Class Trip

Jamie wants to go on a class trip during spring vacation. His teacher and some classmates will be biking and hiking through the state park. Jamie needs $498 to go on the trip. He received $168 for his birthday. If he uses his birthday money and saves $15 each week, when will Jamie have enough money for the trip?

1. Jamie decided to write an equation to model the situation.

   a. Write a verbal model.

   b. Use numbers and variables to write expressions.

   c. Write an equation.

In the previous activity, you solved equations by using a single inverse operation. Two-step equations can also be solved using a flowchart and working backwards.

When solving an equation such as $4x + 7 = 23$, think of $x$ as the input and $4x + 7$ as the output. Start by making a flowchart to show the operations needed to go from the input to the output.

**READING MATH**

4x means “4 times $x$”. In algebra, a multiplication sign is not used between a number and a variable.

3n is the same as “3 $\times$ n” or 3(n). Not using the multiplication symbol helps avoid confusion between $x$ and $\times$. 
To work backward, start from the output value and undo each operation using its inverse operation until you find the input. Since the original equation says that $4x + 7 = 23$, $4x + 7$ in the output oval can be replaced with 23.

The last step to reach the output was adding 7. Subtract 7 to undo that step. Notice where $-7$ is placed in the flow chart. As you continue backward, the next step is multiplying by 4. Divide by 4 to undo that step. Notice where $\div 4$ is placed in the flow chart.

2. Complete the flow chart above. Start with 23 and use the inverse operations in the flow chart to fill in the last two ovals. What is the solution for $x$? Explain.

3. Use this flow chart with the backward method to solve the problem $\frac{x}{3} - 2 = 10$.

4. Now use the flowchart method to find a solution to the equation you wrote in Question 1c. How long will it take Jamie to save up for the trip?
5. Draw a flowchart and work backward to solve each of the following equations. Check your solutions.

   a. $3x + 8 = 17$
   b. $\frac{b}{5} - 2 = 13$

In addition to using flowcharts, you can also solve equations algebraically. An equation that requires two arithmetic operations to solve is called a two-step equation. Arithmetic operations are addition, subtraction, multiplication, and division.

**EXAMPLE 1**

Solve $4x + 7 = 23$.

**Step 1:** Subtract 7 from both sides and simplify.

$4x + 7 - 7 = 23 - 7$

$4x = 16$

**Step 2:** Divide each side by 4 and simplify.

$\frac{4x}{4} = \frac{16}{4}$

$1x = 4$

**Solution:**

$x = 4$

**TRY THESE A**

Solve these equations algebraically.

   a. $3x + 5 = 35$
   b. $20 = 3x + 8$
   c. $\frac{x}{4} - 2 = 11$
   d. $12 = \frac{x}{2} + 3$

Sometimes you may need to apply the distributive property to solve an equation.

$3(x + 2) = 12$

$3x + 6 = 12$

$3x + 6 - 6 = 12 - 6$

$\frac{3x}{3} = \frac{6}{3}$

$x = 2$
6. Now that you have examined two methods for solving equations, compare and contrast them.

a. Describe the ways in which solving equations algebraically is the same as working backward.

b. Describe the ways in which solving algebraically is different from working backward.

Jamie wanted to choose clothes to take on the class trip. He looked up the average temperature for the state park during the time of year they were going on the trip. He found that the mean temperature at the park was 30° Celsius.

Jamie only knew temperature in degrees Fahrenheit, so he did not know whether this was hot or cold. He looked for a formula to convert Celsius to Fahrenheit temperatures and found one based on cricket chirps. The number of chirps that a cricket will make in a minute is dependent on the temperature in degrees Fahrenheit.

To use a formula, replace all variables that have given numbers and then solve the resulting equation for the remaining variable.

7. The formula using cricket chirps is \( n = 4F - 128 \), where \( n \) is the number of chirps per minute and \( F \) is the temperature in degrees Fahrenheit. If a cricket chirps 184 times in a minute, what is the temperature? Show your work.
Jamie also found two versions of another formula for converting temperature:

\[
C = \frac{5}{9} F - \frac{160}{9} \quad \quad \quad \quad \quad C = \frac{5}{9} (F - 32)
\]

- The variable \( C \) represents temperature in degrees Celsius.
- The variable \( F \) represents temperature in degrees Fahrenheit.

Jamie decides to use the first version of the equation to convert the Celsius temperature to Fahrenheit. Both versions result in the same answer.

8. When Jamie replaced the \( C \) in the formula with the number 30, he obtained the following equation:

\[
30 = \frac{5}{9} F - \frac{160}{9}
\]

a. Solve the equation for \( F \) algebraically.

b. What kind of clothing should Jamie take? Explain.

Jamie’s teacher told the students to leave their cell phones at home because there is no reception in the park. They can use a pay phone at the ranger’s station, so Jamie will take a phone card with him.

9. Jamie’s phone card is worth $2.80. To call home from the park there is $0.40 connection fee and it costs $0.12 each minute you talk.

a. Write an equation to determine how many minutes Jamie can talk.

b. Solve the equation and check your answer.
You can also use inverses to solve two-step inequalities.

**EXAMPLE 2**
Solve $\frac{x}{3} - 4 > 8$ and graph the solution.

*Step 1: Add 4 to both sides and simplify.*

\[
\frac{x}{3} - 4 + 4 \geq 8 + 4
\]
\[
\frac{x}{3} \geq 12
\]

*Step 2: Multiply each side by 3 and simplify.*

\[
\frac{x}{3} \times 3 \geq 12 \times 3
\]
\[
x \geq 36
\]

**TRY THESE B**

<table>
<thead>
<tr>
<th>a. $2x + 6 &gt; 20$</th>
<th>b. $5x - 6 \geq 14$</th>
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<tr>
<td>c. $\frac{x}{7} + 3 &lt; 12$</td>
<td>d. $\frac{x}{3} - 5 \leq 10$</td>
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**CHECK YOUR UNDERSTANDING**

Write your answers on notebook paper. Show your work.

1. Work backward to solve the equation $8x - 9 = 15$ using a flow chart.
2. Work backward to solve the equation $\frac{n}{4} + 3 = 14$ using a flow chart.
3. Solve each equation or inequality. Check your solution.
   - a. $12 = 5w - 3$
   - b. $7x + 5 = 19$
   - c. $\frac{2}{3}y + 7 = 17$
   - d. $5.12 = \frac{n}{6.3} - 11.1$
   - e. $8x - 7 < 25$
   - f. $\frac{4}{5}n + 3.5 \geq 19.5$
   - g. $\frac{y}{3} + 5 \geq 24$
   - h. $1.2x - 6 > 18$
   - i. $2(x + 3) = 16$
   - j. $28 = 4(x - 3)$

4. Graph the solutions of the inequalities in 3e and 3f.
5. A taxi ride costs $2.85 plus $0.35 for each quarter-mile. How many quarter miles can you go for $8.10?
6. The formula for finding the perimeter of a rectangle is $P = 2l + 2w$, where $P$ is perimeter, $l$ is length, and $w$ is width. Find the length of a rectangle if its perimeter is 18 cm and its width is 6 cm.
7. **Mathematical Reflection** Describe how first learning the flowchart method of solving equations helped you understand the algebraic method.