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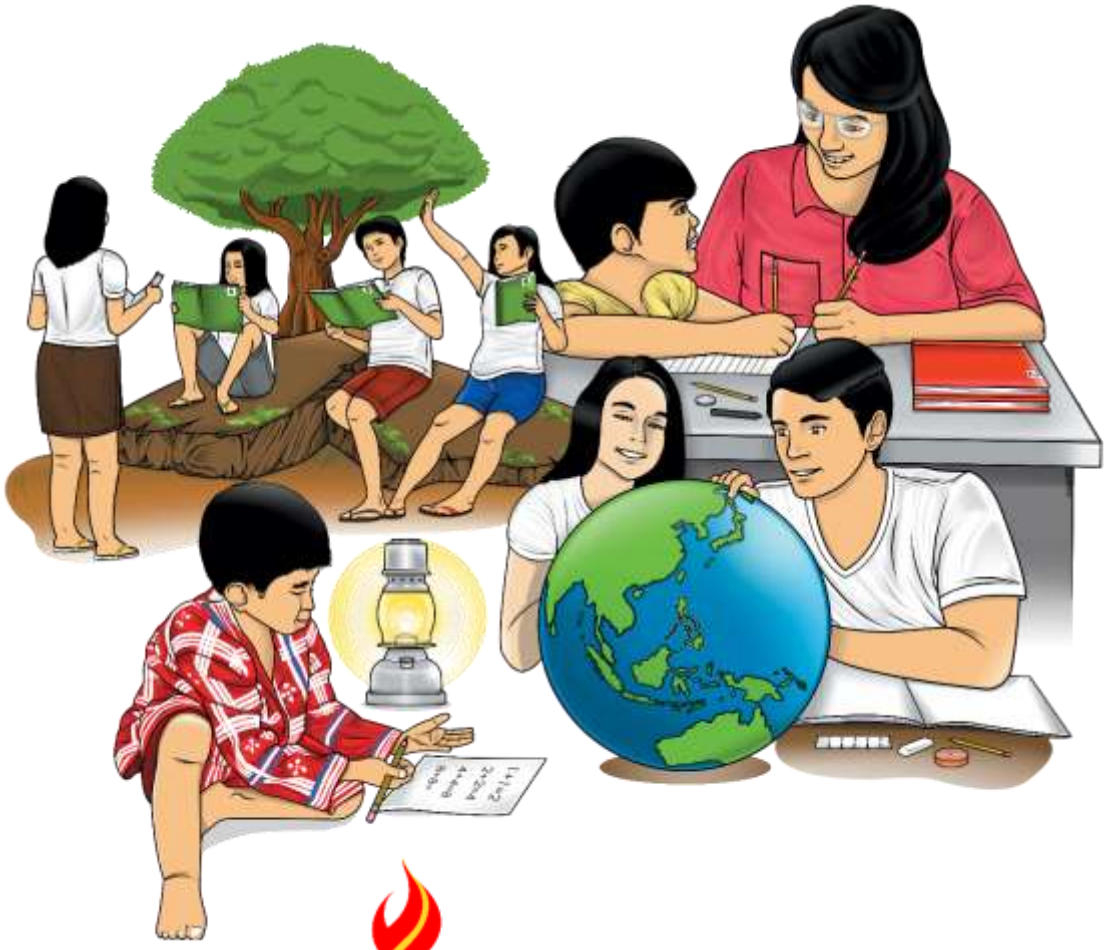
Science

Quarter 3 - Module 2
Motion in Graphs and Dots



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Development Team of the Module

Writers:	Elvina L. Taran, Myrna V. Deniega
Editors:	Cynthia S. Bustillo, Miraflor O. Albios, Lenie G. Forro, Rian S. Linao
Reviewers:	Mary Joy D. Bautista, Agabai S. Kandalayang, Marivic D. Devibar, Maria Jane N. Agrave
Layout Artist:	Glen D. Napoles, Analyn J. Madera, and Allan T. Basubas, Christian Mark A. Julian
Management Team:	Allan G. Farnazo
	Isagani S. Dela Cruz
	Gilbert B. Barrera
	Arturo D. Tingson, Jr.
	Peter Van C. Ang-ug
	Elpidio B. Daquipil
	Juvy B. Nitura
	Lenie G. Forro

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Office Address: Regional Center, Brgy. Carpenter Hill, City of Koronadal
Telefax: (083) 2281893
E-mail Address: region12@deped.gov.ph

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Quarter 3 – Module 2
Motion in Graphs and Dots

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

What I Need to Know

When you walk to the store near your house to buy your favorite snack, there is motion. When a car passes by your house, that car is in motion. Basically, motion is the change in position over an interval of time. The motion of an object can be described in many ways through its position, how far it has travelled, or how fast it is moving. The equations you have learned in the previous lesson are great ways to mathematically describe the different concepts of motion.

Similarly, using mathematical pictures like motion graphs and tape charts are also effective tools in representing the motion of objects. By simply analyzing visual representations like diagrams, graphs, and charts you will know if an object is in motion or not, whether it is moving with constant speed, or changing in speed or not. In this module, you will learn how to create and interpret the motion of objects through tape charts and graphs.

Most Essential Learning Competency:

- Create and interpret visual representation of the motion of objects such as tape charts and motion graphs **(S7FE-IIIb-3)**.

This module is divided into two lessons:

- Lesson 1- Motion Graphs
- Lesson 2 – Ticker Tape Diagrams

After going through this module, you are expected to:

1. describe the motion of objects in relation to the slope of the line on a distance-time graph and speed-time graph;
2. create motion graphs to represent the motion of objects;
3. describe the motion of objects by interpreting ticker tape diagrams; and
4. create ticker tape diagrams to represent the motion of objects.

What I Know

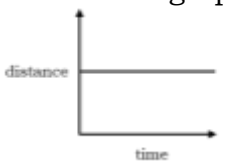
Directions: Read the following questions carefully. Choose and write the letter of the correct answer on a separate sheet of paper.

1. What does the vertical axis represent on a position-time graph?
   A. Speed of the object
   B. Position of the object
   C. Velocity of the object
   D. Total time travelled by the object

2. What do you call a graph that is plotted in terms of the distance travelled by the object and the time it took to cover that distance?
   A. Speed-time graph
   B. Position-time graph
   C. Distance-time graph
   D. Displacement-time graph

3. Which is TRUE about displacement?
   A. How fast an object is moving
   B. Change in position in a given time
   C. Length of the entire path that an object travelled
   D. Shortest distance between the object's two positions

4. What does a horizontal line in the distance-time graph indicate?
   A. No movement
   B. Constant speed
   C. Object is accelerating
   D. Object is decelerating

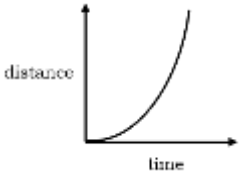


5. When looking at a displacement-time graph, what variable should be plotted on the y-axis and x-axis?
   A. Y-axis: Time; X-axis: Distance
   B. X-axis: Time; Y-axis: Distance
   C. X-axis: Time; Y-axis: Displacement
   D. Y-axis: Time; X-axis: Displacement

6. Which of the following illustrates acceleration?
   A. Constant velocity
   B. Changing direction
   C. The direction does not change
   D. The speed and direction remains the same

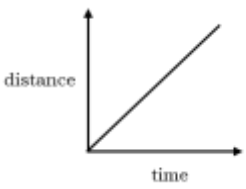
7. The following are correctly matched, **EXCEPT**
   A. Speed: Scalar
   B. Velocity: Vector
   C. Distance: Scalar
   D. Displacement: Scalar

8. What does a line on a graph that is curving upwards mean in a distance-time graph?
   A. The object is not moving.
   B. The object has a constant speed.
   C. The speed of the object is increasing.
   D. The speed of the object is decreasing.

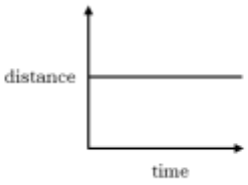


9. The following units can be used to mathematically express speed, **EXCEPT**
   A. m
   B. m/s
   C. km/hr
   D. miles/hr

10. Ethan is playing with his toy car. While watching him, you observed that the toy car is accelerating. Which of the following graphs show that the toy car is accelerating?



A



B

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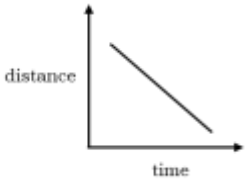
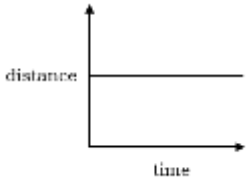


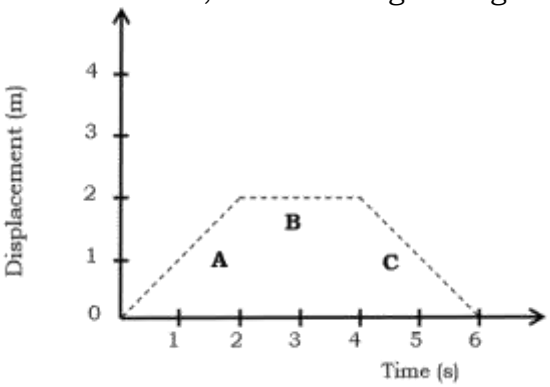
D

11. Examine the given graph. What conclusion can you make from this graph?



   A. The object is stationary.
   B. The object is decelerating.
   C. The object's acceleration is increasing.
   D. The object is moving at a constant speed.

For items 12-13, refer to the given figure below.



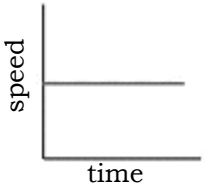
12. What does the **part B** of the displacement-time graph tell us about the object?
   A. The object has a velocity of 2 m/s.
   B. The object is not moving for 2 seconds.
   C. The object travels 2 meters in 2 seconds.
   D. The object travels 2 meters in 2 seconds back~~s~~ to its starting position.

13. What conclusion can you make about the motion of the object after it travels from point A to point C?

I. The object has zero displacement. II. The object returns to its starting position. III. The object moves in constant speed from point A to C. IV. The object accelerates uniformly all throughout its travel.

A. I and II only
B. II and III only
C. I and IV only
D. II, III, and IV only

14. Examine the graph below. Is it correct to say that the straight horizontal line on the speed-time graph means that the object is not moving?



A. Yes, a horizontal line means that the object is at rest or stationary.
B. Yes, a straight line always means that an object is not moving at all.
C. No, a horizontal line indicates that the object has uniform acceleration.
D. No, a horizontal line indicates that the speed is not changing over time.

15. During their science class, Jessa was assigned to discuss about distance-time graphs. In one of her graphs, Jessa shows a graph with a diagonal line that slopes upward to the right. She explained that the graph means that an object is moving at a constant speed. Do you think her explanation is correct?
    A. No, the distance-time graph should show a horizontal straight line going to the right.
    B. No, a diagonal line that slopes upward to the right in a distance-time graph means that the speed is increasing.
    C. Yes, the motion of objects plotted in a distance-time graph has similar interpretation if plotted in a speed-time graph.
    D. Yes, a diagonal line that slopes upward to the right means that distance is increasing constantly with time, thus an object is moving in a steady speed.

Lesson 1 Motion Graphs

What's In

In order to describe the motion of a given object, you need to know its position. When you know the point of reference, you will be able to determine how far the object has travelled, how fast it is moving, and the direction to where it is moving. With the help of visual representations like diagrams, you can easily describe the position of an object. Study the figure below, what is the position of the ball at 15 seconds?

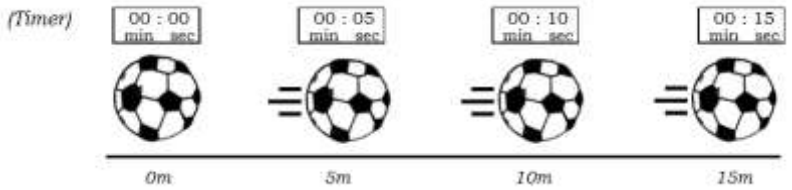


Figure 1. Position of a rolling ball for the same interval time

Aside from diagrams, another way of describing the motion of objects is through the use of motion graphs. Using motion graphs, you will be able to show the change in the object's position over time. You will also know if the object's speed is increasing, decreasing or constant and whether it is moving or not. Do the next activity to learn how to create and interpret motion graphs.

What's New

Directions: Convert the figure of the rolling ball into motion graph. Follow the guide given below. Write your answer on a graphing paper.

1. Make a table similar to Table 1 and fill it out using the data provided in *Figure 1.* Note that the positions of the ball are shown every 5 seconds.

Table 1. Position of the ball vs. time

Time (seconds)	Position of the ball (meters)
0	0

2. Plot the values in Table 1 as points on the graph in your graphing paper. Note that the **time** is plotted on the *x-axis (horizontal line)* while the **position** is plotted on the *y-axis (vertical line).* For example, examine *Figure 2.* Assuming that in 20 seconds, the ball will reach 5 meters, the position-time graph will look like the figure below.

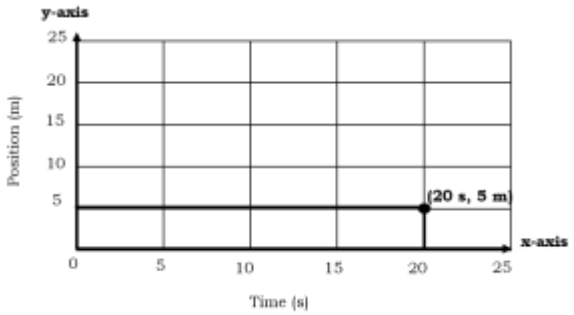


Figure 2. Position vs. Time Graph

3. Draw a straight diagonal line through the points in your graph. This graph is called **position-time graph.** Using this graph, you can describe the position of the ball at any given time. Based on your graph, can you locate the position of the ball at 10 seconds?

What is It

Motion graphs are useful and effective tools in visually presenting the motion of objects. By examining the slope of the graphs, we can obtain meaningful amount of information about the objects' motion. The **slope** is the slant or angle of the line in the graph. The shape of the line on the graph whether straight, curved, or steeply sloped have different interpretations with regards to the motion of the object. In mathematical meaning, the slope of a line is the **rise over the run**, or the **change in y divided by the change in x**. So, if you pick two points on a line, (x_1, y_1) and (x_2, y_2), the slope of the line is calculated by subtracting the value of the y-coordinates ($y_2 - y_1$) and the x-coordinates ($x_2 - x_1$). Then, divide the difference of the y-coordinates by the difference of the x-coordinates. So, the slope of the line is equals to:

$$\text{slope} = \frac{\text{change in y}}{\text{change in x}} = \frac{y_2 - y_1}{x_2 - x_1}$$

The slope of the line reveals useful information about the motion of the object. For instance, in *Figure 3*, when we apply the rise over run, the slope of a horizontal line will always be equal to zero. Since a horizontal line has an unchanging y-value (height does not change), the *rise* is equals to zero no matter what the *run* is. Therefore, the value of the slope is also zero. On one hand, a line that slants up from left to right as shown in *Figure 4* has a constant and positive slope whereas a line that slants down from left to right as shown in *Figure 5* has a constant and negative slope. It should be noted that, a steeper line indicates a larger slope and a less steep line means a smaller slope. In this case, the greater the slope, the steeper the line as shown in *Figure 6.* On the other hand, curve lines indicate a changing slope.

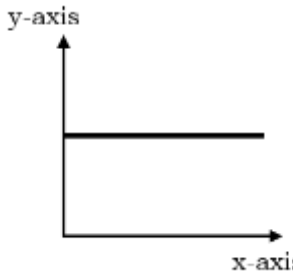


Figure 3. A horizontal line parallel to the x-axis has a slope of zero

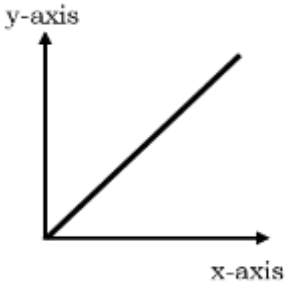


Figure 4. A positive slope where line slants up from left to right

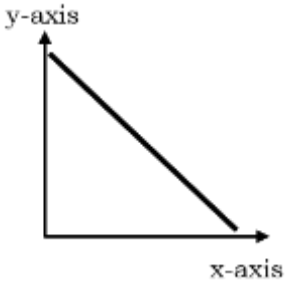


Figure 5. A negative slope where line slants down from left to right

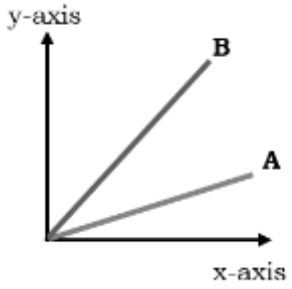


Figure 6. Line B has larger slope than Line A because it is steeper than Line A

Position-time graphs are motion graphs that show a change in an object's location over time. In this type of graph, **time** is always plotted on the *x-axis* and the **position** is plotted on the y-axis. Refer to Figure 7 for the position-time graph.

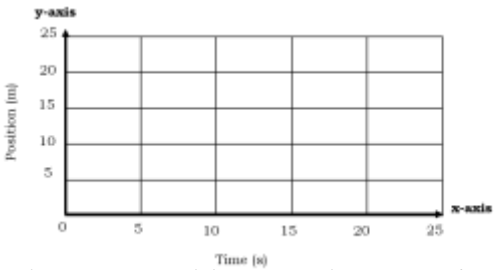


Figure 7. Position vs. Time Graph

When a graph is plotted in terms of the distance travelled by the object and the time it took to cover that distance, the graph can be called **distance-time graph.** On the other hand, if the graph is plotted in terms of displacement and time, it is called **displacement-time graph**.

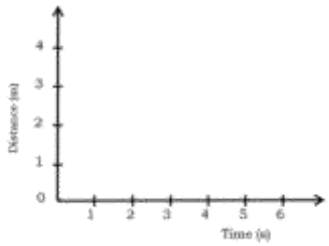


Figure 8. Distance vs. Time Graph

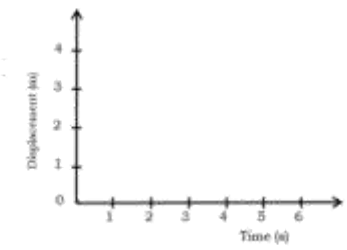
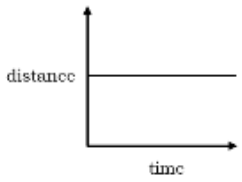


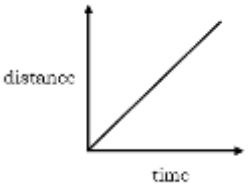
Figure 9. Displacement vs. Time Graph

The distance-time graph can tell us how far an object has moved with respect to time. A displacement-time graph can show us if an object is going backwards or forwards (direction) which cannot be shown on a distance-time graph.

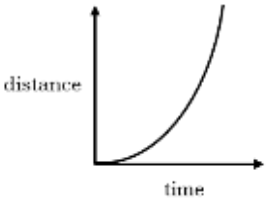
Distance-Time Graphs



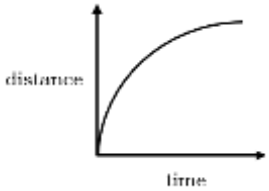
The horizontal straight line in the graph means that the slope is equal to zero indicating that the **object is at rest or not moving**.



The diagonal line that slopes upward to the right shows a constant and positive slope. This indicates that distance is increasing constantly with time. **The object moves at a constant speed**.

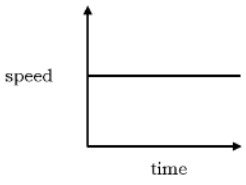


Curved lines indicate that speed is changing. In this graph, the line curving upwards shows that the **object is increasing its speed**. As time passes, the change in distance increases.

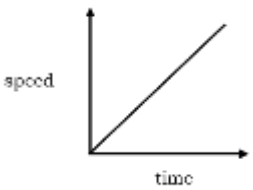


The speed is changing as shown by the slope of the line. In this graph, the line curving downwards shows that **the object is decreasing its speed**. The change in distance decreases as time passes.

Speed-Time Graphs

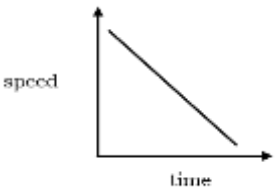


The slope of the graph is equal to zero but this does not mean that the object is not moving. The straight horizontal line signifies that **the speed of the object is constant**. It is not changing over time.



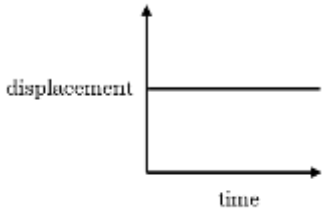
The sloping line shows that the speed of the object is changing. In this graph, the object is **increasing in speed**. The upward slope to the right indicates that the object is speeding up.

A horizontal line along the x-axis in this graph means that **the object is not moving.** As time passes, the object remains stationary.

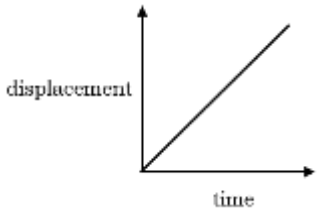


In this graph, the line slopes downward from left to right which shows that the object is **slowing down**.

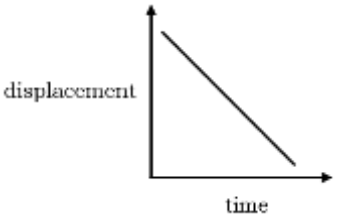
Displacement-Time Graphs



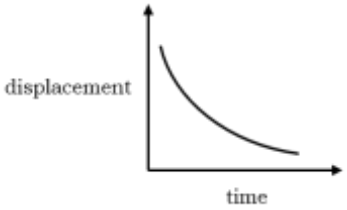
A horizontal line parallel to the x-axis has a slope of zero as shown in the graph and indicates that the **object is not moving**. The object has zero velocity.



A constant positive slope represented by a diagonal line moving upward in the graph means that the object is moving with a **constant velocity**.

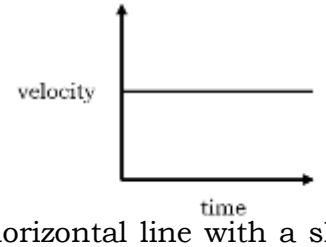


A constant negative slope means that an object is moving with **constant velocity** but in the **reverse direction** of the positive direction.

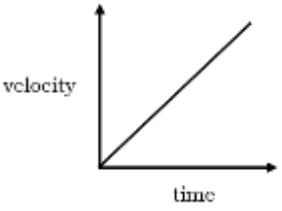


A curved line indicates that the instantaneous **velocity is changing** at every given point in time.

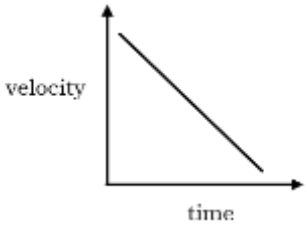
Velocity-Time Graphs



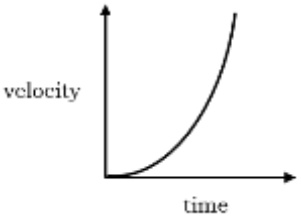
A horizontal line with a slope of zero in the graph indicates that the object is moving with a **constant velocity.** Therefore, the object has **zero acceleration**.



A constant positive slope indicates that the **velocity of an object is increasing** by a constant amount each second. Thus, the object is moving in **constant acceleration.**

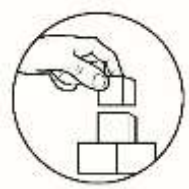


A constant negative slope means that the **velocity of an object is decreasing** by a constant amount each second. This indicates that the object is moving in **constant deceleration**.



A curved line in the graph indicates that the rate of the object's **acceleration is increasing.**

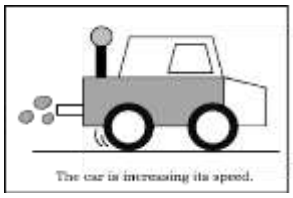
If you recall in our previous lesson, the distance travelled by an object divided by the time it took to do so will give us speed. In this case, the slope of a distance vs. time graph represents the **speed** of the object. On the other hand, the slope of the speed vs. time graph represents the rate of change of speed or the **acceleration** of the object along a straight line. In addition, since displacement divided by time is equals to velocity, the slope of a displacement vs. time graph represents the **velocity** of the object. Finally, the slope of the velocity vs. time graph represents the **acceleration** of the object because change in velocity per unit time is actually acceleration.

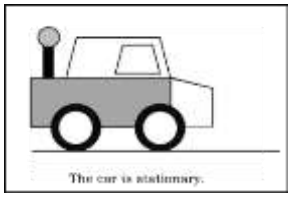


What's More

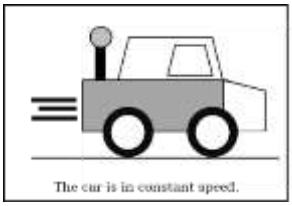
Directions: Match each diagram to the graph that correctly represents its motion. Write your answers on a separate sheet of paper.

Diagrams

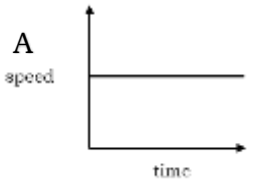
1. 

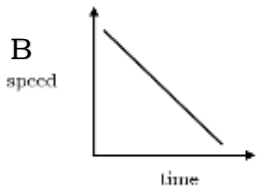
2. 

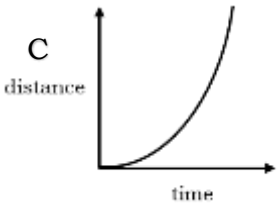
3. 

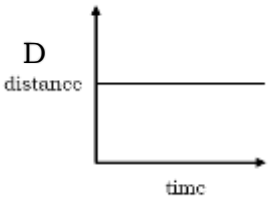
4. 

Motion Graphs









What I Have Learned

Directions: Identify the correct word from the words inside the box to make the paragraph complete. Write your answers on a separate sheet of paper.

Time	Motion graphs	Distance-time	Slope	Not moving
Acceleration	Position	Horizontal	Constant speed	Speed

1. _____ are useful and effective tools in visually presenting the motion of objects. By examining the slope of the graphs, we can obtain meaningful amount of information about the objects' motion. The 2. _____ is the slant or angle of the line in the graph. The shape of the line on the graph whether straight, curved, or steeply sloped have different interpretations with regards to the motion of the object.

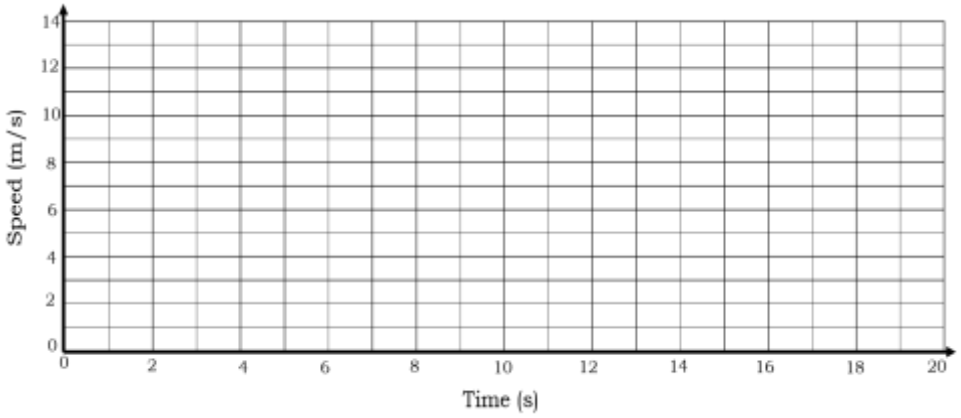
Position-time graphs are motion graphs that show a change in an object's location over time. In this type of graph, 3. _____ is always plotted on the *x-axis* and the 4. _____ is plotted on the y-axis. When a graph is plotted in terms of the distance travelled by the object and the time it took to cover that distance, the graph can be called 5. _____ graph. On the other hand, if the graph is plotted in terms of displacement and time, it is called displacement-time graph.

In a distance-time graph, a horizontal straight line means that the object is at rest or 6. _____. A diagonal line that slopes upward to the right means that the object moves at a 7. _____. The line curving upwards shows that the object is increasing in speed. The line curving downwards shows that the object is decreasing in speed. In a speed-time graph, a straight 8. _____ line above the x-axis means that the speed of the object is constant. The slope of a distance vs. time graph represents the 9. _____ of the object while the slope of the speed vs. time graph represents the 10. _____ of the object along a straight line.

What I Can Do

Directions: Create a speed-time graph that shows how the speed of a vehicle changes throughout its travel. Refer your data on the given scenario below. Plot your answers on a graphing paper.

Assuming that your mother requested you to go to a store to buy essential groceries. To go to the store, you need to ride a public utility vehicle. From rest, the speed of the vehicle changes from 0 to 10 m/s in 5 seconds and moves in a constant speed of 10 m/s for 5 seconds. Then it slows down from 10 m/s to 6 m/s in 3 seconds and eventually travels in a steady speed of 6 m/s in 6 s until it comes to a stop when it reaches the grocery store. How do you think the motion graph will look like? Plot the given values and draw a line through the points in your graph to show the changes in speed of the vehicle.



Graphing Rubric

Criteria	**Excellent** (5 points)	**Fair** (3 points)	**Needs Improvement** (1 point)
Plotting Points	All points are plotted correctly on the graph and match up with the given data.	Most of the points are plotted correctly, however minor errors can be seen on the graph.	The points on the graph do not match up with the data and errors are very evident on the graph.
Line	Points are connected correctly from left to right with no mistakes. Line is straight from point to point.	Some of the points are not connected correctly from left to right. Line is crooked or curved.	Points are connected in random manner. Line is crooked or curved.

Assessment

Directions: Read the following questions carefully. Choose the correct answer from the given choices. Write the letter of your choice on a separate sheet of paper.

1. What does the slope of a distance vs. time graph represent?
   A. Acceleration
   B. Distance
   C. Displacement
   D. Speed

2. Which of the following statements CORRECTLY describes distance?
   A. Change in position over a period of time
   B. The direction to where the object is moving
   C. Length of the entire path that an object travelled
   D. Shortest distance between the object's two positions

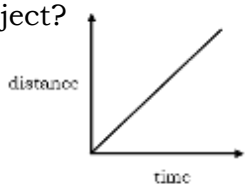
3. A speed-time graph shows a horizontal straight line above the x-axis. What does this indicate?
   A. The object is slowing down.
   B. The speed does not change.
   C. The object is increasing in speed.
   D. There is an increase in the distance travelled.

4. Which of the following is **NOT** correctly matched when plotting on a motion graph?
   A. X-axis: Time; Y-axis: Speed
   B. X-axis: Time; Y-axis: Position
   C. Y-axis: Time; X-axis: Distance
   D. X-axis: Time; Y-axis: Displacement

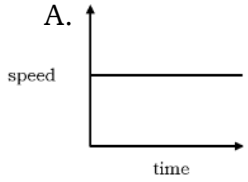
5. The following quantities can tell us both the magnitude and direction of an object, **EXCEPT**
   A. Acceleration
   B. Displacement
   C. Speed
   D. Velocity

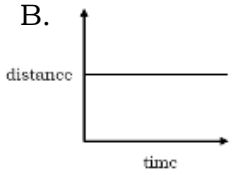
6. What does the slope of a velocity vs. time graph represent?
   A. Acceleration
   B. Distance
   C. Force
   D. Speed

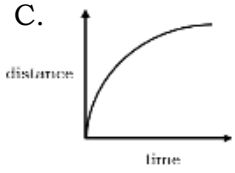
7. A diagonal line that slopes upward to the right is recorded in a distance-time graph below. What does this tell us about the motion of the object?
   A. The object is at rest.
   B. The object is increasing its speed.
   C. The object is decreasing its speed.
   D. The object is moving in a steady speed.

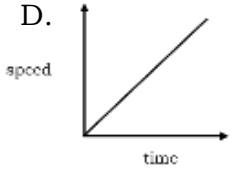


8. Which of the following slope of a line on a graph represents a constant speed?

A. 

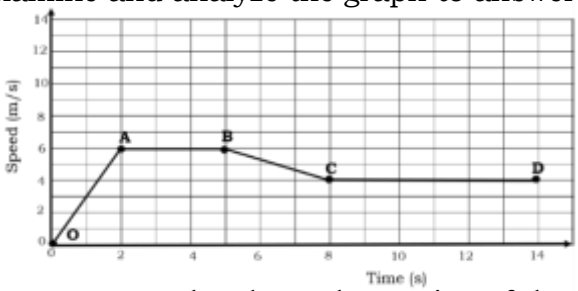
B. 

C. 

D. 

9. Which of the following statements is TRUE about motion graphs?
   A. Time is plotted on the x-axis while position is plotted on the y-axis.
   B. A distance-time graph can tell us the direction to where an object is moving.
   C. In a speed-time graph, a horizontal straight line above the x-axis means that the object is not moving.
   D. In a distance-time graph, a horizontal straight line means that the object is moving on a constant speed.

For items 10-12, a car is travelling down a road. The graph below shows the changes in speed of the car. Examine and analyze the graph to answer the questions that follow.



10. What conclusion can you make about the motion of the car from point O to point A?

I. The car is not moving. II. The car is accelerating. III. The car is moving in a constant speed of 6 m/s. IV. The car increases in speed from 0 to 6 m/s in 2 seconds.

   A. II only
   B. II and IV only
   C. I, II, and III only
   D. I, III, and IV only

11. Which point of the car's journey did it move in a constant speed?

I. Point O-A	II. Point A-B	III. Point B-C	IV. Point C-D

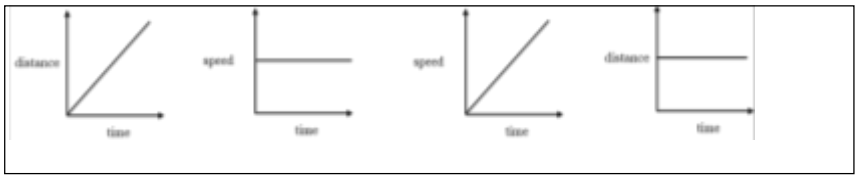
   A. I only
   B. II only
   C. II and III only
   D. II and IV only

12. Which of the following statements CORRECTLY describes the motion of the car?

I. The car is at rest at point A-B and C-D. II. The car is slowing down at point A-O. III. The car increases in speed at point O-A. IV. The car slows down from 6 m/s to 4 m/s at point B-C.

   A. II only
   B. I and III only
   C. II and IV only
   D. I, III, and IV only

13. Which of the following graphs describes uniform speed?

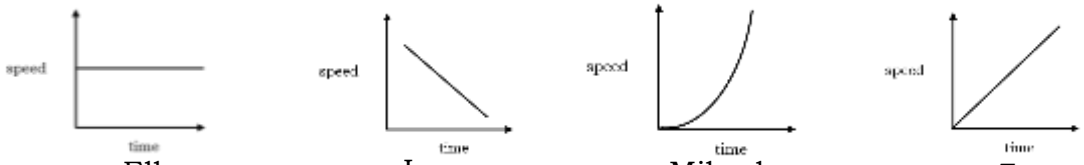


I II III IV

A. I and III only
B. II and IV only
C. I and II only
D. I, II, and IV only

14. Nathan was asked by his teacher to draw a distance-time graph that shows an object is at rest or not moving. He drew a distance-time graph showing a diagonal line that slopes upward to the right. Do you think Nathan is correct?
    A. Yes, a diagonal line that slopes upward indicates that an object not moving.
    B. Yes, a straight line moving upward means that an object is not moving at all.
    C. No, Nathan should draw a distance-time graph with a horizontal straight line.
    D. No, Nathan should draw a distance-time graph with a line curving upwards to the right.

15. Ella, Lance, Mikaela, and Zac were asked by their teacher to draw a speed-time graph showing that an object is moving at a **constant speed**. The following illustrations below show their speed-time graphs. Who do you think among the four students got the correct answer?

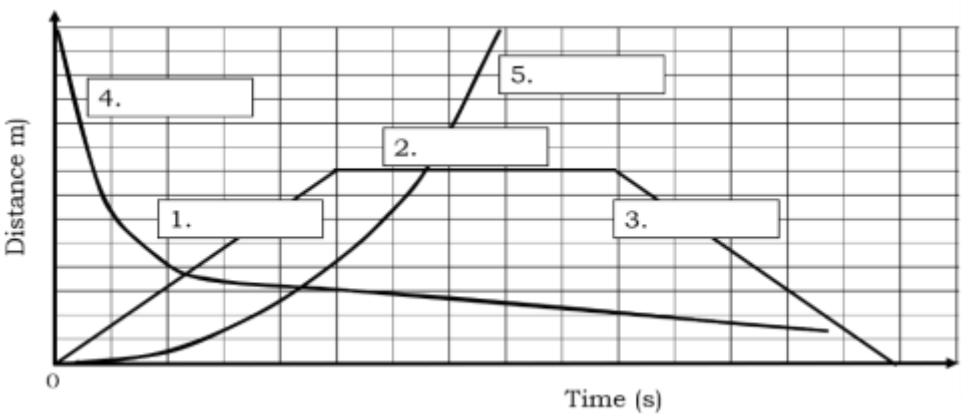


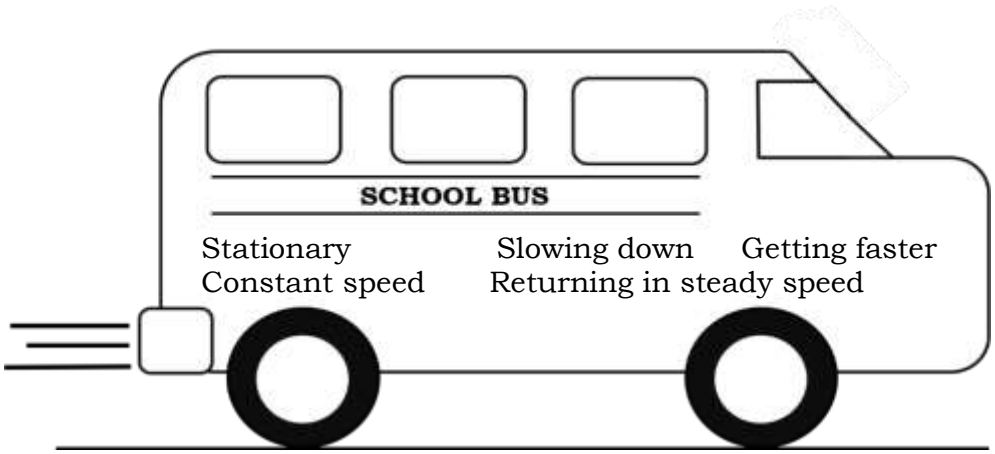
Ella Lance Mikaela Zac

A. Mikaela is correct because a line curving upwards shows a constant speed.
B. Ella is correct because a straight horizontal line above the x-axis means that the speed is not changing over time.
C. Zac is correct because a straight line going to the right indicates that the speed is not changing.
D. Lance is correct because a straight line going to the left indicates that the speed is the same over time.

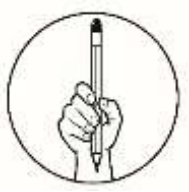
Additional Activities

Directions: Examine the graph below. Label the graph with the motion of the school bus as represented by the shape of the line. Use the words inside the school bus to label the graph. Write your answers on a separate sheet of paper.





Lesson 2 Ticker Tape Diagrams



What I Know

Directions: Read the following questions carefully. Choose the best answer from the given choices. Write the letter of your choice on a separate sheet of paper.

1. Which of the following is **NOT** TRUE about ticker tape diagrams?
   A. The closer the dots on the tape, the slower the object moved.
   B. The further apart the dots on the tape the faster the object moved.
   C. The object moves in constant speed if the spacing of the dots are the same.
   D. The number of dots on the tape represents how fast or slow the object moved.

2. What does it indicate if a ticker tape diagram starts off with closely spaced dots but move further apart as you go?
   A. Speeding up
   B. Steady speed
   C. Slowing down
   D. No acceleration

3. What does the distance between dots on a ticker tape diagram represents?
   A. The displacement of the object.
   B. The total distance travelled by the object.
   C. The time taken by the object while in motion.
   D. The object's position change during that time interval.

4. What does it mean if the dots on a piece of ticker tape are close together?
   A. The object is stationary.
   B. The object is moving fast.
   C. The object is accelerating.
   D. The object is moving slow.

5. A ticker tape diagram with dots that are spaced further apart as you go indicates that an object is _____.
   A. not moving
   B. moving faster
   C. moving slowly
   D. moving in constant speed

6. What quantity does each piece of tape represents in a tape chart?
   A. Displacement
   B. Distance
   C. Speed
   D. Time

7. How do we know that an object is slowing down just by looking on a ticker tape diagram?
   A. The dots are spaced further apart.
   B. The dots are spaced closer together.
   C. There are many dots in the ticker tape.
   D. The spaces among the dots are the same.
8. Which of the following DOES **NOT** result in an acceleration?
   A. Uniform speed
   B. Increasing speed
   C. Decreasing speed
   D. Change in direction

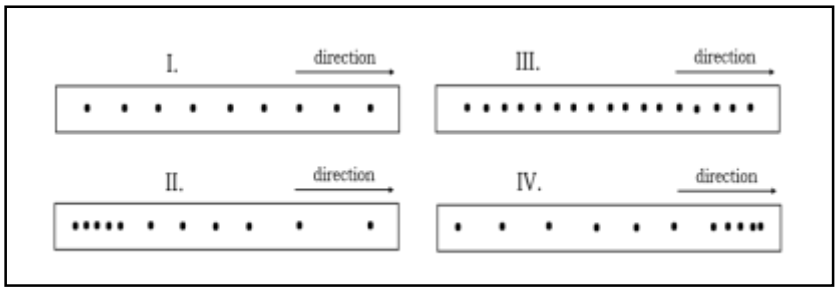
9. When an object decreases in speed, it is said to be _____.
   A. positively accelerating
   B. negatively accelerating
   C. speeding up then slowing down
   D. slowing down then speeding up

10. The speedometer of a vehicle recorded changes in speed in several instants of its travel. If the vehicle is speeding up and the position change of the vehicle during each time interval was presented using a ticker tape diagram, how do you think the ticker tape would look like?
   A. The distance between the dots is further apart.
   B. The distance between the dots is closer together.
   C. The distance between the dots is equal in length.
   D. The distance between dots is random and cannot be analyzed.

11. The ticker tape below shows the motion of a bus. Each dot represents the distance the bus travelled after one second. What does the ticker tape tell us about the motion of the bus?

   A. The bus is moving in a uniform motion.
   B. The bus stops at some point of its travel.
   C. The bus is speeding up, and then slowing down.
   D. The bus is slowing down, and then speeding up.

For items 12-13, refer to the ticker tape diagrams below.

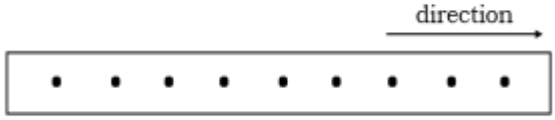


12. Which among the ticker tapes show that an object is moving with a steady speed?
    A. I and III only
    B. II and III only
    C. II and IV only
    D. III and IV only

13. If a motorcycle travelling on the road suddenly speeds up, which among the ticker tape diagrams CORRECTLY represents the acceleration of the motorcycle?

    A. I only
    B. II only
    C. I and IV only
    D. II and IV only

14. A car that is travelling down the road was seen accidentally leaving oil spots along the way. While investigating the road, traces of the oil were still evident. Assuming that the dots on the ticker tape below represents the oil drops, is it correct to say that the car is moving at a constant speed?



    A. No, the dots on the ticker tape indicate that the car was speeding up.
    B. No, the dots on the ticker tape indicate that the car was slowing down.
    C. Yes, the spaces between the dots are the same which mean that the car is moving in a steady speed.
    D. Yes, the car is moving in a constant speed because according to the law, it is wrong to drive very fast.

15. During their science class, Mikaela was asked by her teacher to draw a ticker tape diagram that represents the speed-time graph given below. While analyzing the graph, Mikaela concluded that the speed is not changing, therefore the object is moving in constant speed. She then drew a ticker tape diagram similar to the illustration below. Do you think Mikaela is correct?

    A. Yes, the ticker tape shows that the speed is not changing.
    B. No, the ticker tape shows that the object was moving very fast.
    C. Yes, the spaces between the dots show that the object is not accelerating.
    D. No, the ticker tape shows that the object was moving slowly then it speeds up.

What's In

In the previous lesson, you have learned how to describe and interpret the motion of objects using diagrams and motion graphs. Truly, there are many ways to describe motion. Another way of knowing how an object is moving is through ticker tape analysis. From this, we can create tape charts that can help us describe the speed of objects.

Study the diagram below. A car is travelling on a straight road and leaves oil spots along the way. The oil spots are represented by dots and occurred every second. What can you say about the speed of the car? Do you think the car is speeding up, slowing down or in constant speed?

Figure 10. A moving car while leaving oil spots

What's New

Directions: Read and analyze the situation below. Investigate a crime scene and find out if the suspect is telling the truth. Write your answers on a separate sheet of paper.

Suppose you were having your on-the-job training in a private investigating company. You were asked to join a team assigned to investigate a 'hit and run' case. The alleged suspect was captured by the CCTV camera driving down a road leading to the place of incident. The suspect denied the allegation, saying that he was then driving very slowly with a constant speed. Because of the short time difference when he was caught by the camera and when the accident happened, he insisted that it was impossible that he would already be at the place when the crime happened. But when you were viewing the scene again on the camera, you noticed that his car was leaving oil spots on the road. When you checked these spots on site, you found out that they are still evident. So, you began to wonder if the spots can be used to investigate the motion of the car of the suspect and check whether he was telling the truth or not.

For this activity, assume that the dots represent the 'oil drops' left by the car down the road.

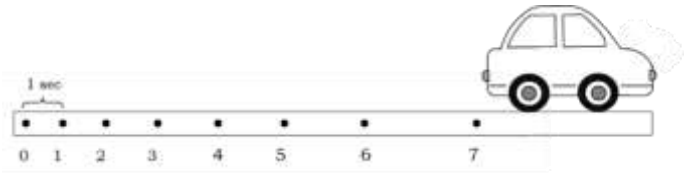


Figure 11. A ticker tape representing the motion of the car

1. In the ticker tape, each dot occurred every 1 second. Examine the distances between successive dots.

   Question 1. *How will you compare the distances between successive dots?*

2. If we cut the strip at each drop, starting from the first drop, and paste them side by side on a graphing paper, we will form a *tape chart*. Examine the given tape chart that is formed from the strips of the ticker tape.

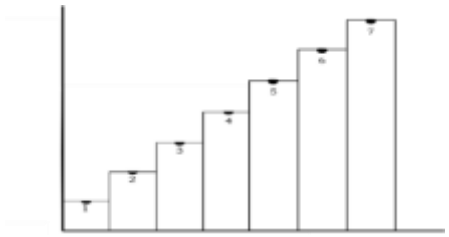


Figure 12. Tape Chart

Question 2. *How do the lengths of the tapes compare?*

Question 3. *If each tape represents the distance travelled by the object for* 1 *second, then what 'quantity' does each piece of tape provide?*

Question 4*. What does the chart tell you about the speed of the car?*

Question 5. *How will you compare the changes in the lengths of two successive tapes?*

Question 6. *What can you say about the acceleration of the moving car?*

Question 7. *Is the suspect telling the truth when he said that he was driving with constant speed?*

Scoring Rubric

	Excellent (5 points)	**Good** (3 points)	**Needs Improvement** (1 point)
Use of Scientific Vocabulary	Uses the science words effectively and in its correct context.	Uses most of the science words in its correct context.	Little or no scientific vocabulary present and science words are incorrectly used.

Conceptual Understanding	All ideas are correct and appropriate and demonstrates comprehensive understanding of scientific concepts related to the question.	Ideas are partially correct and demonstrates understanding of scientific concepts related to the question.	Ideas failed to address the questions or does so in a very limited way and demonstrates minimal or no understanding of scientific concepts related to the question.

What is It

One way of analyzing motion is using ticker tape. A **ticker tape diagram** is the line of dots on the tape that is created when a long tape is attached to an object that is moving. The tape is threaded to a device that puts a 'tick' or impression on the tape at regular time intervals. This creates a line of dots that represents the object's motion as the tape is pulled.

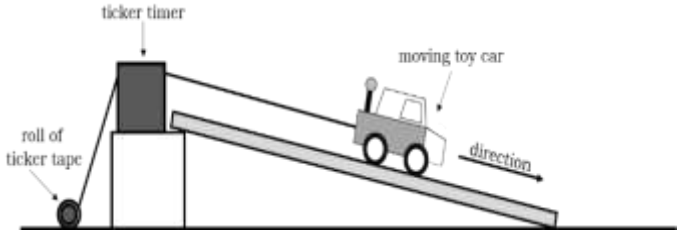


Figure 13. Ticker Timer Set up

Analyzing Ticker Tape Diagrams

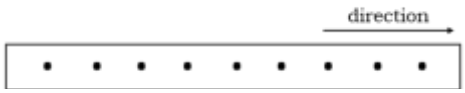


Figure 14. A ticker tape diagram for an object in constant speed

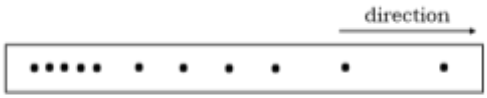


Figure 15. A ticker tape diagram for an object that is speeding up

The ticker tape diagram that starts off with closely spaced dots but move *further apart* as you go along as shown in *Figure 15* represents that the object was **speeding up**. This means that the further apart the dots are on the tape, the faster the object moved.

If a ticker tape diagram has spaces between dots that are not changing all throughout as shown in *Figure 14*, then this indicates that the object was moving at a **constant speed**.

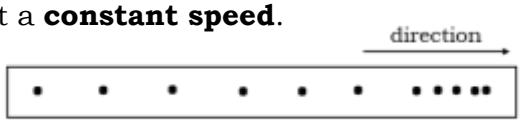
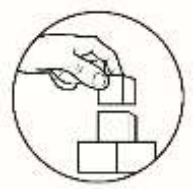


Figure 16. A ticker tape diagram for an object that is slowing down

The ticker tape diagram that starts with dots spaced further apart and gets closer as you go along as shown in *Figure 16* indicates that the object was **slowing down** because the dots are getting closer and closer together.

Always remember that in a ticker tape diagram, if the spacing of the dots is changing, this represents that the speed is changing. A changing speed would mean that there is **acceleration**. Based on the previous module, there are different situations that result to acceleration: changing speed, changing direction and changing both speed and direction. An object that decreases in speed is **negatively accelerating** or simply **decelerating**. Hence, acceleration does not only refer to objects with increasing speed.

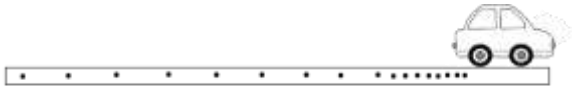


What's More

Directions: Examine each ticker tape diagram and describe the motion of the car using the phrases inside the box. Write your answers on a separate sheet of paper.

Fast, steady speed	Speeding up	Slowing down then speeding up
Slow, steady speed	Slowing down	Speeding up then slowing down

1. 

2. 

3. 

4. 

What I Have Learned

Directions: Identify the correct word from the words inside the box to make the paragraph complete. Write your answers on a separate sheet of paper.

Speeding up	Not changing	Ticker tape diagram	Closer
Constant speed	Slowing down	Negatively accelerating	
Changing speed	Acceleration	Further apart	

One way of analyzing motion is using ticker tape. A 1. _____ is the line of dots on the tape that is created when a long tape is attached to an object that is moving. The tape is threaded to a device that puts a 'tick' or impression on the tape at regular time intervals. This creates a line of dots that represents the object's motion as the tape is pulled.

If a ticker tape diagram has spaces between dots that are 2. _____ all throughout, then this indicates that the object was moving at 3. _____. The ticker tape diagram that starts off with closely spaced dots but move 4. _____ as you go represents that the object was 5. _____. This means that the further apart the dots are on the tape, the faster the object moved. The ticker tape diagram that starts with dots spaced further apart and gets 6. _____ as you go along indicates that the object was 7. _____ because the dots are getting closer and closer together.

Always remember that in a ticker tape diagram, if the spacing of the dots is changing, this represents that the speed is changing. A 8. _____ would mean that there is 9. _____. An object that decreases in speed is 10. _____ or simply decelerating. Hence, acceleration does not only refer to objects with increasing speed.

What I Can Do

Directions: Create ticker tape diagrams showing the type of motion demonstrated by the given objects. Write your answers on a separate sheet of paper.

1. 

A ball rolling fast in steady speed.

2. 

A car speeding up and then slowing down.

3. 

A bus travelling slowly in constant speed.

Rubric for Ticker Tape Diagram

	Excellent (5 points)	**Good** (3 points)	**Needs Improvement** (1 point)
Content	All diagrams are correct, appropriate and correspond to the motion of the object.	Most diagrams are correct, appropriate and correspond to the motion of the object.	The diagrams contain many errors and do not correspond to motion of the object.
Presentation	Neat, organized, and clearly illustrates the type motion shown by the object.	Fairly neat with little organization and illustrates the type motion shown by the object.	Messy and unorganized and does not clearly illustrate the type of motion shown by the object.

Assessment

Directions: Read the following questions carefully. Choose the correct answer from the given choices. Write the letter of your choice on a separate sheet of paper.

1. What does a ticker tape diagram indicate if the dots are spaced further apart?
   A. Moving fast
   B. Not moving
   C. Moving slow
   D. Decelerating

2. If the length of the tape increases by the same amount in each time interval, what does it tells us about the motion of the object?
   A. The object has a uniform acceleration.
   B. The object has a negative acceleration.
   C. The object is increasing the distance travelled.
   D. The object is speeding up and then slowing down at some point.

3. A ticker tape diagram with dots that are spaced closer together means that the object is _____.
   A. stationary
   B. moving faster
   C. moving slowly
   D. moving in steady speed

4. An accelerating object is _____.
   A. changing its speed
   B. not changing its direction
   C. moving in constant speed
   D. moving in uniform velocity

5. The space between dots on a ticker tape diagram represents _____.
   A. distance travelled
   B. total displacement
   C. acceleration of the object
   D. position change over time

6. What does a ticker tape diagram look like if an object is moving faster?
   A. Dots are spaced further apart.
   B. Dots are spaced closer together.
   C. There are many dots in the ticker tape.
   D. The spaces among the dots are the same.

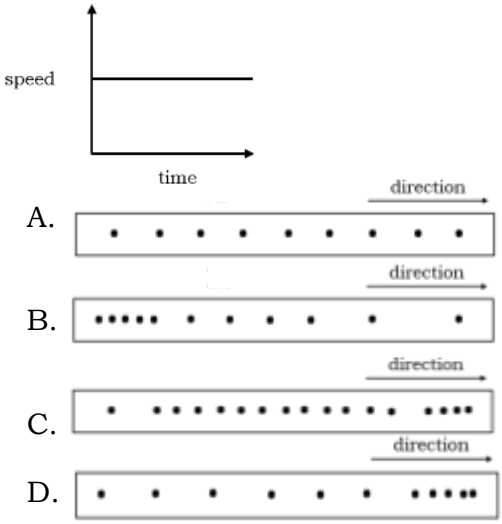
7. When an object increases in speed, it is said to be _____.
   A. accelerating
   B. negatively accelerating
   C. speeding up then slowing down
   D. slowing down then speeding up

8. Which of the following statements CORRECTLY describes a ticker tape diagram?

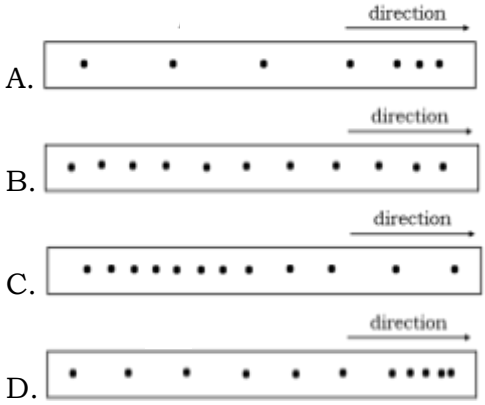
   A. If the dots are spaced closer, the object is moving fast.
   B. If the dots are spaced closer, the object is moving slowly.
   C. The dots on the tape always have the same amount of spaces.
   D. The dots that are spaced further apart indicate that the object is at rest.

9. What does it mean if a ticker tape diagram starts off with dots that are spaced further apart but move closer and closer as you go?
   A. No acceleration
   B. Constant speed
   C. Increasing speed
   D. Decreasing speed

10. Based on the speed-time graph below, which ticker tape diagram CORRECTLY matches the kind of motion illustrated by the graph?



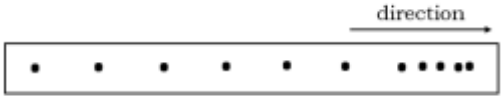
11. A ball that is moving slowly with steady speed in a straight track suddenly speeds up as it rolls down a hill. Which of the following ticker tape diagrams correctly represent the motion of the ball?



12. Examine the ticker tape diagram below. What conclusion can you make about the motion of the object?

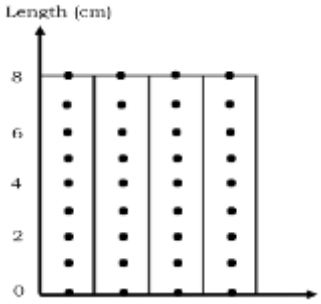
A. The object is moving very fast.
B. The object is moving very slow.
C. The object is increasing its speed.
D. The object is moving in a constant speed.

13. The motion of a toy car is recorded in the ticker tape diagram below? What do you think happens to the speed of the toy car?



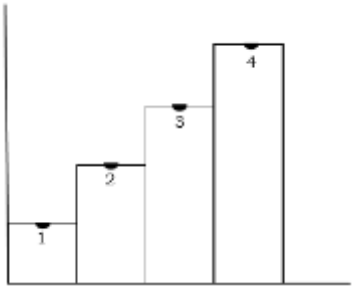
A. The toy car was moving very fast then stops.
B. The toy car was moving slowly then suddenly speeds up.
C. The toy car was moving in a steady speed then suddenly slows down.
D. The toy car was moving in a constant speed then speeds up in an instant.

14. In their physics class, Ben was asked by his teacher to describe the motion of an object based on the given tape chart. Each strip of tape represents the speed of the object every one second. From the tape chart, Ben concluded that the object is moving with a uniform speed. Do you think his answer is correct?



A. No, the tape chart shows that the speed decreases uniformly.
B. Yes, there are equal number of dots in each tape in the chart.
C. No, the tape chart shows that the object is accelerating uniformly.
D. Yes, the length of the tapes in the chart is the same indicating constant speed.

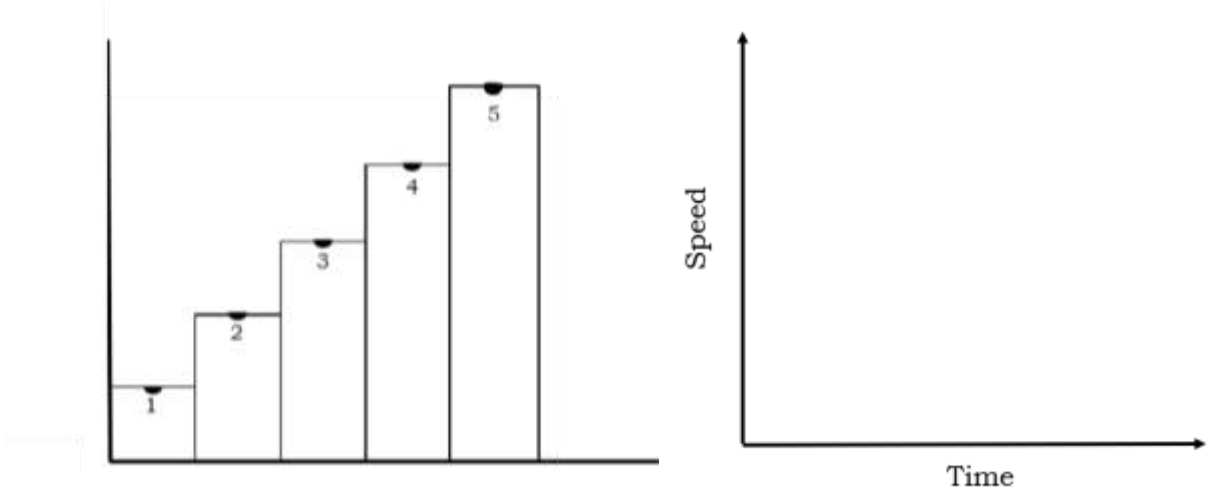
15. Examine the given tape chart. Is it correct to say that the speed of the object increases uniformly?



A. Yes, because the tapes in chart have equal length.
B. Yes, because the length of the tape increases uniformly.
C. No, the tape chart indicates that the object is slowing down.
D. No, the length of the tapes cannot determine the speed of an object.

Additional Activities

Directions: Convert the tape chart below into a speed-time graph and describe the motion represented by the graph. Plot your graph on a separate sheet of paper.



Graphing Rubric

Criteria	**Excellent** (5 points)	**Fair** (3 points)	**Needs Improvement** (1 point)
Labels and Axes	The graph has a clear title and the labels for the axes and variables being measured are accurate and clearly indicated. Independent variable is on the x-axis and the dependent variable is in the y-axis.	The graph has a title and the labels for the axes and variables being measured are indicated. Independent variable is on the x-axis and the dependent variable is in the y-axis.	The graph has no title and labels for the axes and variables being measured are not indicated. The independent and dependent variables are not on the correct axis.
Interpretation	The interpretation of the data pattern shown on the graph about the motion of the object is clear and accurate.	The interpretation of the data pattern shown on the graph about the motion of the object is clear and partially correct.	The interpretation of the data pattern shown on the graph about the motion of the object is incorrect and not clear.

Answer Key

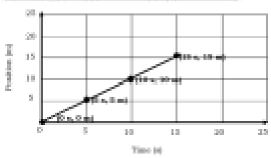
Lesson 1

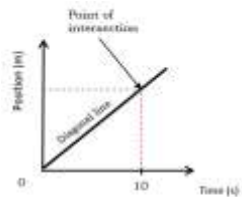
What I Know

1. B
2. C
3. D
4. A
5. C
6. B
7. D
8. C
9. A
10. C
11. A
12. B
13. A
14. D
15. D

What's New

Time (seconds)	Position of the ball (meters)
0	0
5	5
10	10
15	15





What I Have Learned

1. Motion graphs
2. Slope
3. Time
4. Position
5. Distance-time graph
6. Not moving
7. Constant speed
8. Horizontal
9. Speed
10. Acceleration

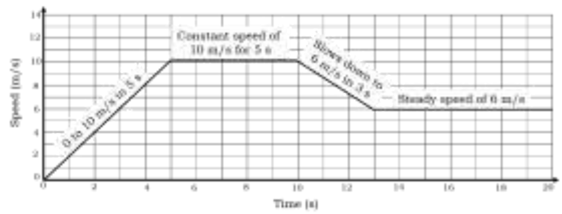
What's More

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

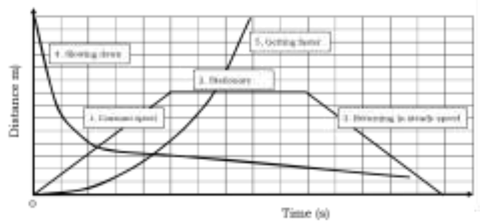
Assessment

1. D
2. C
3. B
4. C
5. C
6. A
7. D
8. A
9. A
10. B
11. D
12. D
13. C
14. C
15. B

What I Can Do



Additional Activities



Lesson 2

What I Know

1. D
2. A
3. D
4. D
5. B
6. C
7. B
8. A
9. B
10. A
11. D
12. A
13. B
14. C
15. D

What's New

Q1. The distance between two successive dots increases uniformly.
Q2. The length of the strips of tape in the chart increases uniformly.
Q3. Each strip of tape provides the speed (or velocity) of the object every 1 second.
Q4. Because the length of the tape increases uniformly, it means that the speed (or velocity) of the object increases uniformly.
Q5. The change in length of the tape is constant. The change in speed is constant. Or the length of the tape increases by the same amount in each time interval. The speed increases by the same amount in each time interval.
Q6. The acceleration of the moving car is constant.
Q7. No, the suspect is not driving in constant speed but in uniform acceleration.

What I Have Learned

1. Ticker tape diagram
2. Not changing
3. Constant speed
4. Further apart
5. Speeding up
6. Closer
7. Slowing down
8. Changing speed
9. Acceleration
10. Negatively accelerating

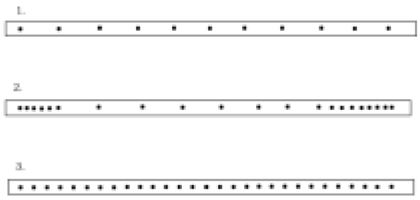
What's More

1. Speeding up
2. Slowing down
3. Slow, steady speed
4. Fast, steady speed

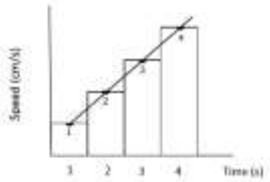
Assessment

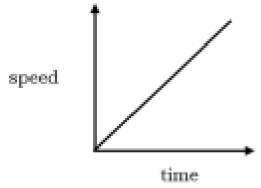
1. A
2. A
3. C
4. A
5. D
6. A
7. A
8. B
9. D
10. A
11. C
12. D
13. C
14. D
15. B

What I Can Do



Additional Activities





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For inquiries or feedback, please write or call:

Department of Education - Bureau of Learning Resources (DepEd-BLR)

Ground Floor, Bonifacio Bldg., DepEd Complex
Meralco Avenue, Pasig City, Philippines 1600

Telefax: (632) 8634-1072; 8634-1054; 8631-4985

Email Address: blr.lrqad@deped.gov.ph * blr.lrpd@deped.gov.ph