Objective: Solve Exponential Equations Using the Exponential Property of Equality

Concept

An **exponential equation** is an equation where **the variable is in the exponent expression**.

Examples

$5^x = 6$

$2^{3x-5} = 4^{5x}$

$8^{0.2t} = 7.6^{t+2}$

Non-examples

$5^3 = x + 8$
(the variable is not the exponent)

$x^2 = 36$
(the variable is not the exponent)

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Concept

The **Exponential Property of Equality** can be used to solve exponential equations where both sides of the equation can be written as a power of the same base.

Exponential Property of Equality

If $b^m = b^n$

Then $m = n$

Steps to Solve an Exponential Equation Using the Exponential Property of Equality

1. Write the equation with a single term on each side.
2. Write each term as a power using the same base.
3. Use the Exponential Property of Equality to set the exponents equal.
4. Solve this equation.
5. State the solution to the exponential equation.

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Ex) Solve the equation.

1) $2^{6x} = 8^{x+1}$

2) $2^{6x} = (2^3)^{x+1}$

3) $6x = 3(x+1)$

4) $6x = 3x + 3$

$-3x \quad -3x$

$\frac{3x}{3} = \frac{3}{3}$

5) $x = 1$

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Ex) Solve the equation.

1) $9^{x-4} = \left(\frac{1}{27}\right)^{2x+3}$

2) $(3^2)^{x-4} = (3^{-3})^{2x+3}$

3) $2(x-4) = -3(2x+3)$

4) $2x - 8 = -6x - 9$

$8x = -1$

5) $x = \frac{-1}{8}$

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Ex) Solve the equation.

1) $25 = 125^{x-4}$

2) $5^2 = (5^3)^{x-4}$

3) $2 = 3(x-4)$

4) $2 = 3x - 12$

$+12 \qquad +12$

$\frac{14}{3} = \frac{3x}{3}$

5) $x = \frac{14}{3}$

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Ex) Solve the equation.

$$e^{x^2} - e^{3x+4} = 0$$

1) $+e^{3x+4} \quad +e^{3x+4}$

2) $e^{x^2} = e^{3x+4}$

3) $x^2 = 3x + 4$
$-3x - 4 \quad -3x - 4$

4) $x^2 - 3x - 4 = 0$
$(x-4)(x+1) = 0$
$x - 4 = 0 \qquad x + 1 = 0$
$x = 4 \qquad x = -1$

5) $x = -1, 4$

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Closure

Amy solved the equation $64^{x+3} = \frac{1}{4}$. Her work is shown.
Explain Amy's error and determine the correct solution.

$64^{x+3} = \frac{1}{4}$

$\left(4^3\right)^{x+3} = 4^{-1}$

$3x + 3 = -1$

$3x = -4$

$\boxed{x = -\frac{4}{3}}$

Amy's error is that she didn't distribute the 3 to the $x + 3$.
The correct solution is $-\frac{10}{3}$.

$64^{x+3} = \frac{1}{4}$

$\left(4^3\right)^{x+3} = 4^{-1}$

$3(x+3) = -1$

$3x + 9 = -1$

$3x = -10$

$\boxed{x = -\frac{10}{3}}$