UNIT 2

Powers and Exponent Laws

What You'll Learn

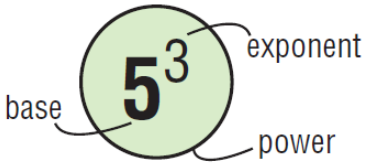
- Use powers to represent repeated multiplication.
- Use patterns to understand a power with exponent 0.
- Solve problems involving powers.
- Perform operations with powers.
- Explain and apply the order of operations with exponents.

Why It's Important

Powers provide an efficient way to record our work. The properties of powers lead to even more efficient ways to perform some calculations. Powers are used in many formulas with applications in science, construction, and design.

Connect

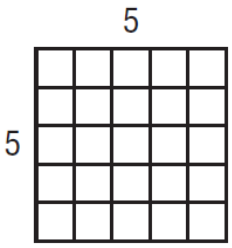
When an integer, other than 0, can be written as a product of equal factors, we can write the integer as a **power**.
For example, $5 \times 5 \times 5$ is 5^3.
5 is the **base**.
3 is the **exponent**.
5^3 is the *power*.
5^3 is a power of 5.



We say: 5 to the 3rd, or 5 cubed or, 5 to the power of 3.

► A power with an integer base and exponent 2 is a **square number**.
When the base is a positive integer, we can illustrate a square number.

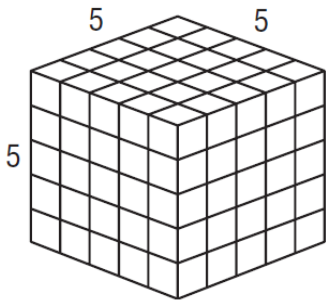
Here are 3 ways to write 25.
Standard form: 25
As repeated multiplication: 5×5
As a power: 5^2



$5 \times 5 = 5^2$
$= 25$
25 is a square number.

► A power with an integer base and exponent 3 is a **cube number**.
When the base is a positive integer, we can illustrate a cube number.

Here are 3 ways to write 125.
Standard form: 125
As repeated multiplication: $5 \times 5 \times 5$
As a power: 5^3



$5 \times 5 \times 5 = 5^3$
$= 125$
125 is a cube number.

Powers in Nature

Many mathematical formulas used to make physical calculations of the universe contain powers.

Position of an Object: $\vec{d}_f = \vec{d}_o + \vec{v}_o t + \frac{1}{2}\vec{a}t^2$

Velocity of an Object: $|\vec{v}| = \sqrt{{v_{fx}}^2 + {v_{fy}}^2}$

Acc due gravity: 9.81 (m/s^2; surface of the Earth)

Circular Force: $F_c = \frac{mv^2}{r}$

Potential Energy: $E_e = \frac{1}{2}kx^2$

Stored Current: $I(t) = I_o e^{\frac{-t}{\tau}}$

Force of Gravity: $\vec{F}_g = G\frac{m_1 m_2}{r^2}$

Kepler's Constant: $\frac{Gm}{4\pi^2} = \frac{r^3}{T^2}$

Stellar Luminosity: $L = 4\pi R^2 \sigma {T_e}^4$

Example 2 Evaluating Powers

Write as repeated multiplication and in standard form.

a) 3^5 b) 7^4

A Solution

a) $3^5 = 3 \times 3 \times 3 \times 3 \times 3$ As repeated multiplication

$= 243$ Standard form

b) $7^4 = 7 \times 7 \times 7 \times 7$ As repeated multiplication

$= 2401$ Standard form

Example 3 Evaluating Expressions Involving Negative Signs

Identify the base of each power, then evaluate the power.

a) $(-3)^4$ b) -3^4 c) $-(-3^4)$

$-(3^4)$

A Solution

a) The base of the power is -3.

$(-3)^4 = (-3) \times (-3) \times (-3) \times (-3)$ As repeated multiplication

Apply the rules for multiplying integers:
The sign of a product with an even number of negative factors is positive.

So, $(-3)^4 = 81$ Standard form

b) The base of the power is 3.

The exponent applies only to the base 3, and not to the negative sign.

$-3^4 = -(3^4)$

$= -(3 \times 3 \times 3 \times 3)$

$= -81$

c) From part b, we know that $-3^4 = -81$.

So, $-(-3^4) = -(-81)$

$= 81$

Pg. 55 #s 7 - 10.

Pg. 56 #s11 - 14, 16.

Pg. 57 #s 20, 21.