In the morning, Harrison checked the temperature outside to find that it was -12°F. Later in the afternoon, the temperature rose to 12°F. Write an expression representing the temperature change. What was the afternoon temperature?

\[-12 + 12\]

The afternoon temperature was 0°F.
Opening Exercise

- Rewrite subtraction as adding the inverse (copy, add, opposite) for the following problems and find the sum.

  a. $2 - 2$

  $2 + (-2)$

  $2 + (-2) = 0$
Opening Exercise

- Rewrite subtraction as adding the inverse (copy, add, opposite) for the following problems and find the sum.

b. \(-4 - (-4)\)

\[-4 + 4\]

\[-4 + 4 = 0\]
Opening Exercise

- Rewrite subtraction as adding the inverse (copy, add, opposite) for the following problems and find the sum.

- c. The difference of 5 and 5.

  \[ 5 - 5 \]
  \[ 5 + (-5) \]
  \[ 5 + (-5) = 0 \]
Opening Exercise

- Rewrite subtraction as adding the inverse (copy, add, opposite) for the following problems and find the sum.

- d. \( g - g \)

  \[
g + (-g) \\
g + (-g) = 0
\]
What pattern do you notice in Opening Exercises 1 and 2?

The sum of a number and its additive inverse is equal to zero.
Opening Exercise

- Add or subtract.
- a. $16 + 0$
  16
Opening Exercise

- Add or subtract.
- b. $0 - 7$
  
  $0 + (-7) = -7$
Add or subtract.

c. \(-4 + 0\)

\(-4\)
Opening Exercise

- Add or subtract.
- d. 0 + d
  - d
e. What pattern do you notice in parts (a) through (d)?

The sum of any quantity and zero is equal to the value of the quantity.
Example 1

- Write the sum and then write an equivalent expression by collecting like terms and removing parentheses.

a. $2x$ and $-2x + 3$

$$
\begin{align*}
2x + (-2x + 3) \\
(2x + (-2x)) + 3 \\
0 + 3 \\
3
\end{align*}
$$

- Associative property, collect like terms
- Additive inverse
- Additive identity property of zero
Example 1

- Write the sum and then write an equivalent expression by collecting like terms and removing parentheses.

- b. $2x - 7$ and the opposite of $2x$

  \[
  2x - 7 + (-2x) \\
  2x + (-2x) + (-7) \\
  0 + (-7) \\
  -7
  \]

  Commutative property, associative property
  Additive inverse
  Additive identity property of zero
Example 1

► Write the sum and then write an equivalent expression by collecting like terms and removing parentheses.

► c. The opposite of \((5x - 1)\) and \(5x\)

\[
\begin{align*}
-(5x - 1) + 5x \\
-1(5x - 1) + 5x \\
-5x + 1 + 5x \\
(-5x + 5x) + 1 \\
0 + 1 \\
1
\end{align*}
\]

Taking the opposite is equivalent to multiplying by \(-1\)

Distributive property

Commutative property, any order property

Additive inverse

Additive identity property of zero
Exercise 1

- Write the sum and then write an equivalent expression by collecting like terms and removing parentheses wherever possible.

- a. -4 and 4b + 4

  -4 + (4b + 4)
  (-4 + 4) + 4b
  0 + 4b
  4b

  Any order, any grouping
  Additive inverse
  Additive identity property of zero
Exercise 1

- Write the sum and then write an equivalent expression by collecting like terms and removing parentheses wherever possible.

b. 3x and 1 – 3x

\[
3x + (1 - 3x) \\
3x + (1 + (-3x)) \\
(3x + (-3x)) + 1 \\
0 + 1 \\
1
\]

Subtraction as adding the inverse
Any order, any grouping
Additive inverse
Additive identity property of zero
Exercise 1

- Write the sum and then write an equivalent expression by collecting like terms and removing parentheses wherever possible.

- c. The opposite of 4x and -5 + 4x

\[-4x + (5 + 4x)\]
\[(-4x + 4x) + (-5)\]
\[0 + (-5)\]
\[-5\]

Any order, any grouping
Additive inverse
Additive identity property of zero
Exercise 1

- Write the sum and then write an equivalent expression by collecting like terms and removing parentheses wherever possible.

- d. The opposite of \(-10t\) and \(t - 10t\)

\[
\begin{align*}
10t + (t - 10t) & \quad \text{Any order, any grouping} \\
(10t + (-10t)) + t & \quad \text{Additive inverse} \\
0 + t & \quad \text{Additive identity property of zero}
\end{align*}
\]
Exercise 1

- Write the sum and then write an equivalent expression by collecting like terms and removing parentheses wherever possible.

- e. The opposite of \((-7 - 4v)\) and \(-4v\)

\[
\begin{align*}
\text{\(-(-7 - 4v) + (-4v)\)} & \quad \text{Taking the opposite is equivalent to multiplying by \(-1\)} \\
\text{-1(-7 - 4v) + (-4v)} & \quad \text{Distributive property} \\
\text{7 + 4v + (-4v)} & \quad \text{Any grouping, Additive inverse} \\
\text{7 + 0} & \quad \text{Additive identity property of zero} \\
\text{7} & \\
\end{align*}
\]
Example 2

- $\frac{3}{4} \cdot \frac{4}{3} = 1$
- $4 \cdot \frac{1}{4} = 1$
- $\frac{1}{9} \cdot 9 = 1$
- $(-\frac{1}{3}) \cdot (-3) = 1$
- $(-\frac{6}{5}) \cdot (-\frac{5}{6}) = 1$

What are these pairs of numbers called? Reciprocal

What is another term for reciprocal? Multiplicative inverse
Example 2

- Write the product and then write the expression in standard form by removing parentheses and combining like terms. Justify each step.

- a. The multiplicative inverse of $\frac{1}{5}$ and $2x - \frac{1}{5}$

\[
5(2x - \frac{1}{5})
\]

\[
5(2x) - 5\left(\frac{1}{5}\right)
\]

Distributive property

\[
10x - 1
\]

Multiplicative inverses
Example 2

Write the product and then write the expression in standard form by removing parentheses and combining like terms. Justify each step.

b. The multiplicative inverse of 2 and $2x + 4$

\[
\frac{1}{2}(2x + 4) \\
\frac{1}{2}(2x) + \frac{1}{2}(4) \\
1x + 2 \\
x + 2
\]

- Distributive property
- Multiplicative inverses, multiplication
- Multiplicative identity property of one
Example 2

- Write the product and then write the expression in standard form by removing parentheses and combining like terms. Justify each step.

- c. The multiplicative inverse of \( \frac{1}{3x+5} \) and \( \frac{1}{3} \)

\[
(3x + 5) \cdot \frac{1}{3} = 3x\left(\frac{1}{3}\right) + 5\left(\frac{1}{3}\right)
\]

- Distributive property

\[
1x + \frac{5}{3}
\]

- Multiplicative inverse

\[
x + \frac{5}{3}
\]

- Multiplicative identity property of one
Exercise 2

- Write the product and then write the expression in standard form by removing parentheses and combining like terms. Justify each step.
- a. The reciprocal of 3 and $-6y - 3x$

\[
\left(\frac{1}{3}\right)(-6y + (-3x))
\]

Rewrite subtraction as an addition problem

\[
\left(\frac{1}{3}\right)(-6y) + \left(\frac{1}{3}\right)(-3x)
\]

Distributive property

\[-2y - 1x\]

Multiplicative inverse

\[-2y - x\]

Multiplicative identity property of one
Exercise 2

Write the product and then write the expression in standard form by removing parentheses and combining like terms. Justify each step.

b. The multiplicative inverse of 4 and 4h – 20

\[ \frac{1}{4} (4h + (-20)) \quad \text{Rewrite subtraction as an addition problem} \]

\[ \frac{1}{4} (4h) + \frac{1}{4} (-20) \quad \text{Distributive property} \]

\[ 1h + (-5) \quad \text{Multiplicative inverse} \]

\[ h - 5 \quad \text{Multiplicative identity property of one} \]
Exercise 2

- Write the product and then write the expression in standard form by removing parentheses and combining like terms. Justify each step.

- c. The multiplicative inverse of $-\frac{1}{6}$ and $2 - \frac{1}{6}j$

\[
(-6)(2 + (-\frac{1}{6}j)) \quad \text{Rewrite subtraction as an addition problem}
\]

\[
(-6)(2) + (-6)(-\frac{1}{6}j) \quad \text{Distributive property}
\]

\[-12 + 1j \quad \text{Multiplicative inverse}
\]

\[-12 + j \quad \text{Multiplicative identity property of one}
\]
Homework

- Problem Set #1-4
- Study for Engage NY Lessons 4-6 quiz Friday