

EXAMPLE 1**Graph real numbers on a number line**

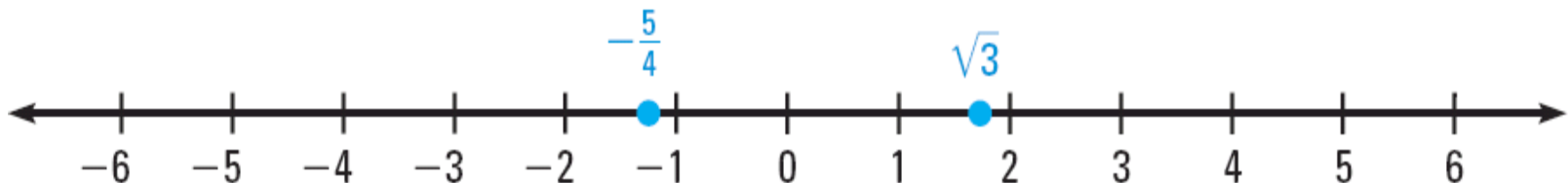
Graph the real numbers $-\frac{5}{4}$ and $\sqrt{3}$ on a number line.

SOLUTION

Note that $-\frac{5}{4} = -1.25$. Use a calculator to approximate $\sqrt{3}$ to the nearest tenth:

$\sqrt{3} \approx 1.7$. (The symbol \approx means *is approximately equal to*.)

So, graph $-\frac{5}{4}$ between -2 and -1 , and graph $\sqrt{3}$ between 1 and 2 , as shown on the number line below.



EXAMPLE 2**Standardized Test Practice**

The table shows the lowest elevations of six continents. Which list shows the elevations from lowest to highest?

| Continent | Africa | Asia | Australia | Europe | North America | South America |
|------------------|--------|--------|-----------|--------|---------------|---------------|
| Lowest elevation | -156 m | -408 m | -16 m | -28 m | -86 m | -40 m |

- (A) -408, -156, -86, -28, -40, -16 (B) -408, -156, -28, -86, -40, -16
 (C) -16, -28, -40, -86, -156, -408 (D) -408, -156, -86, -40, -28, -16

SOLUTION

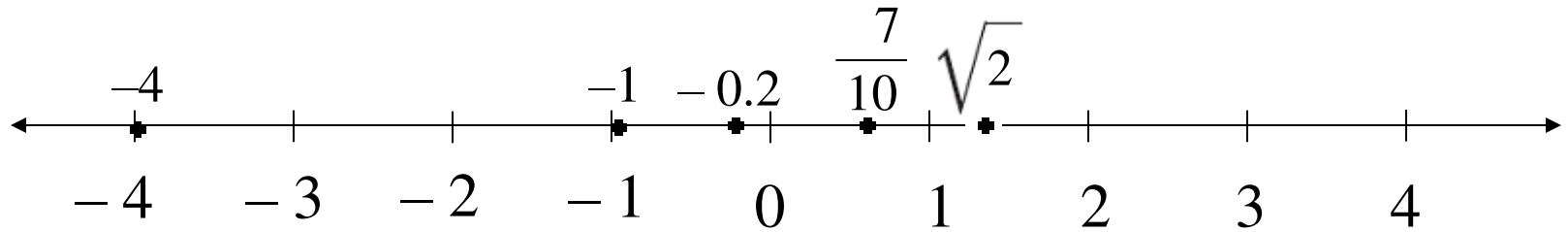
From lowest to highest, the elevations are -408 , -156 , -86 , -40 , -28 , and -16 .

ANSWER

The correct answer is D. (A) (B) (C) (D)

GUIDED PRACTICE**for Examples 1 and 2**

1. Graph the numbers -0.2 , $\frac{7}{10}$, -1 , $\sqrt{2}$, and -4 on a number line.

SOLUTION

2. Which list shows the numbers in increasing order?

Ⓐ $-0.5, 1.5, -2, -0.75, \sqrt{7}$

Ⓑ $-0.5, -2, -0.75, 1.5, \sqrt{7}$

Ⓒ $-2, -0.75, -0.5, 1.5, \sqrt{7}$

Ⓓ $\sqrt{7}, 1.5, -0.5, -0.75, -2$

ANSWER**The correct answer is C.**

EXAMPLE 3**Identify properties of real numbers**

Identify the property that the statement illustrates.

a. $7 + 4 = 4 + 7$

SOLUTION Commutative property of addition

b. $13 \cdot \frac{1}{13} = 1$

SOLUTION Inverse property of multiplication

EXAMPLE 4**Use properties and definitions of operations**

Use properties and definitions of operations to show that $a + (2 - a) = 2$. Justify each step.

SOLUTION

$$a + (2 - a) = a + [2 + (-a)]$$

Definition of subtraction

$$= a + [(-a) + 2]$$

Commutative property of addition

$$= [a + (-a)] + 2$$

Associative property of addition

$$= 0 + 2$$

Inverse property of addition

$$= 2$$

Identity property of addition

GUIDED PRACTICE**for Examples 3 and 4**

Identify the property that the statement illustrates.

3. $(2 \cdot 3) \cdot 9 = 2 \cdot (3 \cdot 9)$

SOLUTION Associative property of multiplication.

4. $15 + 0 = 15$

SOLUTION Identity property of addition.

Identify the property that the statement illustrates.

5. $4(5 + 25) = 4(5) + 4(25)$

SOLUTION Distributive property.

6. $1 \cdot 500 = 500$

SOLUTION Identity property of multiplication.

GUIDED PRACTICE**for Examples 3 and 4**

Use properties and definitions of operations to show that the statement is true. *Justify* each step.

7. $b \cdot (4 \div b) = 4$ when $b \neq 0$

SOLUTION

$$b \cdot (4 \div b) = b \cdot \left(4 \cdot \frac{1}{b}\right)$$

Def. of division

$$= b \cdot \left(\frac{1}{b}\right) \cdot 4$$

Comm. prop. of multiplication

$$= \left(b \cdot \frac{1}{b}\right) \cdot 4$$

Assoc. prop. of multiplication

$$= 1 \cdot 4$$

Inverse prop. of multiplication

$$= 4$$

Identity prop. of multiplication

GUIDED PRACTICE**for Examples 3 and 4**

Use properties and definitions of operations to show that the statement is true. *Justify* each step.

8. $3x + (6 + 4x) = 7x + 6$

SOLUTION

$$\begin{aligned} 3x + (6 + 4x) &= 3x + (4x + 6) && \text{Comm. prop. of addition} \\ &= (3x + 4x) + 6 && \text{Assoc. prop. of addition} \\ &= 7x + 6 && \text{Combine like terms.} \end{aligned}$$

EXAMPLE 5**Use unit analysis with operations**

- a. You work 4 hours and earn \$36. What is your earning rate?

SOLUTION

$$\frac{36 \text{ dollars}}{4 \text{ hours}} = 9 \text{ dollars per hour}$$

- b. You travel for 2.5 hours at 50 miles per hour. How far do you go?

SOLUTION

$$(2.5 \text{ hours}) \left(\frac{50 \text{ miles}}{1 \text{ hour}} \right) = 125 \text{ miles}$$

EXAMPLE 5**Use unit analysis with operations**

- c. You drive 45 miles per hour. What is your speed in feet per second?

SOLUTION

$$\left(\frac{45 \text{ miles}}{1 \text{ hour}} \right) \left(\frac{1 \text{ hour}}{60 \text{ minutes}} \right) \left(\frac{1 \text{ minute}}{60 \text{ seconds}} \right) \left(\frac{5280 \text{ feet}}{1 \text{ mile}} \right)$$

$$= 66 \text{ feet per second}$$

EXAMPLE 6

Use unit analysis with conversions

Driving Distance

The distance from Montpelier, Vermont, to Montreal, Canada, is about 132 miles. The distance from Montreal to Quebec City is about 253 kilometers.

- Convert the distance from Montpelier to Montreal to kilometers.
- Convert the distance from Montreal to Quebec City to miles.



EXAMPLE 6**Use unit analysis with conversions****SOLUTION**

a. $132 \text{ miles} \cdot \frac{1.61 \text{ kilometers}}{1 \text{ mile}} \approx 213 \text{ kilometers}$

b. $253 \text{ kilometers} \cdot \frac{1 \text{ mile}}{1.61 \text{ kilometers}} \approx 157 \text{ miles}$

Solve the problem. Use unit analysis to check your work.

- 9. You work 6 hours and earn \$69. What is your earning rate?**

SOLUTION $\frac{69 \text{ dollars}}{6 \text{ hours}} = 11.5 \text{ dollars per hour}$

- 10. How long does it take to travel 180 miles at 40 miles per hour?**

SOLUTION $\left(\frac{180 \cancel{\text{ miles}}}{1} \right) \left(\frac{1 \text{ hour}}{40 \cancel{\text{ miles}}} \right) = 4.5 \text{ hour}$

GUIDED PRACTICE**for Examples 5 and 6**

Solve the problem. Use unit analysis to check your work.

- 11. You drive 60 kilometers per hour. What is your speed in miles per hour?**

SOLUTION

$$\left(\frac{60 \cancel{\text{ km}}}{1 \text{ hour}} \right) \left(\frac{1 \text{ mile}}{1.61 \cancel{\text{ km}}} \right) = \text{about } 37 \text{ mph}$$

Perform the indicated conversion.

12. 150 yards to feet

SOLUTION

$$150 \cancel{\text{yard}} \cdot \frac{3 \text{ feet}}{1 \cancel{\text{yard}}}$$

$$= 450 \text{ ft}$$

Perform the indicated conversion.

13. 4 gallons to pints

SOLUTION

$$4 \cancel{\text{gallon}} \cdot \frac{8 \text{ pints}}{1 \cancel{\text{gallon}}}$$

$$= 32 \text{ pints}$$

GUIDED PRACTICE**for Examples 5 and 6**

Perform the indicated conversion.

14. 16 years to seconds

SOLUTION

$$\begin{aligned}
 & 16 \cancel{\text{years}} \cdot \frac{365 \cancel{\text{days}}}{1 \cancel{\text{year}}} \cdot \frac{24 \cancel{\text{hours}}}{1 \cancel{\text{day}}} \cdot \frac{60 \cancel{\text{minutes}}}{1 \cancel{\text{hour}}} \cdot \frac{60 \cancel{\text{seconds}}}{1 \cancel{\text{minute}}} \\
 & = 504,576,000 \text{ sec}
 \end{aligned}$$

EXAMPLE 1**Evaluate powers**

a. $(-5)^4 = (-5) \cdot (-5) \cdot (-5) \cdot (-5) = 625$

b. $-5^4 = -(5 \cdot 5 \cdot 5 \cdot 5) = -625$

EXAMPLE 2**Evaluate an algebraic expression**

Evaluate $-4x^2 - 6x + 11$ **when** $x = -3$.

$$-4x^2 - 6x + 11 = -4(-3)^2 - 6(-3) + 11$$

Substitute -3 **for** x .

$$= -4(9) - 6(-3) + 11$$

Evaluate power.

$$= -36 + 18 + 11$$

Multiply.

$$= -7$$

Add.

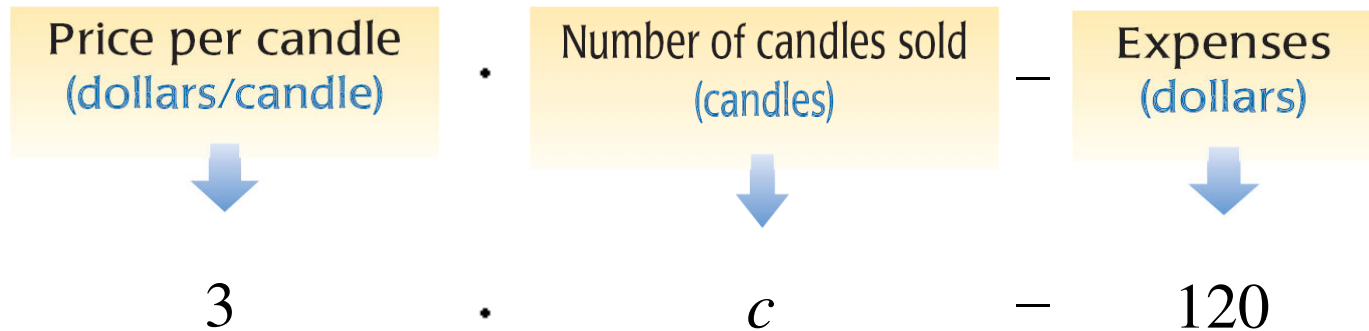
EXAMPLE 3**Use a verbal model to solve a problem****Craft Fair**

You are selling homemade candles at a craft fair for \$3 each. You spend \$120 to rent the booth and buy materials for the candles.

- **Write an expression that shows your profit from selling c candles.**
- **Find your profit if you sell 75 candles.**

EXAMPLE 3**Use a verbal model to solve a problem****SOLUTION**

STEP 1 Write: a verbal model. Then write an algebraic expression. Use the fact that profit is the difference between income and expenses.



An expression that shows your profit is
 $3c - 120$.

EXAMPLE 3**Use a verbal model to solve a problem**

STEP 2 Evaluate: the expression in Step 1 when $c = 75$.

$$3c - 120 = 3(75) - 120$$

Substitute 75 for c .

$$= 225 - 120$$

Multiply.

$$= 105$$

Subtract.

ANSWER

Your profit is \$105.

Evaluate the expression.

1. 6^3

SOLUTION

$$6^3 = 6 \cdot 6 \cdot 6 = 216$$

2. -2^6

SOLUTION

$$-2^6 = -(2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2) = -64$$

GUIDED PRACTICE

Graph Exponential Growth and Decay Functions
for Examples 1, 2, and 3

3. $(-2)^6$

SOLUTION

$$(-2)^6 = (-2) \cdot (-2) \cdot (-2) \cdot (-2) \cdot (-2) \cdot (-2) = 64$$

4. $5x(x - 2)$ when $x = 6$

SOLUTION

$$\begin{aligned} 5x(x - 2) &= 5(6)(6 - 2) \\ &= 30(4) \\ &= 120 \end{aligned}$$

Substitute 6 for x .

Multiply.

GUIDED PRACTICE**for Examples 1, 2, and 3**

5. $3y^2 - 4y$ when $y = -2$

SOLUTION

$$\begin{aligned}3y^2 - 4y &= 3(-2)^2 - 4(-2) \\ &= 3(4) + 8 \\ &= 20\end{aligned}$$

Substitute -2 for y .

Multiply.

GUIDED PRACTICE

for Examples 1, 2, and 3

6. $(z + 3)^3$ when $z = 1$

SOLUTION

$$\begin{aligned}(z + 3)^3 &= (1 + 3)^3 \\ &= (4)^3 \\ &= 64\end{aligned}$$

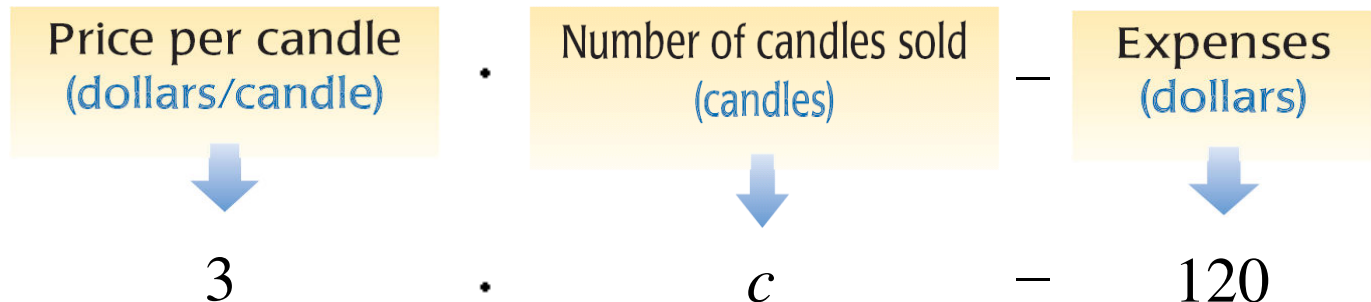
Substitute 1 for z .

Evaluate Power.

7. **What If?** In Example 3, find your profit if you sell 135 candles.

SOLUTION

STEP 1 Write a verbal model. Then write an algebraic expression. Use the fact that profit is the difference between income and expenses.



GUIDED PRACTICE

Graph Exponential Growth and Decay Functions
for Examples 1, 2, and 3

An expression that shows your profit is $3c - 120$.

STEP 2 Evaluate: the expression in Step 1 when $c = 135$.

$$3c - 120 = 3(135) - 120 \quad \text{Substitute 135 for } c.$$

$$= 405 - 120 \quad \text{Multiply.}$$

$$= 185 \quad \text{Subtract.}$$

ANSWER Your profit is \$185.

EXAMPLE 4**Simplify by combining like terms**

a. $8x + 3x = (8 + 3)x$

Distributive property

$$= 11x$$

Add coefficients.

b. $5p^2 + p - 2p^2 = (5p^2 - 2p^2) + p$

Group like terms.

$$= 3p^2 + p$$

Combine like terms.

c. $3(y + 2) - 4(y - 7) = 3y + 6 - 4y + 28$

Distributive property

$$= (3y - 4y) + (6 + 28)$$

Group like terms.

$$= -y + 34$$

Combine like terms.

EXAMPLE 4**Simplify by combining like terms**

d. $2x - 3y - 9x + y = (2x - 9x) + (-3y + y)$ **Group like terms.**

$= -7x - 2y$ **Combine like terms.**

GUIDED PRACTICE**for Example 5**

8. Identify the terms, coefficients, like terms, and constant terms in the expression $2 + 5x - 6x^2 + 7x - 3$. Then simplify the expression.

SOLUTION

Terms: $2, 5x, -6x^2, 7x, -3$

Coefficients: 5 from $5x$, -6 from $-6x^2$, 7 from $7x$

Like terms: $5x$ and $7x$, 2 and -3

Constants: 2 and -3

Simplify:

$$\begin{aligned} & 2 + 5x - 6x^2 + 7x - 3 \\ &= -6x^2 + 5x + 7x - 3 + 2 \\ &= -6x^2 + 12x - 1 \end{aligned}$$

State the problem.

Group like terms.

Combine like terms.

Simplify the expression.

9. $15m - 9m$

SOLUTION

$$15m - 9m = 6m$$

Combine like terms.

10. $2n - 1 + 6n + 5$

SOLUTION

$$\begin{aligned} 2n - 1 + 6n + 5 &= 2n + 6n + 5 - 1 \\ &= 8n + 4 \end{aligned}$$

Group like terms.

Combine like terms.

11. $3p^3 + 5p^2 - p^3$

SOLUTION

$$\begin{aligned} 3p^3 + 5p^2 - p^3 &= 3p^3 - p^3 + 5p^2 \\ &= 2p^3 + 5p^2 \end{aligned}$$

Group like terms.

Combine like terms.

12. $2q^2 + q - 7q - 5q^2$

SOLUTION

$$\begin{aligned} 2q^2 + q - 7q - 5q^2 &= 2q^2 - 5q^2 - 7q + q \\ &= -3q^2 - 6q \end{aligned}$$

Group like terms.

Combine like terms.

GUIDED PRACTICE**for Example 5**

13. $8(x - 3) - 2(x + 6)$

SOLUTION

$$\begin{aligned}8(x - 3) - 2(x + 6) &= 8x - 24 - 2x - 12 \\ &= 8x - 2x - 24 - 12 \\ &= 6x - 36\end{aligned}$$

Distributive property

Group like terms.

Combine like terms.

14. $-4y - x + 10x + y$

SOLUTION

$$\begin{aligned}-4y - x + 10x + y &= -4y + y - x + 10x \\ &= 9x - 3y\end{aligned}$$

Group like terms.

Combine like terms.

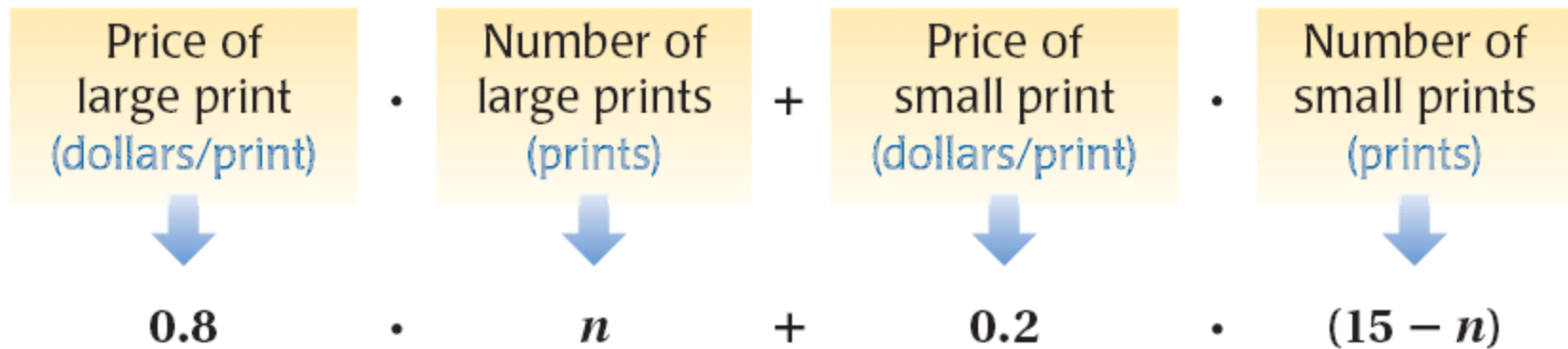
EXAMPLE 5**Simplify a mathematical model****Digital Photo Printing**

You send 15 digital images to a printing service that charges \$.80 per print in large format and \$.20 per print in small format. Write and simplify an expression that represents the total cost if n of the 15 prints are in large format. Then find the total cost if 5 of the 15 prints are in large format.



EXAMPLE 5**Simplify a mathematical model****SOLUTION**

Write a verbal model. Then write an algebraic expression.



An expression for the total cost is $0.8n + 0.2(15 - n)$.

$$0.8n + 0.2(15 - n) = 0.8n + 3 - 0.2n \quad \text{Distributive property.}$$

$$= (0.8n - 0.2n) + 3 \quad \text{Group like terms.}$$

EXAMPLE 5**Simplify a mathematical model**

$$= 0.6n + 3$$

Combine like terms.

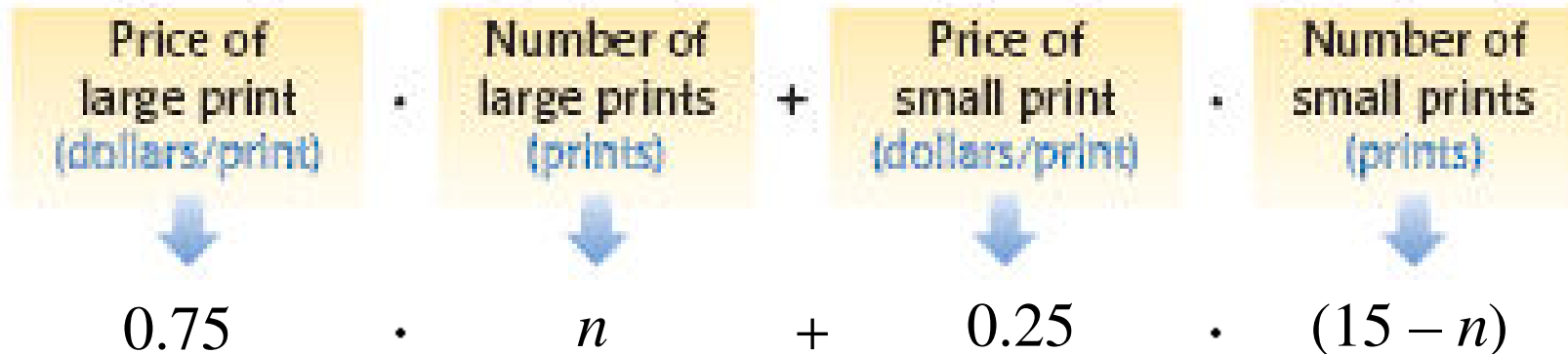
ANSWER

When $n = 5$, the total cost is $0.6(5) + 3 = 3 + 3 = \$6$.

15. **What If?** In Example 5, write and simplify an expression for the total cost if the price of a large print is \$.75 and the price of a small print is \$.25.

SOLUTION

Write a verbal model. Then write an algebraic expression.



GUIDED PRACTICE

for Example 5

An expression for the total cost is $0.75n + 0.25(15 - n)$.

$$0.75n + 0.25(15 - n) = 0.75n + 3.75 - 0.2n \quad \text{Distributive property.}$$

$$= 7.5n - 0.25n + 3.75 \quad \text{Group like terms.}$$

$$= 0.5n + 3.75 \quad \text{Combine like terms.}$$