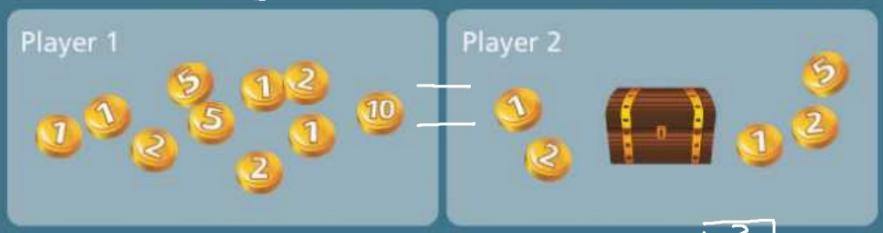
2-1 Solving One-Step Equations

OBJECTIVE: **I can solve one-step equations in one variable**

With the person sitting next to you, discuss the problem provided and document your response

The diagram shows the amount of money that each player starts with in a video game. To be fair, each player should have the same amount of money. What amount must be in the chest? How do you know?



30 = 11 + ?

? = 19

Essential Understanding

Essential Understanding Equivalent equations are equations that have the same solution(s). You can find the solution of a one-step equation using the properties of equality and inverse operations to write a simpler equivalent equation.

Key Concept: Inverse Operations

→ What is happening to the variable?

→ **Addition Property of Equality** Adding the same number to each side of an equation produces an equivalent equation.

Algebra
For any real numbers a, b, and c,
if $a = b$, then $a + c = b + c$.

Example
$x - 3 = 2$
$x - 3 + 3 = 2 + 3$

$x - 3 = 2$
$+3 \quad +3$
$x = 5$

→ **Subtraction Property of Equality** Subtracting the same number from each side of an equation produces an equivalent equation.

Algebra
For any real numbers a, b, and c,
if $a = b$, then $a - c = b - c$.

Example
$x + 3 = 2$
$x + 3 - 3 = 2 - 3$

$x + 3 = 2$
$-3 \quad -3$
$x = -1$

→ the inverse operation of addition is subtraction
→ The inverse operation of subtraction is addition

Example #1 Solving an Equation Using Subtraction

What is the solution of $x + 13 = 27$?

To solve for any variable is to Isolate that variable using inverse operations

$x + 13 = 27$ → what is happening to the variable? x is being added 13 Do the inverse Subtract

$-13 \quad -13$

$x = 14$

Check your solution

$x + 13 = 27$ ← subtitute the solution found

$(14) + 13 = 27$

$14 + 13 \overset{?}{=} 27$

$27 = 27$ ✓

Example #2 Solving an Equation Using Addition

What is the solution of $-7 = b - 3$?

$-7 = b - 3$

$+3 \quad +3$

$-4 = b$

what is happening to the variable?
b is subtracted by 3 Do, add 3

Check your solution

substitute the solution into b

$-7 \stackrel{?}{=} b - 3$

$-7 \stackrel{?}{=} (-4) - 3$

$-7 \stackrel{?}{=} -4 - 3$

$-7 \stackrel{\checkmark}{=} -7$

Concept Understanding

Key Concept: Inverse Operations

Multiplication Property of Equality Multiplying each side of an equation by the same nonzero number produces an equivalent equation.

Algebra

For any real numbers a, b, and c, if $a = b$, then $a \cdot c = b \cdot c$.

Example

$\frac{x}{3} = 2$

$\frac{x}{3} \cdot 3 = 2 \cdot 3$

$\frac{x}{3} = 2$

$3\left(\frac{x}{3}\right) = (2) \cdot 3$

$x = 6$

Division Property of Equality Dividing each side of an equation by the same nonzero number produces an equivalent equation.

Algebra

For any real numbers a, b, and c, such that $c \neq 0$, if $a = b$, then $\frac{a}{c} = \frac{b}{c}$.

Example

$5x = 20$

$\frac{5x}{5} = \frac{20}{5}$

$5x = 20$

$\frac{5x}{5} = \frac{20}{5}$

$x = 4$

Example #3 Solving an Equation Using Division

What is the solution of $4x = 6.4$?

$4x = 6.4$ what is happening to the variable?

$\frac{4x}{4} = \frac{6.4}{4}$

$x = 1.6$

Check your solution

$4x \stackrel{?}{=} 6.4$ substitute your solution into the variable

$4(1.6) \stackrel{?}{=} 6.4$

$4 \cdot 1.6 \stackrel{?}{=} 6.4$

$6.4 \stackrel{\checkmark}{=} 6.4$

Example #4 Solving an Equation Using Multiplication

What is the solution of $\frac{x}{4} = -9$?

$$\frac{x}{4} = -9$$

what is happening to the variable?
- variable is being divided by 4
- Inverse the operation multiply by 4

$$4\left(\frac{x}{4}\right) = (-9)\cdot 4$$

$$\frac{4x}{4} = -36$$

$$x = -36$$

Check your Solution

$$\frac{x}{4} \stackrel{?}{=} -9$$

Subtitute my solution into the variable

$$\frac{(-36)}{4} \stackrel{?}{=} -9$$

$(-) \div (+) = (-)$

$$-9 \stackrel{\checkmark}{=} -9$$

Solution checks ✓

Example #5 Solving Equations Using Reciprocals

What is the solution of $\frac{4}{5}m = 28$?

$\frac{4}{5}m = 28$ → What is happening to the variable?

$\frac{4m}{5} = 28$

- 4 is multiplying
- 5 is dividing

} inverse operations } 4 is diving, 5 is multiplying

$\frac{5}{4}\left(\frac{4}{5}m\right) = (28)\frac{5}{4}$

$\frac{20}{20}m = \frac{28 \cdot 5}{4}$

$m = 35$

$\frac{28 \cdot 5}{4}$

$\frac{(7 \cdot 4) \cdot 5}{4} = 35$

Check your solution

$\frac{4}{5}m \stackrel{?}{=} 28$

$\frac{4(35)}{5} \stackrel{?}{=} 28$

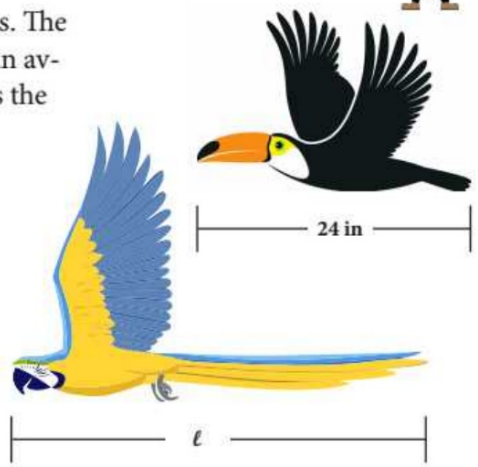
$28 \stackrel{\checkmark}{=} 28$

Substitute your solution

$\frac{4 \cdot (7 \cdot 5)}{5} = 28$ ↙

Example #6 Using a One-Step Equation as a Model

Biology Toucans and blue-and-yellow macaws are both tropical birds. The length of an average toucan is about (two thirds) $\frac{2}{3}$ of the length of an average blue-and-yellow macaw. Toucans are about 24 in. long. What is the length of an average blue-and-yellow macaw?



length of Toucan is $\frac{2}{3}$ of length of Macaw

$24 = \frac{2}{3} \cdot \ell$

What is the reciprocal of $\frac{2}{3}$ → $\frac{3}{2}$

$\frac{3}{2}(24) = \left(\frac{2}{3} \cdot \ell\right)\frac{3}{2}$

$\frac{3 \cdot 24}{2} = \frac{6}{6} \cdot \ell$

$\frac{3 \cdot 12 \cdot 2}{2} = \ell$

$36 = \ell$

Check your work

$24 \stackrel{?}{=} \frac{2}{3}\ell$

$24 \stackrel{?}{=} \frac{2}{3}(36)$ Substitute your solution into the variable

$24 \stackrel{?}{=} \frac{2 \cdot 36}{3}$

$24 = \frac{2 \cdot (12 \cdot 3)}{3}$

$24 = 24$ ✓