8

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Mathematics

Quarter 1 – Module 7: Equation of the Line Problems Involving Linear Equation

ALTERNATIVE DELIVERY MODE
ADM

Mathematics – Grade 8
Alternative Delivery Mode
Quarter 1 – Module 7: Equation of the Line
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8

Mathematics

Quarter 1 – Module 7: Equation of the Line Problems Involving Linear Equations

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Introductory Message

For the facilitator:

Welcome to the Grade 8 Mathematics Alternative Delivery Mode (ADM) Module on Equation of the Line Problems Involving Linear Equations.

This module was collaboratively designed, developed and reviewed by educators, both from public and private institutions to assist you, the teacher or facilitator, in helping the learners meet the standards set by the K to 12 Curriculum while overcoming their personal, social, and economic constraints in schooling.

This learning resource hopes to engage the learners into guided and independent learning activities at their own pace and time. Furthermore, this also aims to help learners acquire the needed 21st century skills while taking into consideration their needs and circumstances.

In addition to the material in the main text, you will also see this box in the body of the module:

Notes to the Teacher

This contains helpful tips or strategies that will help you in guiding the learners.

As a facilitator, you are expected to orient the learners on how to use this module. You also need to keep track of the learners' progress while allowing them to manage their own learning. Furthermore, you are expected to encourage and assist the learners as they do the tasks included in the module.

For the learner:

Welcome to the Mathematics 8 Alternative Delivery Mode (ADM) Module on Equation of the Line Problems Involving Linear Equations.

The hand is one of the most symbolized part of the human body. It is often used to depict skill, action and purpose. Through our hands, we may learn, create and accomplish. Hence, the hand in this learning resource signifies that you, as a learner, is capable and empowered to successfully achieve the relevant competencies and skills at your own pace and time. Your academic success lies in your own hands!

This module was designed to provide you with fun and meaningful opportunities for guided and independent learning at your own pace and time. You will be enabled to process the contents of the learning resource while being an active learner.

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This module has the following parts and corresponding icons:

 ***What I Need to Know***	This will give you an idea of the skills or competencies you are expected to learn in the module.
 ***What I Know***	This part includes an activity that aims to check what you already know about the lesson to take.
 ***What's In***	This is a brief drill or review to help you link the current lesson with the previous one.
 ***What's New***	In this portion, the new lesson will be introduced to you in various ways such as a story, a song, a poem, a problem opener, an activity, or a situation.
 ***What is It***	This section provides a brief discussion of the lesson. This aims to help you discover and understand new concepts and skills.
 ***What's More***	This comprises activities for independent practice to solidify your understanding and skills of the topic. You may check the answers to the exercises using the Answer Key at the end of the module.
 ***What I Have Learned***	This includes questions or blank sentence/paragraph to be filled in to process what you learned from the lesson.
 ***What I Can Do***	This section provides an activity which will help you transfer your new knowledge or skill into real life situations or concerns.
 ***Assessment***	This is a task which aims to evaluate your level of mastery in achieving the learning competency.

Additional Activities	In this portion, another activity will be given to you to enrich your knowledge or skill of the lesson learned. This also tends retention of learned concepts.
Answer Key	This contains answers to all activities in the module.

At the end of this module you will also find:

References	This is a list of all sources used in developing this module.

The following are some reminders in using this module:

1. Use the module with care. Do not put unnecessary mark/s on any part of the module. Use a separate sheet of paper in answering the exercises.
2. Don't forget to answer *What I Know* before moving on to the other activities included in the module.
3. Read the instruction carefully before doing each task.
4. Observe honesty and integrity in doing the tasks and checking your answers.
5. Finish the task at hand before proceeding to the next.
6. Return this module to your teacher/facilitator once you are through with it.

If you encounter any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator. Always bear in mind that you are not alone.

We hope that through this material, you will experience meaningful learning and gain deep understanding of the relevant competencies. You can do it!

What I Need to Know

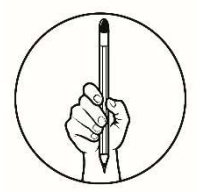
This module was designed and written with you in mind. It is here to help you master the nature of the equation of a line and word problems involving Linear Equations in 2 variables under Grade 8 Mathematics. The scope of this module also serves as one of the vital subtopics under the discussion of Linear Equations. It will be very useful in problems involving Systems of Linear Equations. Also, the lessons you will be learning under this module will be used and applied once you will be tackling Linear Functions. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

The module is divided into three lessons, namely:

- Lesson 1 – Finding the equation of the line given the slope and a point or two points.
- Lesson 2 – Finding the equation of the line given the slope and the intercepts.
- Lesson 3 – Problems involving linear equation – Distance, Speed and Time
- Lesson 4 – Problems involving linear equation – Constant Rate

This module is especially designed for you dear Grade 8 students so that you will be able to:

1. explain the process in finding the equation of a line given the slope and a point on the line or given 2 points on the line;
2. find the equation of a line given the slope and a point on the line or given 2 points on the line;
3. understand the process in finding the equation of a line given the slope and y – intercept or both x – and y - intercepts;
4. find the equation of a line given the slope and y – intercept, or x – and y - intercepts;
5. read and understand the given problems, whether it be motion-related problems or constant rate of change problems;
6. distinguish the dependent or independent variable in the given problem;
7. determine or formulate the linear equation needed to model the problem;
8. solve the problem; and
9. develop logical thinking while performing the assigned activity.



What I Know

Find the slope of the line in the following problems:

1. Find the equation of the line that passes through the points (-1,0) and (-4,12).
   a. $y = -4x - 4$ c. $y = -4x + 4$
   b. $y = 4x - 4$ d. $y = 4x + 4$
2. What is the equation of the line through the points (-2,0) and (-2,4)?
   a. $x = 2$ c. $x = 4$
   b. $x = -2$ d. $x = -3$

4. Find the equation of the line that passes through the points (7,5) and (-9,5).
   a. $y = 7$ c. $y = 5$
   b. $y = 9$ d. $y = -9$
5. Find the equation of the line through the point (3,4) and parallel to the x axis.
   a. $y = 7$ c. $y = 5$
   b. $y = 9$ d. $y = 4$
6. What is the equation of the line through the point (-3,2) and has x intercept at x = -1?
   a. $y = -x - 1$ c. $y = x - 1$
   b. $y = -x - 2$ d. $y = x + 1$

Lesson 1 Finding the Equation of a Line, if the Slope and a Point or two Points of a Line are Given

One of the important topics under Relations and Function is about Equation of the Line. This topic will discuss how to find the equation of a line, if the slope and point/s of the line are given. This will give us enough information to make our future mathematics easy to deal with. Hence, let us focus and do the activities required for us to better understand these lessons.

What's In

The equation of the line can be determined using the following formulae:

1. slope-intercept form: $y = mx + b$;
2. point-slope form: $y - y_1 = m(x - x_1)$; and
3. two-point form: $\left(\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}\right)$

We can only write the equation of a line when we know the slope and the coordinates of any point on the line.

Recall that we can determine the *slope of the line* given two points by using the formula m = $\frac{y_2-y_1}{x_2-x_1}$; therefore, substituting the formula to the slope-intercept form, y=mx+b, we will have the $y = \frac{y_2-y_1}{x_2-x_1}x + b$ as the equation of the line.

Given the slope and one point of the line, we can find the equation.

1) Suppose a line has a slope of $\frac{2}{3}$ and contains the point (9,7).
2) Write an equation of a line containing (1,1) and (3, –1).

Notes to the Teacher

Knowing the slope of the line should be mastered by the students to be able to know better how to find the equation of the line. Recall the formula in finding the slope given the points:

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

What's New

Point-slope form of a line is one method to write the equation of a line. Start with the slope equation, which is basically the difference between two points, and then rearrange the terms to obtain the point-slope form of a line.

The point-slope form of a line provides a formula that is useful in finding the slope of a line from an equation and a point the line passes through.

The point-slope form of the equation of a line is given by: $y - y_1 = m(x - x_1)$, where m is the slope of the line and (x_1, y_1) is a point on the line.

A. Find the equation of the line in $y = mx + b$ form:

1. passing through points (3,4) and (2,8)
2. passing through points (0,-3) (5,0)
3. passing through points (2,4) and (1,3)
4. passing through points (-4,1) and (-2,3)
5. passing through points [illegible]

B. Answer the following:

1. Find the equation of a line with a slope equal to -2 and passes through the points (4,-4).

   a. $y = -2x + 4$ c. $y = 2x + 4$

   b. $y = -2x - 4$ d. $y = 2x - 4$

2. If the slope of a line is 4 and it passes through (1,3), what is its equation?

   a. $y = 4x + 1$ c. $y = 4x + 3$

   b. $y = 4x - 1$ d. $y = 4x - 3$

3. A line passes through (-1,2) and (2,5). Find its equation.

   a. $y = x - 5$ c. $y = 2x + 3$

   b. $y = 2x + 1$ d. $y = x + 3$

4. Find the equation of a line that passes through (2,8) and with an x – intercept = 4.

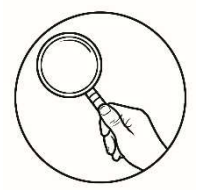
   a. $y = 4x + 4$ c. $y = 4x - 4$

   b. $y = -4x + 16$ d. $y = -4x - 16$

5. What is the equation of a line parallel to y = $\frac{1}{2}$x – 4 and passes through (2,5)?

   a. $y = 2x + 3$ c. $y = \frac{1}{2}x + 3$

   b. $y = 2x + 5$ d. $y = -\frac{1}{2}x + 5$



What is It

1. Given the slope and one point of the line, we can find the equation.

   Suppose a line has a slope of $\frac{2}{3}$ and contains the point (9,7).

   Using the slope-intercept form $y = mx + b$

   Given $m = \frac{2}{3}$ and point (9,7) $7 = \frac{2}{3}(9) + b$

   Solve for b $7 = \frac{18}{3} + b$

   $7 = 6 + b$

   $7 - 6 = b$

   $1 = b$

Now that the value of b = 1, the equation of the line can be written by substituting all the given values to the formula $y = mx + b$.

Equation of the line → $\boldsymbol{y = \frac{2x}{3} + 1}$

2. An equation of a line can also be found when the coordinates of two points are given.

Write an equation of a line containing (1,1) and (3, −1).

Find the slope of the line given (1,1) and (3,-1)	$P_1(1,1) \rightarrow x_1 = 1$ and $y_1 = 1$ $P_2(3,-1) \rightarrow x_2 = 3$ and $y_2 = -1$
Substitute the values to the formula:	$m = \frac{y_2 - y_1}{x_2 - x_1}$
	$m = \frac{-1-1}{3-1} = \frac{-2}{2}$
	$m = -1$

Since the value of slope m is already known, the equation of a line can be written using the slope (m) and any one of the given points.

Using the slope-intercept form	$y = mx + b$
Given $m = -1$ and point (1,1)	$1 = -1(-1) + b$
Solve for b	$1 = -1 + b$
	$1 + 1 = b$
	$2 = b$
Given $m = -1$ and point (3,-1)	$-1 = -1(3) + b$
Solve for b	$-1 = -3 + b$
	$-1 + 3 = b$
	$2 = b$

Observe that any one of the points you use will give the same result. Substituting all the given values of m and b in the slope formula $y = mx + b$

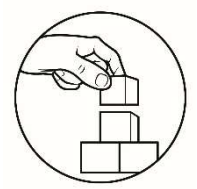
Equation of the line → $\underline{y = -x + 2}$

To write the equation of a line when we know only the slope and the coordinates of any point on the line:

- write the equation in slope – intercept form;
- replace *x* and *y* by the given values;
- solve for *b;* and,
- replace *m* and *b* in *y* = mx + b with the corresponding values.

To find the equation of a line when 2 of its points are given:

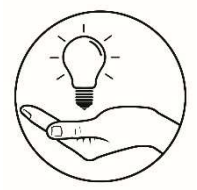
- find the slope of the line through the 2 given points;
- write the slope – intercept from of the line;
- substitute the coordinates of either of the 2 points and then solve for b; and,
- replace m and b in y = mx +b with the values obtained in steps a and c.



What's More

Activity 1. Find the equation of a line given the following:

1. slope equal to 3; passes through point (1,-1)
2. slope of 2; passes through (2,1)
3. passes through (1,6) and (-2,3)
4. passes through (2,4); x – intercept = 1.
5. parallel to y = 3x – 2; passes through (4,2)



What I Have Learned

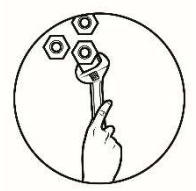
Fill in the blanks with the correct answers.

1. The equation of a line can be determined using y = mx + b, which is called the _____ form.
2. The _____ form of a line is $y - y_1 = m(x - x_1)$.

3. The _____form of a line is $\left(\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}\right)$.

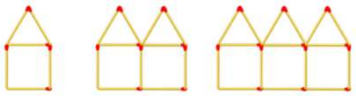
4. We can write the equation of a line when we know only the slope and the _____ of any point on the line.

5. Given only two points, it is easy to find the equation of the line when you find first the _____.



What I Can Do

Look at the pattern of the matchstick houses below:



(a) Copy and complete the table

Number of houses (x)	1	2	3	4	5	6
Number of matchsticks (y)	**6**					

(b) How many extra matchsticks are needed for each extra house?

(c) Write down the equation linking x and y, and check if it works for the table above.

(d) How many matchsticks are needed to make 20 houses?

(e) How many houses could be made with 216 matches?

Assessment

A. Find the equation of the line in $y = mx + b$ form.

1. passing through points (5,6) and (7, -4)
2. passing through points (0,5) (2,0)
3. passing through points (5,3) and (3,1)
4. passing through points (-7,-1) and (1,-3)
5. passing through points (4,-3) and (-2,1)

B. Choose the letter of the correct answer.

6. Find the equation of a line with a slope equal to 2 and passes through points (1,3).

   a. $y = 2x + 3$ c. $y = 2x + 3$

   b. $y = 2x + 1$ d. $y = 2x + 5$

7. If the slope of a line is 6 and it passes through (2,8), what is its equation?

   a. $y = 6x - 20$ c. $y = 6x - 4$

   b. $y = 6x + 20$ d. $y = 6x + 4$

8. A line passes through (1,5) and (2,7). Find its equation.

   a. $y = 2x - 3$ c. $y = 2x + 3$

   b. $y = 2x + 7$ d. $y = -\frac{1}{2}x - 7$

9. Find the equation of a line that passes through (2,11), and with an x – intercept = 1.

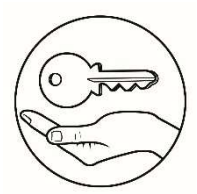
   a. $y = 11x - 11$ c. $y = 11x$

   b. $y = 11x + 11$ d. $y = 11x + 22$

10. What is the equation of a line parallel to y = 2x – 2 and passes through P(3,1)?

    a. $y = 2x + 7$ c. $y = 2x + 5$

    b. $y = 2x - 6$ d. $y = 2x - 5$



Answer Key

What I Know

1. A
2. B
3. C
4. D
5. A

What's New

A.	B.
1. $y = -4x + 16$	1. A
2. $y = \frac{3}{5}x - 3$	2. B
3. $y = x + 2$	3. D
4. $y = x + 5$	4. B
5. $y = \frac{6}{5}x - \frac{7}{5}$	5. C

What's More

1. $y = 3x - 4$
2. $y = 2x - 3$
3. $y = x + 5$
4. $y = 4x - 4$
5. $y = 3x - 10$

What I can Do

a. 11,16,21,26,31
b. 5
c. y=5x+1
d. 101 matchsticks
e. 43 houses

What I have Learned

1. Slope-intercept
2. Point slope
3. Two-point
4. Coordinates
5. slope

Assessment

A.	B.
1. $y = -5x + 31$	6. B
2. $y = \frac{-5}{2}x + 5$	7. C
3. $y = x - 2$	8. C
4. $y = \frac{-x}{4} - \frac{11}{4}$	9. A
5. $y = \frac{-2}{3}x - \frac{1}{3}$	10. D

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What I Know

Answer the following:

1. Find the equation of the line that has an x intercept of - 4 and y intercept of 5.
2. What is the equation of the line passing through the point (-1,0) and perpendicular to the line y = 9?
3. Find the slope, the x and y intercepts of the line given by the equation: $-3x + 5y = 8$.
4. Find the slope intercept form for the line given by its equation: $\frac{x}{4} - \frac{y}{5} = 3$.
5. Are the lines x = -3 and x = 0 parallel or perpendicular?

Lesson 2 Finding the Equation of a Line when the Slope and the Intercept are Given

One of the important topics on relations and functions is about the equation of a line. This topic will discuss how to find the equation of a line given the slope and intercepts. This will give us enough information to make our future mathematics easy to deal with. Hence, let us focus and do the activities required for us to better understand these lessons.

What's In

We can find the equation of a line given its slope and y – intercept, using the slope intercept form of a line, y = mx +b. Take note that slope is m and the y-intercept is b.

However, if the intercepts are given, such as a = x-intercept and b = y-intercept, the formula to be used in finding the equation of the line is $\frac{x}{a} + \frac{y}{b} = 1$.

Examples:

1. If the slope of the line m = -1 and y-intercept b = 2
2. Given as x – intercept is 2 and the y – intercept is 3

Notes to the Teacher

You may also let the students recall the formula in finding the slope, given the intercepts as m = $\frac{-b}{a}$, where a is the x-intercept and b is the y-intercept. This will give them ideas on the other ways of finding the equation of a line.

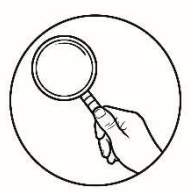
What's New

A. Given the x and y intercepts, write the equation of the line in the form ax+by=c.

	x-intercept	y-intercept	Equation of the line
1.	4	4	_____
2.	-3	-1	_____
3.	-3	-4	_____
4.	6	-11	_____
5.	-8	20	_____

B. Write the equation of the line, given the following:

1. slope of 4 and passing through (0,2)
2. slope of 3 and passing through (0,-3)
3. slope of $\frac{2}{3}$ and passing through (0, $\frac{1}{3}$)
4. slope of -1 and passing through (0,4)
5. slope of $\frac{-1}{5}$ and passing through (0,2)



What is It

1. If the slope of a line is $\frac{2}{3}$ and its y – intercept is 5, what is the equation of the line?

   Since m = $\frac{2}{3}$ and b = 5,

   Substitute the values to the slope-intercept form $y = mx + b$ → $y = \frac{2x}{3} + 5$

2. If the slope of a line is 4 and it passes through the origin, what is its equation?

   If the line passes through the origin (0,0), then b = 0,
   Then the equation we are looking for is y = 4x.

3. A line that passes through (0,-2) has a slope equal to 6, find its equation.

   If the line passes through (0,-2), its y – intercept (b) is -2.
   Thus, the missing equation is y = 6x – 2.

4. Find equation of a line that has with an x–intercept (a) = 3 and y–intercept (b) = 4.

   Here a = 3 and b = 4,

Substitute the values to the formula:

$\frac{x}{a} + \frac{y}{b}$ → $\frac{x}{3} + \frac{y}{4} = 1$

multiply both sides by LCD = 12 → $12\left[\frac{x}{3} + \frac{y}{4}\right] = [1]12$

The equation in standard form → $4x + 3y = 12$.

5. What is the slope of a line that passes through points (0,2) and (7,0)?

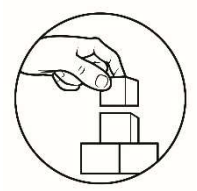
   In this case, a = 7 and b = 2.

   Substitute the values to the formula

   $\frac{x}{a} + \frac{y}{b} = 1$ → $\frac{x}{7} + \frac{y}{2} = 1$

   multiply both sides by LCD = 14 → $14\left[\frac{x}{7} + \frac{y}{2}\right] = [1]14$

   The equation in standard form → $2x + 7y = 14$.

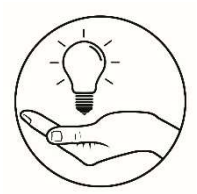


What's More

Activity 1.

Solve for the following examples:

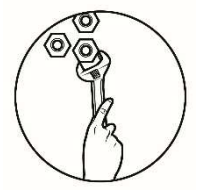
1. What is the equation of a line that passes through points (0,3) and (5,0)?
2. Find the equation of the line with 6 and -3 as its x and y intercepts respectively.
3. Find the equation of the line passing through (0,-8) and (-12,0).
4. Find the equation of the line parallel to $y = 2x + 2$ passing through (0,0).
5. Find the equation of the line perpendicular to $y = 2x$ passing through (2,4).



What I Have Learned

Fill in the blanks with the correct answers.

1. If the slope (m) and y – intercept (b) of a line are given, the equation can be written as _____.
2. If the intercepts of a line are given, the equation is solved using $\frac{x}{a} + \frac{y}{b} = 1$, where a is the _____ and b is the _____.



What I Can Do

Bradley the moose grows by the same measure every year.

At three years old he is 95 cm tall.

At seven years old he is 123 cm tall.

Let h be the height of the moose at age y years.

(a) Find the amount by which the moose is growing each year.

(b) Write down the equation that links h and y.

(c) Use your equation to find the height of the moose at birth, and the height after 20 years.

Assessment

A. Given the x and y intercepts, write the equation of the line in the form ax+by=c.

	x-intercept	y-intercept	Equation of the line
1.	5	6	_____
2.	8	-4	_____
3.	-12	16	_____
4.	1	0	_____
5.	0	-5	_____

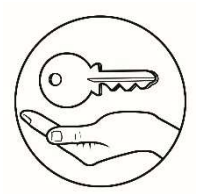
B. Write the equation of the line, given the following:

1. slope of -2 and passing through (0,3)
2. slope of 9 and passing through (0,-4)
3. slope of $\frac{1}{5}$ and passing through (0, $\frac{1}{2}$)
4. slope of 1 and passing through (0,-8)
5. slope of $\frac{-4}{5}$ and passing through (0,$\frac{3}{7}$)

C. Answer the following.

Find the equation of the line.

1. The slope of a line is $\frac{3}{2}$ and its x – intercept is 2.
2. The slope of a line is 5 and it passes through the origin.
3. The line passes through (0,-1) and has a slope equal to 3.
4. The line has an x – intercept of 2 and a y – intercept of 5.
5. What is the equation of the line if the slope = $\frac{-2}{3}$ and y intercept = -4?



Answer Key

What's New

A.

1. $y = -x + 4$
2. $y = \frac{-x}{3} - 1$
3. $y = \frac{-4x}{3} - 4$
4. $y = \frac{11x}{6} - 11$
5. $y = \frac{5x}{2} + 20$

B.

1. $y = 4x + 2$
2. $y = 3x - 3$
3. $y = \frac{2x}{3} + \frac{1}{3}$
4. $y = -x + 4$
5. $y = \frac{-x}{5} + 2$

What I Know

1. $y = \frac{5x}{4} + 5$
2. $x = -1$
3. m= 3/5
   x-int is -8/3 , y-int is 8/5
4. $y = \frac{5x}{4} - 15$
5. *parallel*

What's More

1. $y = \frac{-3x}{5} + 3$
2. $y = \frac{-x}{2} + 3$
3. $y = \frac{-2x}{3} - 8$
4. $y = 2x$
5. $y = \frac{-x}{2} + 5$

What I can Do

a) 7cm a year
b) h=7y+74
c) h=214 cm

Assessment

1. $y = \frac{-6x}{5} + 6$
2. $y = \frac{x}{2} - 4$
3. $y = \frac{4x}{3} - 16$
4. $y = 0$
5. $x = 0$

B. 1. $y = -2x + 3$
   2. $y = 9x - 4$
   3. $y = \frac{x}{5} + \frac{1}{2}$
   4. $y = x - 8$
   5. $y = \frac{-4}{5}x + \frac{3}{7}$

C. 1. $y = \frac{3}{2}x - 3$
   2. $y = 5x$
   3. $y = 3x - 1$
   4. $y = \frac{-5}{2}x$-5
   5. $y = \frac{-2}{3}x - 4$

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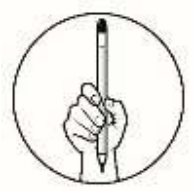


What I Know

This part includes an activity that aims to check what you already know about the lesson you are about to take.

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Leo swims at a constant rate of fifty meters per minute. If he will swim in an Olympic sized pool, how many laps will he make in 10 minutes? Note: the length of an Olympic sized pool is 50m and one lap is also 50m.

   a. 6 laps
   b. 8 laps
   c. 10 laps
   d. 12 laps

2. Two cars start simultaneously from the same place and are moving in opposite directions. Car A travels West and car B travels East. After two and a half hours the cars are 350 kilometers apart. An hour later the gap between the cars are already 490 kilometers. Assuming that both cars are travelling at a constant speed and no detours or stops were made, how long have they travelled if they are 700 kilometers apart?

   a. 3 hours and 30 minutes
   b. 4 hours
   c. 4 hours and 30 minutes
   d. 5 hours

3. Two cars are running towards each other in a straight line 100 kilometers apart. It is observed that in fifteen minutes the distance between them is 70 kilometers, in forty minutes the cars are only 20 kilometers apart. Assuming that both cars are travelling at a constant speed and no detours or stops were made, how long before they meet?

   a. 40 minutes
   b. 45 minutes
   c. 50 minutes
   d. 55 minutes

4. A car traveling at 56 mph overtakes a cyclist who, traveling at 14 mph, had a 1.5-hour head start. How far from the starting point does the car overtake the cyclist?

   a. 22 miles from the start
   b. 24 miles from the start
   c. 26 miles from the start
   d. 28 miles from the start

5. An old recipe book requires 16.907 ounces of milk, but your measuring cup is in liters, so you searched Google for the conversion formula. In a site, it states that 1 ounce = 0.0296 liter. Knowing that, how many liters of milk do you need?

a. 0.4 liters of milk
b. 0.5 liters of milk
c. 0.6 liters of milk
d. 0.7 liters of milk

Lesson 3 Problem Solving Involving Linear Equations

What's In

To help you understand the lessons in this module more easily, try answering the questions below first. This will guide you to identify which among the previous lessons are those that you have mastered, and which need further review. Read, understand, and follow the instructions below.

Choose the letter of the correct answer. Write the chosen letter on a separate sheet of paper.

1. In the equation $y = -\frac{3}{2}x + 5$, what is the value of y when $x = 4$?
   a. $y = -1$
   b. $y = 1$
   c. $y = -29$
   d. $y = -19$
2. In the equation $y = \frac{1}{3}x - 5$, what is the value of x when $y = \frac{1}{2}$?
   a. $x = 16$
   b. $x = -16$
   c. $x = \frac{33}{2}$
   d. $x = -\frac{33}{2}$
3. In the equation $y = \frac{3}{4}x - \frac{1}{2}$, what is the value of x when $y = \frac{1}{2}$?
   a. $x = \frac{3}{4}$
   b. $x = \frac{4}{3}$
   c. $x = -\frac{4}{3}$
   d. $x = 0$

Juan earns his *baon* by helping his mother pack cooked popcorn for resale. His mother gives him fifty centavos for every bag of popcorn he packs. How many bags of popcorn must he pack so that he can have a *baon* of at least twenty pesos?

4. In the given problem, which variable is dependent?

   a. The number of popcorn bags Juan packed is dependent on his *baon*.

   b. Juan's *baon* is dependent on his mother's love.

   c. The number of popcorn bags Juan will pack is dependent on his speed.

   d. Juan's *baon* is dependent on the number of popcorn bags he packed.

5. In the given problem, which variable is independent?

   a. The number of popcorn bags Juan packed is independent of his *baon*.

   b. Juan's *baon* is independent of his mother's love.

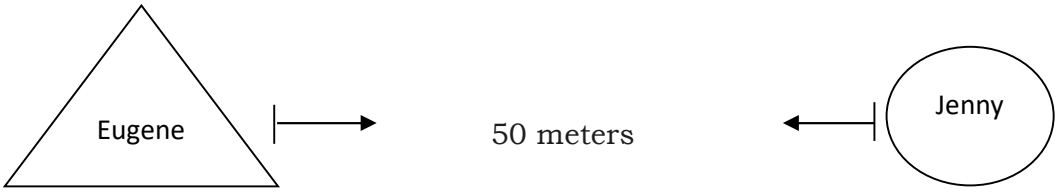
   c. The number of bags Juan will pack is independent of his speed.

   d. Juan's *baon* is independent of the number of popcorn bags he packed.

What's New

Eugene was engaged in reading his favorite Manga while going to his next class. Unknowingly, Jenny who is 50 meters away coming from the opposite direction, is also reading her report for her next class.

If the distance between them is gradually getting smaller by one meter per second, how long will it take before they bump into each other?



What is It

The problem involving Eugene and Jenny is an example of a motion-related problem involving linear equations. Motion-related problems are problems that make use of the formula $d = ax + b$, where d is the distance, a is the constant speed or the constant rate the object is moving per unit time and x pertains to the time the object has moved and b pertains to the initial distance if there is one. Incidentally, it looks very similar to the slope-intercept form of the linear equation: $y = mx + b$…almost all, if not all, word problems involving linear equation is of this form.

Let us break down the steps needed to solve motion-related problems involving linear equations in two variables.

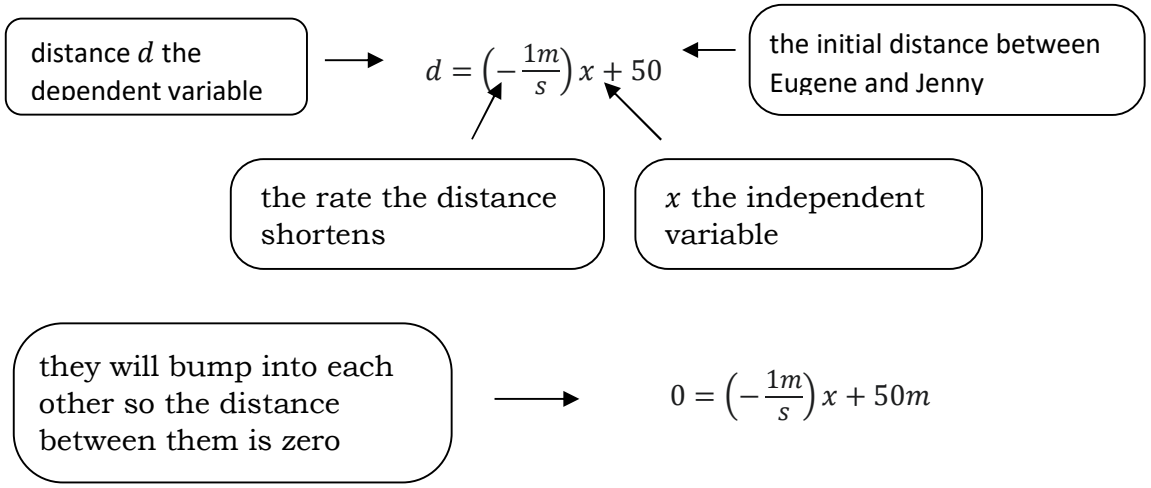
1. Read, understand, and analyze the problem. Illustrate to visualize the problem better.
2. Determine the dependent and independent variables in the problem.
3. Set the dependent variable to be d, and the independent variable to be x .
4. Compute for the slope and set that as a or the rate the object/s is/are moving.
5. If needed, compute for the initial distance or b .
6. Solve the problem.

Let's look back at our problem:

Eugene was engaged in reading his favorite Manga while going to his 5th class. Unknowingly, Jenny who is 50 meters away coming from the opposite direction is also reading her report for her next class. If the distance between them is gradually getting smaller by one meter per second, how long will it take before they bump into each other?

In this case the distance between Eugene and Jenny is dependent on the time they are walking. The distance between them shortens by one meter per second thus a is $-\frac{1\,meter}{second}$ or $-\frac{1m}{s}$. Initially they are 50 meters apart thus b is 50 meters. They will bump into each other if the distance between them is zero.

Let's put all what we have gathered into one equation:



Now let us solve the equation for x or the time needed for them to bump into each other

- Subtract 50m to both side of the equation.

$$0 - 50m = \left(-\frac{1m}{s}\right)x + 50m - 50\text{m}$$

- Simplify both sides of the equation.

$$-50m = \left(-\frac{1m}{s}\right)x$$

- Divide both sides by the coefficient of x .

$$\frac{-50m}{\left(-\frac{1m}{s}\right)} = \frac{\left(-\frac{1m}{s}\right)x}{\left(-\frac{1m}{s}\right)}$$

- Simplify both sides of the equation.

$$50s = x$$

What's More

Now it's your turn to try solving motion-related problems on your own to solidify your understanding and skills of the topic. You may check the answers to the exercises using the Answer Key at the end of the module.

I. Alfred rode a bicycle to a repair shop and then walked home. His speed is 14 kph riding to the shop and 3.5 kph walking home. The round trip took an hour. How far is it from the student's home to the repair shop? (Hint: if the time going to the repair shop is represented by t, then the time coming home is represented by $1 - t$).

1. What is the working equation for the problem?

a. $14t = 3.5(1 - t)$
b. $14(1 - t) = 3.5t$
c. $14 = 3.5(1 - t)$
d. $14t = 3.5$

2. How long did Alfred ride his bike while going to the repair shop?

a. 8 minutes
b. 30 minutes
c. 12 minutes
d. 48minutes

3. How long did Alfred walk from the repair shop back to his home?

a. 8 minutes
b. 30 minutes
c. 12 minutes
d. 48minutes

4. How far is the repair shop from Alfred's home?

a. 2.4 kilometers
b. 2.6 kilometers
c. 2.8 kilometers
d. 3kilometers

II. Vincent and Dennis start at the same point and drove in opposite ways at exactly 6:00am. At 6:20am their cars are 35 kilometers apart, and at 6:45am their cars are 78.75 kilometers apart. After an hour of traveling, they both reached their destinations.

1. What will be the working formula in determining their distance from each other after a given time x, in minutes?

a. $d = 105x$
b. $d = 95x$
c. $d = \frac{4}{7}x$
d. $d = \frac{7}{4}x$

2. How far are Vincent and Dennis from each other when they reached their destinations?

a. 90 km apart
b. 95 km apart
c. 100 km apart
d. 105 km apart

3. Assuming that both cars are traveling at a constant speed and Vincent drives faster by 15 kph, what will be the working equation to determine Dennis and Vincent's speed? Hint: let $a = Dennis' \ speed$ $a + 15 = Vincent's \ speed$ and x be the time in hours

a. $d = (2a + 15)x$
b. $d = (2a^2 + 15)x$
c. $\mathrm{d} = (\mathrm{a}^2 + 15)\mathrm{x}$
d. $\mathrm{d} = 2(\mathrm{a} + 15)\mathrm{x}$

4. What will be Dennis' driving speed?

a. 30 kph
b. 45 kph
c. 60 kph
d. 75 kph

What Have I Learned

So far. you have learned about different kinds of problems involving linear equations in two variables.

Fill in the blanks. Write the appropriate word, phrases, mathematical expressions, or mathematical equations to process what you have learned in the lesson.

1. The equation $d = ax$ is the basic equation in our lesson about distance, speed, and time, where d represents _____, a represents _____ and x represents _____.

2. The distance, d, is always dependent on _____.

3. _____ is the independent variable in distance, speed, and time problems.

4. In solving distance, speed, and time problems; you must always remember that _____ is always a constant.

5. If two objects come from two different locations and travel towards each other, the distance between them _____ as time goes by and when the objects meet or collide into each other, the distance between them is _____.

6. For a round trip, the distance going to a designated place is _____ to the distance coming back.

7. You are traveling at 60kph and you need to get to your work in 30 minutes before you will be marked late and get a deduction. If you got in your office in 25 minutes, your workplace must be _____ kilometers away from your home.

For numbers 8 and 9, refer to the following problem:

The distance between two towns is 380 km. At the same moment, a passenger car and a truck start moving towards each other from different towns. They meet 4 hours later. If the car drives 5 kph faster than the truck, what are their speeds in kilometers per hour?

8. The working equation for the problem is _____.

9. The truck is traveling at a constant speed of _____.

Assessment

This is a task which aims to evaluate your level of mastery in achieving the learning competency. On a separate answer sheet, write the letter of the best answer.

1. Two cyclists leave their homes 12 km apart at 6:00 am the same time and travel towards each other. If each cyclist travels at a constant speed of 15kph (kph = kilometers per hour), at what time will they meet?

   a. $6{:}24am$
   b. $6{:}30am$
   c. $6{:}36am$
   d. $6{:}42am$

2. Two trains start from the same station at the same time, train A is going north bound while train B is going south bound. After 5 minutes the trains are 10km apart, in 15 minutes they are 30km apart. How many minutes will it take for the trains to be 50km apart?

   a. 22 minutes
   b. 25 minutes
   c. 28 minutes
   d. 31 minutes

3. A long-distance runner started a course running at an average speed of 6 mph. One and one-half hours later, a cyclist traveled the same course at an average speed of 12mph. How long after the runner started did the cyclist overtake the runner?

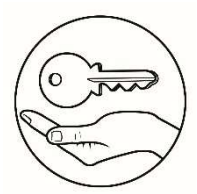
a. 1.5 hours
b. 3 hours
c. 4.5 hours
d. 6 hours

4. A high school volleyball team traveled to a game in a jeep at a speed of 30 miles per hour. Half an hour later after the volleyball team set off, the chess team left the school in a grab car, traveling in the same direction at 45 miles per hour. How long did it take the chess team to catch up with the volleyball team?

a. 0.5 hours
b. 0.75 hours
c. 1 hour
d. 1.5 hours

5. Layla and Mia drove along the same road but in opposite directions. Layla left her house at 8:00am, traveling westbound at 59 mph. Mia left her house at the same time, traveling eastbound at 56 mph. Layla and Mia were 575 miles apart when they started driving. At what time did they pass each other?

a. 11:30am
b. 12:00nn
c. 12:30pm
d. 1:00pm



Answer Key

What's More

I	II
1. A	1. D
2. C	2. D
3. D	3. A
4. C	4. B

What's In

1. A
2. C
3. B
4. D
5. A

What I Know

1. C
2. D
3. C
4. D
5. B

Assessment

1. A
2. B
3. B
4. C
5. D

What Have I Learned

1. distance
   speed
   time
2. x, time
3. Time
4. speed
5. decreases
   zero
6. equal / the same
7. 25
8. $d = (2a + 5)x$
9. 45 kph

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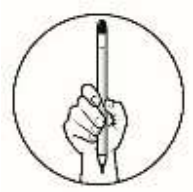


What I Know

1. A tutor charges a fixed amount per hour for his services plus an additional one hundred pesos to pay for his gas. A client paid him one thousand one hundred fifty pesos for a three-hour long tutorial. Another client paid him one thousand five hundred pesos for a four-hour tutorial. You hired him for an hour of tutorial, how much should you pay him?

   a. 400 pesos
   b. 450 pesos
   c. 500 pesos
   d. 550 pesos

2. A farmer earns by selling sacks of rice however he has to shell out a fixed amount to cover his expenses for fertilizer. Pedro harvests an average of 180 *cavans* of rice during the dry season in his 1-hectare farm however he expends 9,000 pesos for the fertilizer needed in his farm. Last year Pedro harvested 190 *cavans* of rice and earned 276,000 pesos. This year he harvested 170 *cavans* of rice and earned 246,000 pesos. Assuming that the price per sack of rice is fixed, how much will he earn if he can harvest 200 *cavans* of rice?

   a. 289,000 pesos
   b. 291,000 pesos
   c. 293,000 pesos
   d. 295,000 pesos

3. Jose a cabinet maker is estimating the cost for furniture he will make for a client. His cost estimate depends on the number of ¾" plywood he uses plus one thousand five hundred pesos for finishing. He gives an estimate of 4,890 pesos for furniture that will use 3 pieces of plywood; on the other hand he gives an estimate of 7,150 pesos for furniture that will use 5 pieces of plywood. You supposed that the furniture you want will need 4 pieces of plywood, how much do you think will Jose charge you?

   a. 6,020 pesos
   b. 6,420 pesos
   c. 6,820 pesos
   d. 7,220 pesos

4. In business the simplest formula to use to compute for the total cost is $C = mx + b$, where ***m*** represents the cost of each item to produce or to acquire and ***b*** represents the fixed costs to run or operate the business. Consider a small bakery that sells pandesal has a daily fixed cost of one thousand pesos and each *pandesal* costs 2 pesos to make. How many *pandesals* can you make if your budget for a day is three thousand pesos?

   a. 900 pieces of pandesal
   b. 1,000 pieces of pandesal
   c. 1,100 pieces of pandesal
   d. 1,200 pieces of pandesal

5. In business the simplest way to compute for your gain/profit is to compute for your revenue minus your expenses. Which is given by the formula: $P = ax - bx$, where $\boldsymbol{a}$ is the price per item sold, $\boldsymbol{x}$ is the number of items sold and $\boldsymbol{b}$ is the cost per item to make. Suppose you sold fifty pieces of *empanada* that sells for fifteen pesos each, if each *empanada* costs seven pesos to make, how much did you gain?

a. 350 pesos
b. 400 pesos
c. 450 pesos
d. 500 pesos

Lesson 4 Problem Solving Involving Constant Rate Problems

What's New

Read this short story first.

Eugene: Hi Jenny!

Jenny: Hi Eugene. Why are you in a hurry?

Eugene: I need to catch the 5 o'clock bus so I can go home early. I always help in our bakery after classes.

Jenny: Oh I see, lucky me. Our house is just a few blocks away.

Eugene: Lucky you! It's nice meeting you again…

Eugene was able to catch up to Jenny after some time, although he is hurrying, not because he wants to meet Jenny again but because he wants to go home early and help in their small bakery. Upon entering the house, Eugene saw his mother in deep thought.

Eugene: What's up mommy? You look like you're in deep thought.

Mommy: The price of flour and milk has gone up. Fortunately, we are not renting, so our overhead remains the same.

Eugene: Is it that bad?

Mommy: I'll give you an example. Each *pandesal* now costs 2.50 pesos to make, and our daily expenses amount to 1000 pesos per day.

If Eugene's bakery sells an average of 1500 pieces of *pandesal* per day at 5 pesos each, how much profit do they gain in a day?

What is It

In the previous lesson you have learned that linear equations can be used in distance, rate, and time problems. Actually, linear equations can be used in a variety of problems, be it in science, in business or in day to day activities like converting English measurement to metric measurement.

The main thing you have to look for if a problem or a situation can be solved using linear equations is that the rate of change is constant. Like in the previous lesson, the object moves in a constant speed. In Eugene's bakery problem, the cost of making per piece of *pandesal* does not change, so it is also solvable using linear equations.

Notes to the Teacher

Let us break down the steps needed to solve motion-related problems involving linear equations in two variables.

1. Read, understand, and analyze the problem. Illustrate to better visualize the problem.
2. Determine the dependent and independent variables in the problem.
3. Set the dependent variable to be y, and the independent variable to be x .
4. Compute for the slope and set that as the rate the dependent variable is changing, with respect to the independent variable.

Let's get back to the problem:

If Eugene's bakery sells an average of 1500 pieces of *pandesal* per day, how much profit do they gain in a day?

How would we compute for the profit? The simplest way of computing for the profit is to subtract the total costs from the revenue.

P = R – C where: P is the profit. In Filipino it is called "*tubo*".

R is the revenue. In Filipino it is called "*kabuuang benta*".

C is the total cost. In Filipino it is called "*kabuuang gastos*".

It doesn't look linear to me, you might say. But believe me, it is a linear equation. Wait up a bit, it's still not complete.

R = (price per item)·(number of items sold)

C = (cost per item to make)·(number of items sold) + overhead

If we assign certain variables to represent certain amounts:

a = price per item x = number of items

b = cost per item c = overhead

Let's finalize our equation for profit:

$$P = ax - (bx + c)$$

If we combine similar terms:

$$P = (a - b)x - c$$

There, you now have a linear equation you are familiar with.

Using the formula to find the daily profit of Eugene's bakery:

$$P = (a - b)x - c$$

$$P = (5 - 2.5)1500 - 1000$$

$$P = (2.5)1500 - 1000$$

$$P = 3750 - 1000$$

$$P = 2750$$

Thus, Eugene's bakery gains a daily profit of 2750 pesos.

What's More

Now it's your turn to try solving problems involving linear equations on your own, to solidify your understanding and skills of the topic. You may check the answers to the exercises using the Answer Key at the end of the module.

1. A jogger running at 9 mph burns approximately 14 Calories per minute.

   a. Write a linear equation for the number of Calories ***C*** burned by the jogger in terms of the number of ***m*** minutes run.
   b. Use your equation to find the number of Calories that the jogger has burned after jogging for 32 minutes.

2. A building contractor estimates that the cost to build a home is 750,000 pesos plus 23,000 pesos for each square meter of floor space in the house.

   a. Determine a linear equation that will give the cost ***C*** of building a house that contains a given number of square meters ***x***.
   b. Use this equation to determine the cost to build a house that contains 76 square meters of floor space.

3. The tank of a certain car contains 61 liters of gasoline. Every time there is a trip the owner fills the car full. Each kilometer driven by the owner decreases the amount of gas in the tank by 0.095 liters.

   a. Write a linear equation for the number of liters ***L*** of gas in the tank in terms of the number of kilometers ***x*** driven.
   b. Use your equation to find the number of liters in the tank after 200 kilometers are driven.

4. In the Fahrenheit scale water freezes at 32°F and boils at 212°F. While in the Celsius temperature scale, water freezes at 0°C and boils at 100°C.

   a. Determine a linear equation that can be used to predict the Celsius temperature when the Fahrenheit temperature is known.
   b. If the temperature is 95°F, what is it in °C?

What Have I Learned

For numbers 1 to 3, refer to the following problem:

In Eugene's bakery, they sell each *pandesal* at 5 pesos per piece, however it costs them 2.50 pesos to make. If their overhead is 1000 pesos per day, what is their break-even point?

1. Break-even is a term used in business it is the point where you don't gain but you also don't lose money either. In other words, the revenue is equal to the total cost. The working equation for this problem is _____.

2. The break-even point in Eugene's bakery is _____ pieces of *pandesal*.

3. If the bakery operates an average of 25 days in a month, then they should sell _____ pieces of *pandesal* per day to have a total of at least 40,000 pesos in total profit per month.

For numbers 4 to 6, refer to the following:

One of the most significant changes that occur in high altitude areas concerning cooking is the boiling point of water. As the altitude increases, the atmospheric pressure pushing down on water decreases, which allows the water to boil at lower temperatures.

Boiling Point of Water at Different Altitudes

Height	Boiling Point
At sea level or 0 meters	100℃
305 meters	99℃
610 meters	98℃

4. In the phenomenon above, _____ is the dependent variable.

5. The working equation needed to determine the boiling point $\boldsymbol{T}$ of water at a specified height $\boldsymbol{h}$ is given by _____.

6. In Baguio City, located around 1400 meters above sea level, the boiling point of water is _____.

What I Can Do

In this activity, write 3 instances where you have experienced actual situations or problems involving linear equations. You must be able to state how you applied what you have learned to solve the problem/s or to overcome the situation.

Assessment

For numbers 1 to 3 refer to the occurrence below:

According to science, the ambient temperature varies with height. The ground temperature is 33℃ and the ambient temperature in Tagaytay, situated at a height of 639 meters, is 29℃.

1. Assuming that the relationship between the temperature and height is linear, express the temperature $\boldsymbol{T}$ (in ℃) in terms of the height $\boldsymbol{h}$ (in meters). Hint: ground temperature is at 0 meters elevation.

   a. $T = -\frac{4}{639}h + 33$
   b. $T = \frac{4}{639}h$
   c. $T = \frac{4}{639}h + 33$
   d. $T = -\frac{4}{639}h - 33$

2. Baguio, situated at 1400 meters above sea level, is known as the Summer Capital of the Philippines due to its cool temperature. However, Sagada in the Mountain Province boasts of a much cooler temperature due to its height of 1522.3 meters above sea level. How much cooler is the ambient temperature in Sagada compared to Baguio?

   a. It is cooler by 0.80℃
   b. It is cooler by 0.77℃
   c. It is cooler by 0.74℃
   d. It is cooler by 0.71℃

3. Strawberries grow ideally at 60°F – 80°F. In the Philippines it is ideally grown in La Trinidad in Benguet, which is situated at 1318 meters above sea level, because of its _____ temperature.

   a. 75.45°F
   b. 76°F
   c. 76.55°F
   d. 77.10°F

For numbers 4 to 6 refer to the situation below:

A small company buys computer equipment for 200,000 pesos. After 2 years the value of the computer equipment is expected to be 120,000 pesos. For accounting purposes, the business uses linear depreciation to assess the value of the computer equipment at a given time.

Straight line depreciation or linear depreciation is a common method of depreciation in business where the value of a fixed asset, like building and equipment, is reduced constantly over time.

4. What linear equation can be used to assess the value $\boldsymbol{V}$ of the equipment given a time $\boldsymbol{t}$ in years after it is bought?

   a. $V = -40{,}000t + 200{,}000$
   b. $V = \ 40{,}000t + 200{,}000$
   c. $V = -40{,}000t - 200{,}000$
   d. $V = \ 40{,}000t - 200{,}000$

5. What will be the value of the computer equipment 4 years after it was bought?

   a. P 40,000
   b. P 50,000
   c. P 60,000
   d. P 70,000

6. When will the company buy a new set of computer equipment? Hint: the company will buy a new set if the value of the equipment is zero.

   a. 8 years after it is bought
   b. 7 years after it is bought
   c. 6 years after it is bought
   d. 5 years after it is bought

For numbers 7 to 10 refer to the conversation below:

Jenny: Hi Eugene, are you familiar with the following units of measurement?

9 ounces of cake flour

1/8 pints of sour cream

10 tablespoons of butter

Eugene: What are you up to? Specifically, what are you baking?

Jenny: I saw an old recipe book of *Lola* and I want to try the banana cake

Eugene: I'll give you a hint so as not to spoil your fun.

4.5 ounces = 1 cup
1 pint = 2 cups
I know you are already familiar with tablespoons

Jenny: I am familiar with tablespoons, but I don't want to melt all the butter to get 10 tablespoons of butter

Eugene: I see…16 tbsp = 1 cup, by the way 1 bar of butter = 1 cup of butter

Jenny: Thanks for your help…I'll give you a piece when I'm done.

Eugene: I'll look forward to it. Before I forget, you should bake that in 375°F for 30 minutes or until a toothpick comes out clean when you stick it in the middle.

Jenny: I'll take note of that. Thanks again!

7. How many cups of cake flour does Jenny need?

   a. 1.5 cups
   b. 2 cups
   c. 2.5 cups
   d. 3 cups

8. How many cups of sour cream does Jenny need?

   a. 1 cup
   b. 1/2 cup
   c. 1/4 cup
   d. 1/8 cup

9. What fraction of a bar of butter does Jenny need?

   a. 5/8
   b. 1/2
   c. 3/8
   d. 1/4

10. At what temperature in ℃ does Jenny need to set the oven to bake the banana cake?

    a. 188.89℃
    b. 189.44℃
    c. 190℃
    d. 190.56℃

Assessment

1. A
2. B
3. C
4. A
5. A
6. D
7. B
8. C
9. A
10. D

What I Can Do

Answers may vary since answers are dependent on the individual experiences of the students

What I Know

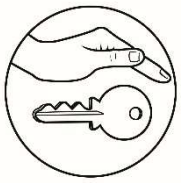
1. B
2. B
3. A
4. B
5. B

What's More

1. a. $C = 14m$
   b. 448 calories
2. a. $C = 23{,}000x + 750000$
3. a. $C = -0.095x + 61$
   b. 42 L
4. a. $C = \frac{5}{9}(F - 32)$
   b. 35℃

What Have I Learned

1. $5x = 2.5x + 1000$
2. 400
3. 1040
4. boiling point of water
5. $T = -\frac{1}{305}h + 100$
6. 95.41℃



Answer Key

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