Name _____ Date_____

Solving Equations Using Algebra

Susan and Bonnie are shopping for school clothes. Susan has $\$50$ and a coupon for a $\$10$ discount at a clothing store where each shirt costs $\$12$.

Susan thinks that she can buy three shirts, but Bonnie says that Susan can buy five shirts. The equations they used to model the problem are listed below. Solve each equation algebraically, justify your steps, and determine who is correct and why.

Susan's Equation

$12n + 10 = 50$

Bonnie's Equation

$12n - 10 = 50$

For each problem below, explain the steps in finding the value of the variable. Then find the value of the variable, showing each step. Write if-then statements to justify each step in solving the equation.

1. $7(m + 5) = 21$

2. $-2v + 9 = 25$

3. $\frac{1}{3}y - 18 = 2$

4. $6 - 8p = 38$

5. $15 = 5k - 13$

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Susan's Equation	Bonnie's Equation
$12n + 10 = 50$	$12n - 10 = 50$

Bonnie is correct. The equation that would model this situation is $12n - 10 = 50$. Solving this equation would involve "Making zero" by adding 10. And by doing so, $12n - 10 + 10 = 50 + 10$, we arrive at $12n = 60$. So, if a group of shirts that cost $\$12$ each totals $\$60$, then there must be five shirts, since $\frac{60}{12}$ equals 5.

Bonnie's Equation:

$12n - 10 = 50$	
$12n - 10 + 10 = 50 + 10$	*Addition property of equality for the additive inverse of -10*
$12n + 0 = 60$	
$12n = 60$	*Additive identity*
$\left(\frac{1}{12}\right)12n = \left(\frac{1}{12}\right)60$	*Multiplication property of equality using the multiplicative inverse of 12*
$1n = 5$	
$n = 5$	*Multiplicative identity*

Susan's Equation:

$12n + 10 = 50$	
$12n + 10 - 10 = 50 - 10$	*Subtraction property of equality for the additive inverse of 10*
$12n + 0 = 40$	
$12n = 40$	*Additive identity*
$\left(\frac{1}{12}\right)12n = \left(\frac{1}{12}\right)40$	*Multiplication property of equality using the multiplicative inverse of 12*
$1n = 3\frac{1}{3}$	
$n = 3\frac{1}{3}$	*Multiplicative identity*

For each problem below, explain the steps in finding the value of the variable. Then find the value of the variable, showing each step. Write if-then statements to justify each step in solving the equation.

1. $7(m+5) = 21$

Multiply both sides of the equation by $\frac{1}{7}$, then subtract 5 from both sides of the equation; $m = -2$.

If: $7(m+5) = 21$

Then: $\frac{1}{7}[7(m+5)] = \frac{1}{7}(21)$ *Multiplication property of equality using the multiplicative inverse of 7*

If: $1\,(m+5) = 3$

Then: $m+5 = 3$ *Multiplicative identity*

If: $m+5 = 3$

Then: $m+5-5 = 3-5$ *Subtraction property of equality for the additive inverse of 5*

If: $m+0 = -2$

Then: $m = -2$ *Additive identity*

2. $-2v+9 = 25$

Subtract 9 from both sides of the equation and then multiply both sides of the equation by $-\frac{1}{2}$; $v = -8$.

If: $-2v+9 = 25$

Then: $-2v+9-9 = 25-9$ *Subtraction property of equality for the additive inverse of 9*

If: $-2v+0 = 16$

Then: $-2v = 16$ *Additive identity*

If: $-2v = 16$

Then: $-\frac{1}{2}(-2v) = -\frac{1}{2}(16)$ *Multiplication property of equality using the multiplicative inverse of -2*

If: $1\,v = -8$

Then: $v = -8$ *Multiplicative identity*

3. $\frac{1}{3}y - 18 = 2$

Add 18 to both sides of the equation and then multiply both sides of the equation by 3; $y = 60$.

If: $\frac{1}{3}y - 18 = 2$

Then: $\frac{1}{3}y - 18 + 18 = 2 + 18$ *Addition property of equality for the additive inverse of* -18

If: $\frac{1}{3}y + 0 = 20$

Then: $\frac{1}{3}y = 20$ *Additive identity*

If: $\frac{1}{3}y = 20$

Then: $3\left(\frac{1}{3}y\right) = 3\,(20)$ *Multiplication property of equality using the multiplicative inverse of* $\frac{1}{3}$

If: $1\,y = 60$

Then: $y = 60$ *Multiplicative identity*

4. $6 - 8p = 38$

Subtract 6 from both sides of the equation and then multiply both sides of the equation by $-\frac{1}{8}$; $p = -4$.

If: $6 - 8p = 38$

Then: $6 - 6 - 8p = 38 - 6$ *Subtraction property of equality for the additive inverse of* 6

If: $0 + (-8p) = 32$

Then: $-8p = 32$ *Additive identity*

If: $-8p = 32$

Then: $\left(-\frac{1}{8}\right)(-8p) = \left(-\frac{1}{8}\right)32$ *Multiplication property of equality using the multiplicative inverse of* -8

If: $1\,p = -4$

Then: $p = -4$ *Multiplicative identity*

5. $15 = 5k - 13$

Add 13 to both sides of the equation and then multiply both sides of the equation by $\frac{1}{5}$; $k = 5.6$.

If: $15 = 5k - 13$

Then: $15 + 13 = 5k - 13 + 13$ *Addition property of equality for the additive inverse of* -13

If: $28 = 5k + 0$

Then: $28 = 5k$ *Additive identity*

If: $28 = 5k$

Then: $\left(\frac{1}{5}\right)28 = \left(\frac{1}{5}\right)5k$ *Multiplication property of equality using the multiplicative inverse of* 5

If: $5.6 = 1k$

Then: $5.6 = k$ *Multiplicative identity*