 10^{-2}) \times (2 \times 10^{3}) = 1.5 \times 10^{2}$
23. $(4 \times 10^{7}) \div (5 \times 10^{-2}) = 8 \times 10^{8}$

Solutions (1 of 5)

Exponent Rules

Laws of exponents

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

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

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

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

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

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

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

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

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

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

Square and Cube Roots

Square and cube roots

1. **$\sqrt{196}$ = ___**

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

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

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

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

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

Check it: 14 × 14 = 196. So √196 = 14.

Solutions (2 of 5)

Square and Cube Roots (continued)

Square and cube roots (continued)

2. $\sqrt{729} =$ ___

$27 \times 27 = 729$

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

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

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

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

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

Check it: $27 \times 27 = 729$. So $\sqrt{729} = 27$.

Estimating Roots

Estimating square roots

1. $\sqrt{165} >$ ___

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

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.

2. $\sqrt{260} >$ ___

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

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

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

The smaller of the two is 16.

Solutions (3 of 5)

Rational and Irrational Numbers

Rational or irrational

1. **√484 Rational / Irrational**

√484 is **rational**

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

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

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

2. **√28 Rational / Irrational**

√28 is **irrational**

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

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

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

Scientific Notation

Scientific notation

1. **$4.6 \times 10^3 =$ _____**

4.6

46

460

4600

$4.6 \times 10^3 =$ **4600**

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

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

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

Solutions (4 of 5)

Scientific Notation (continued)

Scientific notation (continued)

2. **$7.5 \times 10^6 =$ _____**

7.5

75

750

7500

75000

750000

7500000

7.5×10^6 = **7500000**

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

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

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

Solutions (5 of 5)

Working in Scientific Notation

Multiplying and dividing in scientific notation

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

   c = ___ n = ___

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

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

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

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

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

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

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

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

   c = ___ n = ___

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

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

Divide the coefficients: $5 \div 2.5 = 2$.

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

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

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