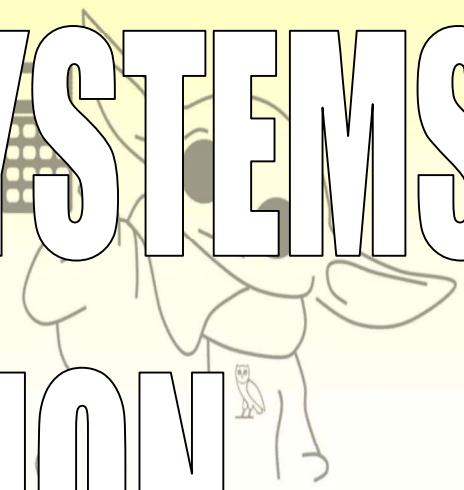
ST. JEAN DE BREBEUF MATHEMATICS

CHAPTER 5.2

SOLVING LINEAR SYSTEMS BY SUBSTITUTION



CHAPTER 5.2 SOLVING LINEAR SYSTEMS BY SUBSTITUTION

WARM UP – REVIEW ON SUBSTITUTING NUMBERS FOR VARIABLE

For the equation **2x + 3y = 24**

(a) Determine the value of x when **y = 4**

$2x + 3y = 24$
$2x + 3(4) = 24$
$2x + 12 = 24$

$2x = 24 - 12$
$\frac{2x}{2} = \frac{12}{2}$
x = 6

(b) Determine the value of y when **x = – 6**

$2x + 3y = 24$
$2(-6) + 3y = 24$
$-12 + 3y = 24$

$3y = 24 + 12$
$\frac{3y}{3} = \frac{36}{3}$
y = 12

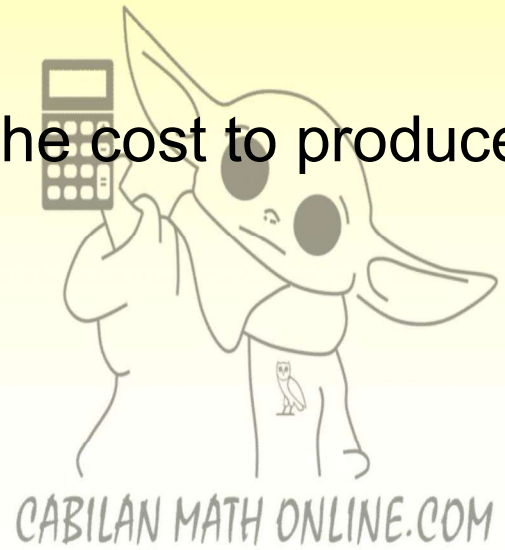
CHAPTER 5.2 SOLVING LINEAR SYSTEMS BY SUBSTITUTION

KEY CONCEPTS

A system of linear equations can be solved *algebraically* using the **substitution** method.

To solve a linear system by substitution, **one equation is solved for one variable**, then that value is *substituted* into the other equation.

The **break-even point** is the point at which the cost to produce an item is equal to its selling price.



CHAPTER 5.2 SOLVING LINEAR SYSTEMS BY SUBSTITUTION

EXAMPLE 1 *Solve by Substitution*

Solve the following system of linear equations by **substitution**.

(a) (1) $2x + y = 17$
(2) $x = 12 - y$

The *x* in (2) is already isolated!

Substitute **x = 12 – y** into *x* in Equation **(1)**

$$2x + y = 17$$

$$2(12 - y) + y = 17$$

$$24 - 2y + y = 17$$

$$24 - y = 17$$

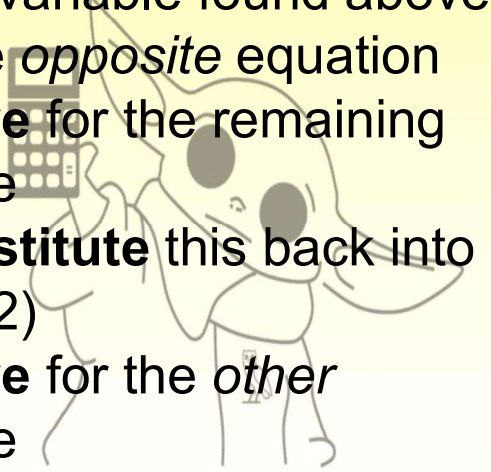
$$-y = 17 - 24$$

$$\frac{-1y}{-1} = \frac{-7}{-1}$$

$$y = 7$$

STEPS

1. **Isolate** one of the variables in one of the equations
2. **Substitute** the expression for the variable found above into the *opposite* equation
3. **Solve** for the remaining variable
4. **Substitute** this back into (1) or (2)
5. **Solve** for the *other* variable



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CHAPTER 5.2 SOLVING LINEAR SYSTEMS BY SUBSTITUTION

EXAMPLE 1 *Solve by Substitution*

Solve the following system of linear equations by **substitution**.

(a) (1) $2x + y = 17$

(2) $x = 12 - y$

Substitute **y = 7** into **(2)**

$y = 7$

$x = 12 - y$

$x = 12 - 7$

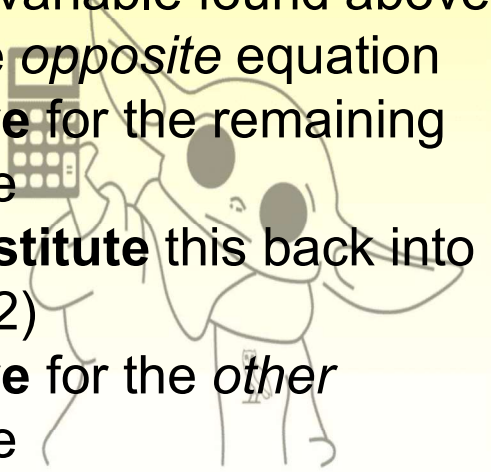
$x = 5$

The solution to the system of equations is **(5, 7)**

*** Note: You will get the same answer if you substitute **y = 7** into **(1)**

STEPS

1. **Isolate** one of the variables in one of the equations
2. **Substitute** the expression for the variable found above into the *opposite* equation
3. **Solve** for the remaining variable
4. **Substitute** this back into (1) or (2)
5. **Solve** for the *other* variable



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CHAPTER 5.2 SOLVING LINEAR SYSTEMS BY SUBSTITUTION

EXAMPLE 1 *Solve by Substitution*

Solve the following system of linear equations by **substitution**.

(b) (1) $-3x + y = 10$
(2) $x + 2y = -1$

This time, we will isolate **y** from **(1)**

$$-3x + y = 10$$

$$y = 3x + 10$$

Substitute **y = 3x + 10** into **y** in Equation **(2)**

$$x + 2y = -1$$

$$x + 2(3x + 10) = -1$$

$$x + 6x + 20 = -1$$

$$7x + 20 = -1$$

$$7x = -1 - 20$$

$$\frac{7x}{7} = \frac{-21}{7}$$

$$x = -3$$

STEPS

1. **Isolate** one of the variables in one of the equations
2. **Substitute** the expression for the variable found above into the *opposite* equation
3. **Solve** for the remaining variable
4. **Substitute** this back into (1) or (2)
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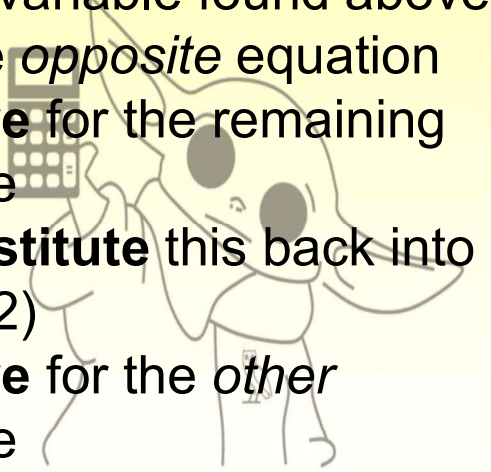

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CHAPTER 5.2 SOLVING LINEAR SYSTEMS BY SUBSTITUTION

EXAMPLE 1 *Solve by Substitution*

Solve the following system of linear equations by **substitution**.

(b) (1) $-3x + y = 10$
(2) $x + 2y = -1$

Substitute **x = – 3** into **x** in Equation **(1)**

$$-3x + y = 10$$

$$x = -3$$

$$-3(-3) + y = 10$$

$$9 + y = 10$$

$$y = 10 - 9$$

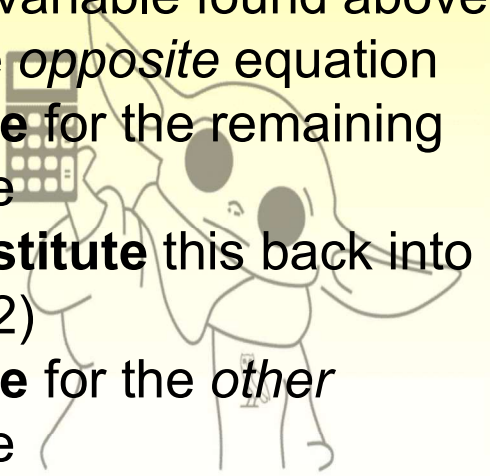
$$y = 1$$

The solution to the system of equations is **(– 3, 1)**

*** Note: You will get the same answer if you substitute **x = – 3** into **(2)**

STEPS

1. **Isolate** one of the variables in one of the equations
2. **Substitute** the expression for the variable found above into the *opposite* equation
3. **Solve** for the remaining variable
4. **Substitute** this back into (1) or (2)
5. **Solve** for the *other* variable



END OF DAY 1

CHAPTER 5.2 SOLVING LINEAR SYSTEMS BY SUBSTITUTION

EXAMPLE 2 *Ages*

Hakeem is **3 times** older than Jamal.

The sum of their ages is **40**.

How old are Hakeem and Jamal?

Step 1: Declare your variables

"j" will represent Jamal's age
"h" will represent Hakeem's age

Step 2: Write two equations which represent the situation

Hakeem's age: **(1)** $h = 3j$

Their total age: **(2)** $h + j = 40$

CHAPTER 5.2 SOLVING LINEAR SYSTEMS BY SUBSTITUTION

EXAMPLE 2 *Ages*

Hakeem is **3 times** older than Jamal.

The sum of their ages is **40**.

How old are Hakeem and Jamal?

Hakeem's age: **(1)** h = 3j

Their total age: **(2)** h + j = 40

h from **(1)** is already isolated!

Substitute **h = 3j** into **h** in Equation **(2)**

$$h + j = 40$$
$$3j + j = 40$$
$$\frac{4j}{4} = \frac{40}{4}$$

$$j = 10$$

STEPS

1. **Isolate** one of the variables in one of the equations
2. **Substitute** the expression for the variable found above into the *opposite* equation
3. **Solve** for the remaining variable
4. **Substitute** this back into (1) or (2)
5. **Solve** for the *other* variable

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CHAPTER 5.2 SOLVING LINEAR SYSTEMS BY SUBSTITUTION

EXAMPLE 2 *Ages*

Hakeem is **3 times** older than Jamal.

The sum of their ages is **40**.

How old are Hakeem and Jamal?

Hakeem's age: **(1)** h = 3j

Their total age: **(2)** h + j = 40

Substitute **j = 10** into **j** in Equation **(1)**

$$h = 3j$$

$$h = 3(10)$$

$$h = 30$$

$$j = 10$$

Hakeem is **30 years old** and Jamal is **10 years old**.

STEPS

1. **Isolate** one of the variables in one of the equations
2. **Substitute** the expression for the variable found above into the *opposite* equation
3. **Solve** for the remaining variable
4. **Substitute** this back into (1) or (2)
5. **Solve** for the *other* variable

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CHAPTER 5.2 SOLVING LINEAR SYSTEMS BY SUBSTITUTION

EXAMPLE 3 *Break-Even Points*

Henry is selling jackets to raise money for his football team. The supplier charges a one-time set-up fee of **$270** plus **$9** for each jacket. Henry is planning to sell the jackets for **$15**.

(a) Using ***C*** to represent total cost and ***j*** to represent the number of jackets:

(i) Write out the equation which represents the **total cost to the supplier**

(1) $C = 270 + 9j$

(ii) Write out the equation which represents the **total costs for selling the jackets**

(2) $C = 15j$

CHAPTER 5.2 SOLVING LINEAR SYSTEMS BY SUBSTITUTION

EXAMPLE 3 *Break-Even Points*

(b) Use the equations and the method of **substitution** to determine **how many jackets** must be sold for Henry to break even.

(1) $C = 270 + 9j$

(2) $C = 15j$

Both equations are already have **C** isolated!

Substitute **C = 270 + 9j** into **C** in Equation **(2)**

$$C = 15j$$

$$270 + 9j = 15j$$

$$9j - 15j = -270$$

$$\frac{-6j}{-6} = \frac{-270}{-6}$$

$$j = 45$$

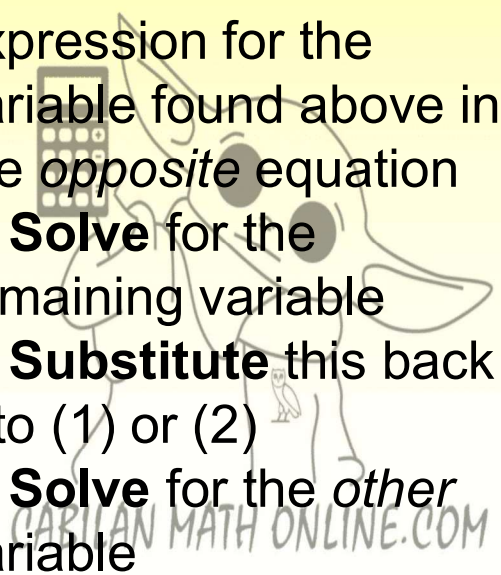
*Move letters to the left

*Move numbers to the right

Henry will need to sell **45 jackets** to break even.

STEPS

1. **Isolate** one of the variables in one of the equations
2. **Substitute** the expression for the variable found above into the *opposite* equation
3. **Solve** for the remaining variable
4. **Substitute** this back into (1) or (2)
5. **Solve** for the *other* variable



CHAPTER 5.2 SOLVING LINEAR SYSTEMS BY SUBSTITUTION

Homework:

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(Day 1) #1aceg, 2ac, 3ac

(Day 2) #4 – 6, 11