

## Justifying Equations

| <b>Property</b> ( $a$ , $b$ and $c$ are real numbers)   | <b>Example</b>                                 |
|---|--|
| <b>Identity Property of Addition</b><br>Any number when added to 0 is itself.   | $c + 0 = c$                                    |
| <b>Identity Property of Multiplication</b><br>Any number multiplied by 1 is itself.   | $b \cdot 1 = b$                                |
| <b>Multiplicative Property of Zero</b><br>Any number multiplied by zero is zero.  | $a \cdot 0 = 0$                                |
| <b>Commutative Property of Addition or Multiplication</b><br>The order in which you add or multiply does not change the sum or product.   | $a + b = b + a$<br>$ab = ba$                   |
| <b>Associative Property of Addition or Multiplication</b><br>The order in which you group numbers does not change the sum or product.   | $(a + b) + c = a + (b + c)$<br>$(ab)c = a(bc)$ |
| <b>Symmetric Property</b><br>If one number is equal to a second number, then the second number is equal to the first.   | If $a = b$ then $b = a$                        |
| <b>Substitution Property</b><br>If $a = b$ then $a$ can be substituted into an equation for $b$ .   | If $a = b$ and $b + c = 6$ then $a + c = 6$ .  |
| <b>Distributive Property</b><br>The product of a number and a sum or difference is the same as the sum or difference of the products of the number and each element of the sum or difference. | $a(b + c) = ab + ac$<br>$a(b - c) = ab - ac$   |
| <b>Additive Inverse</b><br>The sum of a number and its inverse is zero.   | $a + (-a) = 0$                                 |
| <b>Multiplicative Inverse</b><br>The product of a number and its inverse is one.  | $b \cdot \frac{1}{b} = 1$                      |
| <b>Addition Property of Equality</b><br>Adding the same number to each side of an equation produces an equivalent equation.   | If $a = b$ then<br>$a + c = b + c$             |
| <b>Subtraction Property of Equality</b><br>Subtracting the same number to each side of an equation produces an equivalent equation.   | If $a = b$ then<br>$a - c = b - c$             |
| <b>Multiplication Property of Equality</b><br>Multiplying each side of the equation by the same number produces an equivalent equation.   | If $a = b$ then<br>$ac = bc$                   |
| <b>Division Property of Equality</b><br>Dividing each side of the equation by the same number produces an equivalent equation.  | If $a = b$ then<br>$\frac{a}{c} = \frac{b}{c}$ |

**Example 1:** Solve, justifying each step.

|                               |   |
|-------------------------------|---|
| $4x = -8$                     | Justify                                       |
| $\frac{4x}{4} = \frac{-8}{4}$ | Division property of equality                 |
| $x = -2$                      | Multiplicative inverse, substitution property |

**Example 2:** Solve, justifying each step.

|                      |   |
|----------------------|---|
| $x - 5 = -8$         | Justify                                 |
| $x - 5 + 5 = -8 + 5$ | Addition property of equality           |
| $x = -3$             | Additive inverse, substitution property |

**Example 3:** Solve, justifying each step.

|                               |   |
|-------------------------------|---|
| $6x + 3 = 15$                 | Justify                                       |
| $6x + 3 - 3 = 15 - 3$         | Subtraction property of equality              |
| $6x = 12$                     | Additive inverse, substitution property       |
| $\frac{6x}{6} = \frac{12}{6}$ | Division property of equality                 |
| $x = 2$                       | Multiplicative inverse, substitution property |

**Example 4:** Solve, justifying each step.

|                                    |   |
|------------------------------------|---|
| $\frac{x}{2} - 4 = 7$              | Justify                                       |
| $\frac{x}{2} - 4 + 4 = 7 + 4$      | Addition property of equality                 |
| $\frac{x}{2} = 11$                 | Additive inverse, substitution property       |
| $2 \cdot \frac{x}{2} = 2 \cdot 11$ | Multiplication property of equality           |
| $x = 22$                           | Multiplicative inverse, substitution property |

**Example 5:** Solve, justifying each step.

| $-15 + n = -9$           | Justification                              |
|--------------------------|--|
| $-15 + 15 + n = -9 + 15$ | a) Addition property of equality           |
| $n = 6$                  | b) Additive Inverse, Substitution Property |

**Example 6:** Solve, justifying each step.

| $-6 + \frac{b}{-4} = 5$               | Justification                                    |
|---------------------------------------|--|
| $-6 + 6 + \frac{b}{-4} = 5 + 6$       | a) Addition Property of Equality                 |
| $\frac{b}{-4} = 11$                   | b) Additive Inverse, Substitution Property       |
| $-4 \cdot \frac{b}{-4} = 11 \cdot -4$ | c) Multiplication Property of Equality           |
| $b = -44$                             | d) Multiplicative Inverse, Substitution Property |

**Example 7:** Solve, justifying each step.

| $9x + 7 = 2(5x + 12)$         | Justification                              |
|-------------------------------|--|
| $9x + 7 = 10x + 24$           | a) Distributive Property                   |
| $9x - 9x + 7 = 10x - 9x + 24$ | b) Subtraction Property of Equality        |
| $7 = x + 24$                  | c) Additive Inverse, Substitution Property |
| $7 - 24 = x + 24 - 24$        | d) Subtraction Property of Equality        |
| $-17 = x$                     | e) Substitution Property                   |
| $x = -17$                     | f) Symmetric Property                      |