Check Your Understanding

1. Write each expression as a power.

   a) $3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3$

   b) $(-7)(-7)(-7)(-7)(-7)(-7)(-7)(-7)$

   c) $10 \cdot 10 \cdot 10 \cdot 10$

   d) $(-5)(-5)(-5)$

   3^6

   $(-7)^8$

   10^4

   $(-5)^3$

2. Write each power as repeated multiplication.

   a) 7^6 b) $(-17)^5$

   c) 100^3 d) $(-99)^4$

   $7 \cdot 7 \cdot 7 \cdot 7 \cdot 7 \cdot 7$

   $(-17)(-17)(-17)(-17)(-17)$

   $(-99) \cdot (-99) \cdot (-99) \cdot (-99)$

   $100 \cdot 100 \cdot 100$

3. Use mental math to calculate each power.

   a) 3^3 b) 2^4

   c) $(-5)^2$ d) $(-4)^3$

   a) 27   c) 25

   b) 16   d) −64

4. Use a calculator to calculate each power.

   a) 13^5 b) 72^4

   c) $(-24)^4$ d) $(-8)^9$

   a) 371293   c) 331776

   b) 26873856   d) −134217728

5. A shelf contains 8 boxes. Each box contains 8 cartons. Each carton contains 8 pens. Write the number of pens as a power. How many pens are on the shelf?

   $8^3 = 512$

Activate Prior Learning:
Square Roots and Cube Roots

When a number x can be written as the product of two equal factors, then the square root of x, represented by $\sqrt{x}$, is one of these factors.
For example, $\sqrt{64} = 8$ because $8^2 = 64$.

The cube root of a number x, represented by $\sqrt[3]{x}$, is one of three equal factors of the number.
For example, $\sqrt[3]{64} = 4$ because $4^3 = 64$.

Calculate each root: $\sqrt{144}, \sqrt[3]{27}$

(Continues on next page.)

4.1 Math Lab: Estimating Roots

Master 4.1c   Activate Prior Learning: Exponent Laws

Product of powers law

$$a^m \cdot a^n = a^{m+n}$$

When the bases of the powers are the same, add the exponents.

$$2^3 \cdot 2^4 = 2^{3+4}$$
$$= 2^7$$

Quotient of powers law

$$\frac{a^m}{a^n} = a^{m-n}$$

When the bases of the powers are the same, subtract the exponents.

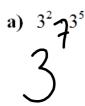$$\frac{3^9}{3^5} = 3^{9-5}$$
$$= 3^4$$

Power of a power law

$$(a^m)^n = a^{mn}$$

Multiply the exponents.

$$\left(4^2\right)^5 = 4^{2 \cdot 5}$$
$$= 4^{10}$$

Check Your Understanding

1. Write as a single power.

   a) $3^2 \cdot 3^5$

   $$3^7$$

   b) $(-4)^7 (-4)^6$

   $$(-4)^{13}$$

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

   $$(-5)^2$$

   d) $\dfrac{2^{12}}{2^7}$

   $$2^5$$

2. Write as a single power.

   a) $(4^2)^5$

   $$4^{10}$$

   b) $\left[(-3)^4\right]^3$

   $$(-3)^{12}$$

   c) $\left[(-5)^2\right]^4$

   $$(-5)^8$$

   d) $\left[(-4)^3\right]^5$

   $$(-4)^{15}$$

3. Why can you not use the exponent laws to calculate $2^6 \cdot 3^4$?

   Bases are different

4. How do you know that $(4^2)^3 = (4^3)^2$?

   $$\overset{\times}{}$$

   $$(4^2)(4^2)(4^2) \; 4^6 = 4^6 \; (4^3)(4^3)$$

1. a) Give 4 examples of radicals. Use a different index for each radical.
    b) Identify the radicand and index for each radical.
    c) Explain the meaning of the index of each radical.

← index

1 - $\sqrt[3]{27}$

← radicand

2 -

3 -

4 -

4.1 Math Lab: Estimating Roots

Check Your Understanding

1. Use mental math to calculate each root.

    a) $\sqrt{36}$ **b)** $\sqrt{144}$ **c)** $\sqrt[3]{27}$ **d)** $\sqrt[3]{-64}$

2. Use mental math to calculate each root.

    a) $\sqrt{3 \cdot 3 \cdot 3 \cdot 3}$ **b)** $\sqrt{2^{12}}$ **c)** $\sqrt[3]{5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5}$ **d)** $\sqrt[3]{9^6}$

3. **a)** A square has an area of 196 cm². Calculate its side length.

    b) A cube has a volume of 216 cm³. Calculate its edge length.

4. Use a calculator to calculate each square root.
    Write the answer to 2 decimal places where necessary.

    a) $\sqrt{289}$ **b)** $\sqrt{3.24}$ **c)** $\sqrt{1000}$ **d)** $\sqrt{\dfrac{3}{5}}$

2. Evaluate each radical. Justify your answer.

a) $\sqrt{36}$ b) $\sqrt[3]{8}$ c) $\sqrt[4]{10\,000}$ d) $\sqrt[5]{-32}$

e) $\sqrt[3]{\dfrac{27}{125}}$ f) $\sqrt{2.25}$ g) $\sqrt[3]{0.125}$ h) $\sqrt[4]{625}$
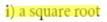
4.1 Math Lab: Estimating Roots

4. a) What happens when you attempt to determine the square root of a number such as −4? Explain the result.

   b) For which other radical indices do you get the same result with a negative radicand, as in part a?

   c) When a radicand is negative:

   i) Which types of radicals can be evaluated or estimated?

   ii) Which types of radicals cannot be evaluated or estimated?

4.1 Math Lab: Estimating Roots

5. For each number below, write an equivalent form as:

  i) a square root   ii) a cube root   iii) a fourth root

  a) 2   b) 3   c) 4   d) 10   e) 0.9   f) 0.2

4.1 Math Lab: Estimating Roots

6. Choose values of n and x so that $\sqrt[n]{x}$ is:
a) a whole number   b) a negative integer
c) a rational number   d) an approximate decimal
Verify your answers.

4.1 Math Lab: Estimating Roots