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REVIEW — Chapter 4

Graphical analysis of motion helps you picture the relationships among position, velocity, and acceleration. If you have a graph of any one of the three variables with respect to time, you can find the other two by determining the area under the curve or the slope of the curve. As you work with the graphs, keep in mind what each axis represents. To derive a position-time graph from a velocity-time graph, graph the time versus the area under the curve at that time. If you label your axes carefully, dimensional analysis will tell you whether you have used the correct relationship. The units of the slope, $(\frac{\Delta y}{\Delta x})$, will be the y-axis units divided by the x-axis units. If your graph is velocity (m/s) versus time (s), the slope will be $\frac{\text{m/s}}{\text{s}} = \text{m/s}^2$, which is acceleration. When you find the area, multiply the units of the y-axis by the units of the x-axis. When you multiply velocity (m/s) by time (s), you get m, which is position.

1. Identify the following.

_____ **a.** the slope of a position-time graph

_____ **b.** the slope of a velocity-time graph

_____ **c.** the area under an acceleration-time graph

_____ **d.** the area under a velocity-time graph

2. A motorboat travels straight down a river at 40.0 m/s.

a. Construct a table showing the total position of the boat at the end of each second for 10.0 seconds.

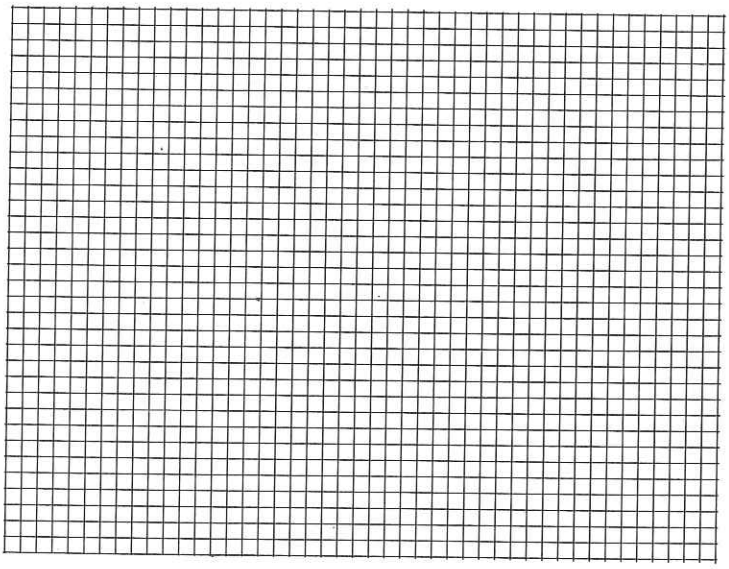
b. Use the data from the table to plot a position-time graph.

c. Show that the slope of the line is equal to the velocity.

d. Plot a velocity-time graph of the boat's motion for the first 10 seconds.

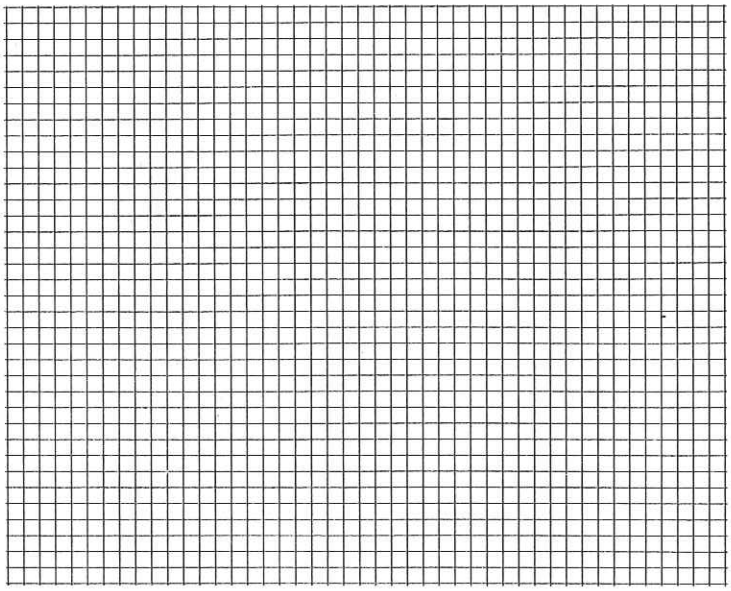
e. Find the displacement between the 5th and 10th seconds.

time	position



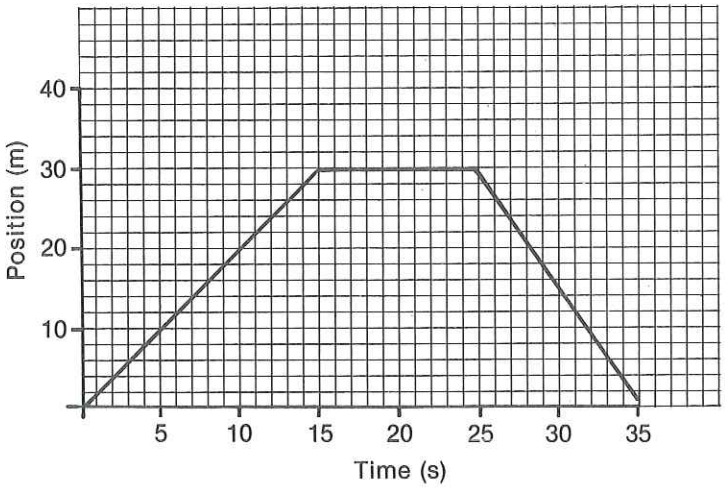
Name _____ Period _____ Date _____

time	velocity



_____ Displacement between the 5th and 10th seconds.

3.



_____ **a.** How far does the object travel between 5 and 10 seconds?

_____ **b.** How far does the object travel between 15 and 20 seconds?

_____ **c.** During what time interval is the velocity zero?

_____ **d.** What is the velocity between 10 and 15 seconds?

_____ **e.** Is the object accelerating during this trip?

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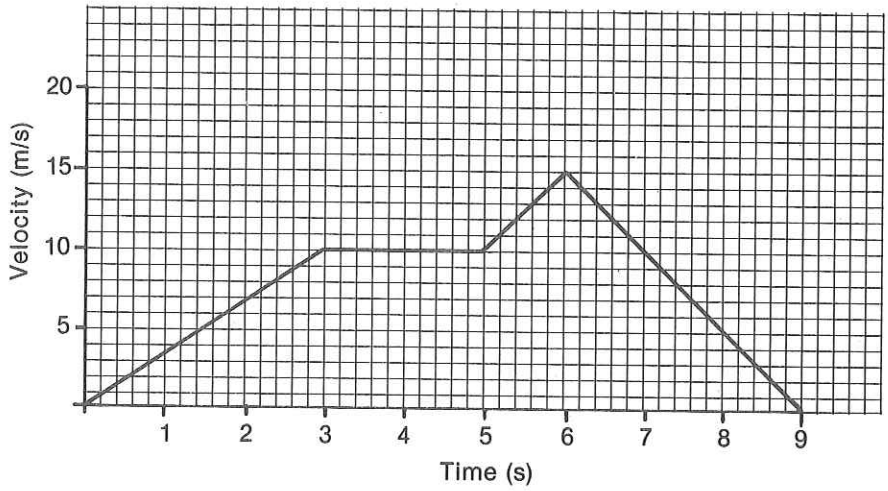
4.



_____ **a.** Is the acceleration greater between 2 and 3 seconds or between 5 and 6 seconds?

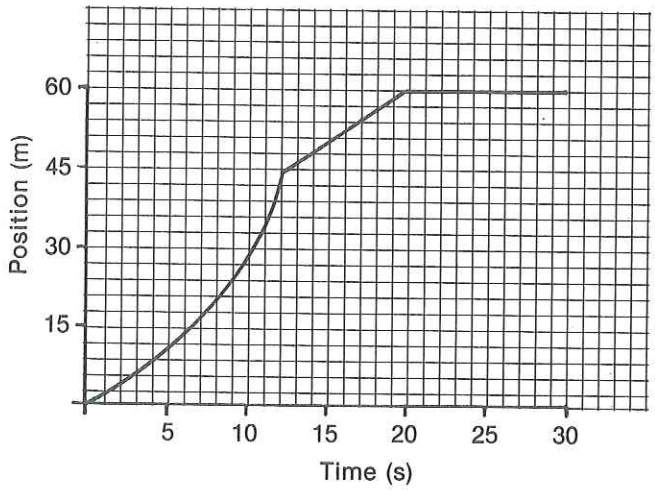
_____ **b.** During what time interval is the acceleration zero?

_____ **c.** What is the displacement between 5 and 6 seconds?

_____ **d.** What is the acceleration between 6 and 8 seconds?

_____ **e.** What is the displacement between 3 and 4 seconds?

5.



_____ **a.** What is the velocity between 20 and 25 seconds?

_____ **b.** Is the velocity greater between 0 and 5 seconds or between 10 and 12 seconds?

_____ **c.** What is the velocity between 15 and 20 seconds?

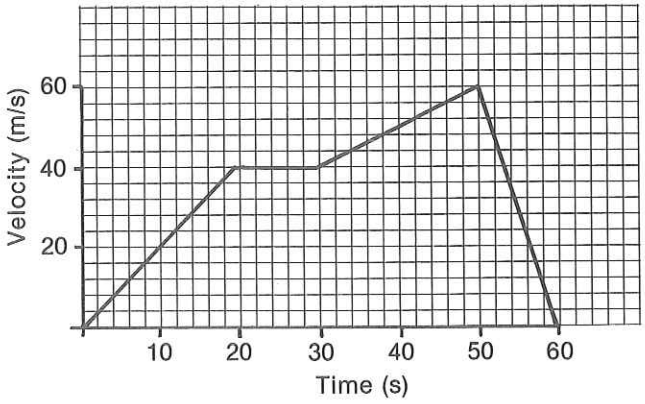
_____ **d.** What is the velocity at nine seconds?

_____ **e.** During what time interval(s) does the object accelerate?

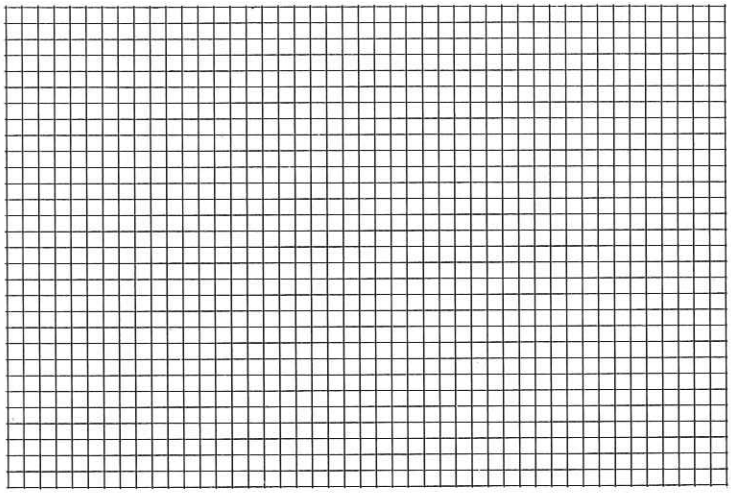
_____ **f.** What is the displacement between 15 and 20 seconds?

Name _____ Period _____ Date _____

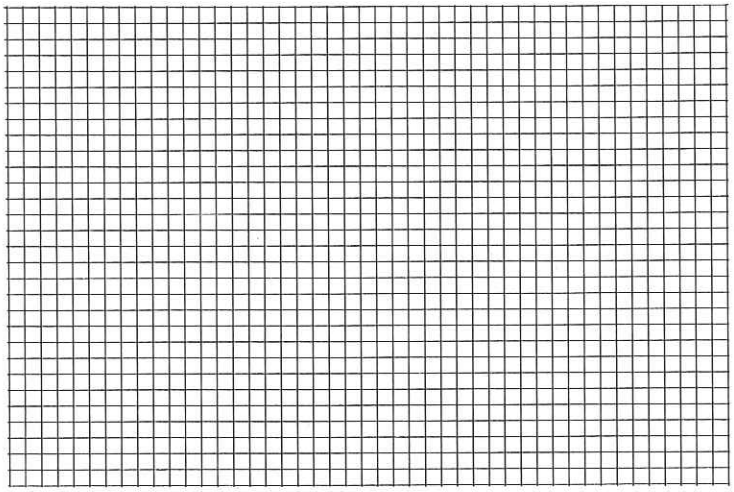
6. Sketch the position-time graph and the acceleration-time graph from the given velocity-time graph.



Time	Position



Time	Acceleration



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MINILAB — Chapter 4

4–1 Graphing Uniformly Accelerated Motion

Equipment

position-time graph
pencil

Objective

During this investigation you will
- study the behavior of an object under the influence of gravity using data from a position-time graph.

Procedure

1. Study Graph I, the position-time graph for an arrow shot vertically into the air. Recall that the slope of the curve at any point is equal to the instantaneous velocity at that time.
2. Determine the instantaneous velocity of the arrow at t = 1, 2, 3, and 4 seconds. To do this, construct the tangents to the curve at these times and determine the slopes of the tangents. Record your data in the second column of Table 4–1.
3. Plot a velocity-time graph using your data from Table 4–1.
4. The slope of a velocity-time graph is equal to the acceleration. Using the same method that you used in Step 2, determine the accelerations at t = 0, 1, 2, 3, and 4 seconds. Enter the values in the third column of Table 4–1.
5. Plot an acceleration-time graph on Graph III.

Interpretation

1. Describe the magnitude and direction of the change in velocity with time.

_____

_____

2. What is the significance of a negative velocity?

_____

_____

3. What does the shape of the curve in Graph III tell you about the acceleration of gravity?

_____

_____

4. What is the acceleration when v = 0 m/s? Explain.

_____

_____

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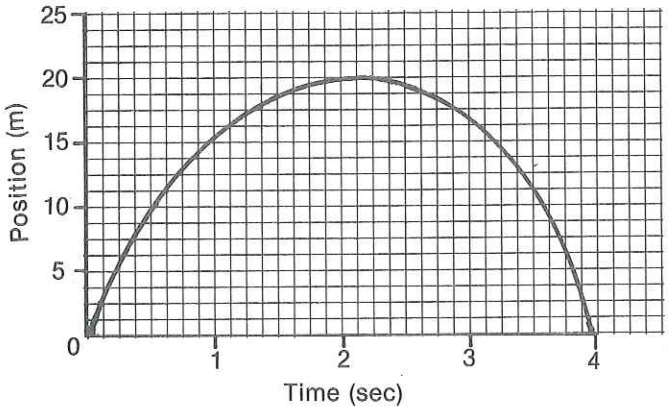
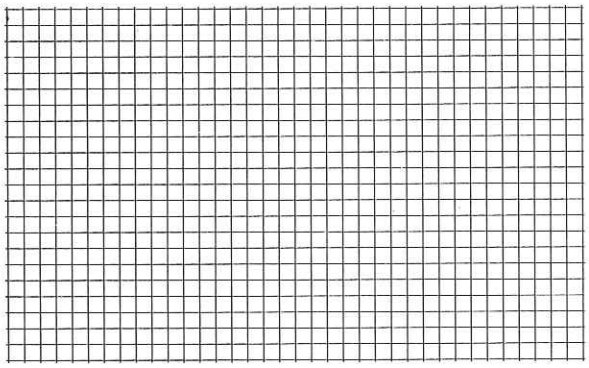
Table 4-1

Time	Velocity	Acceleration

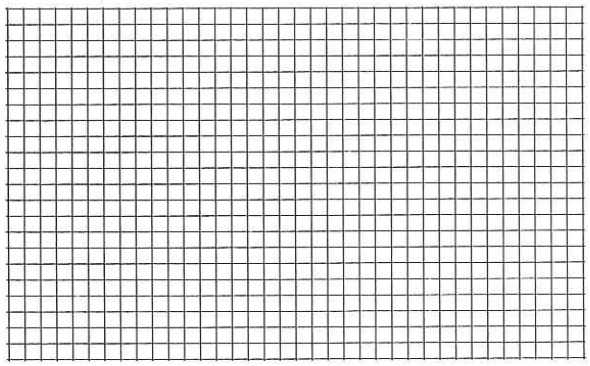
I



II



III

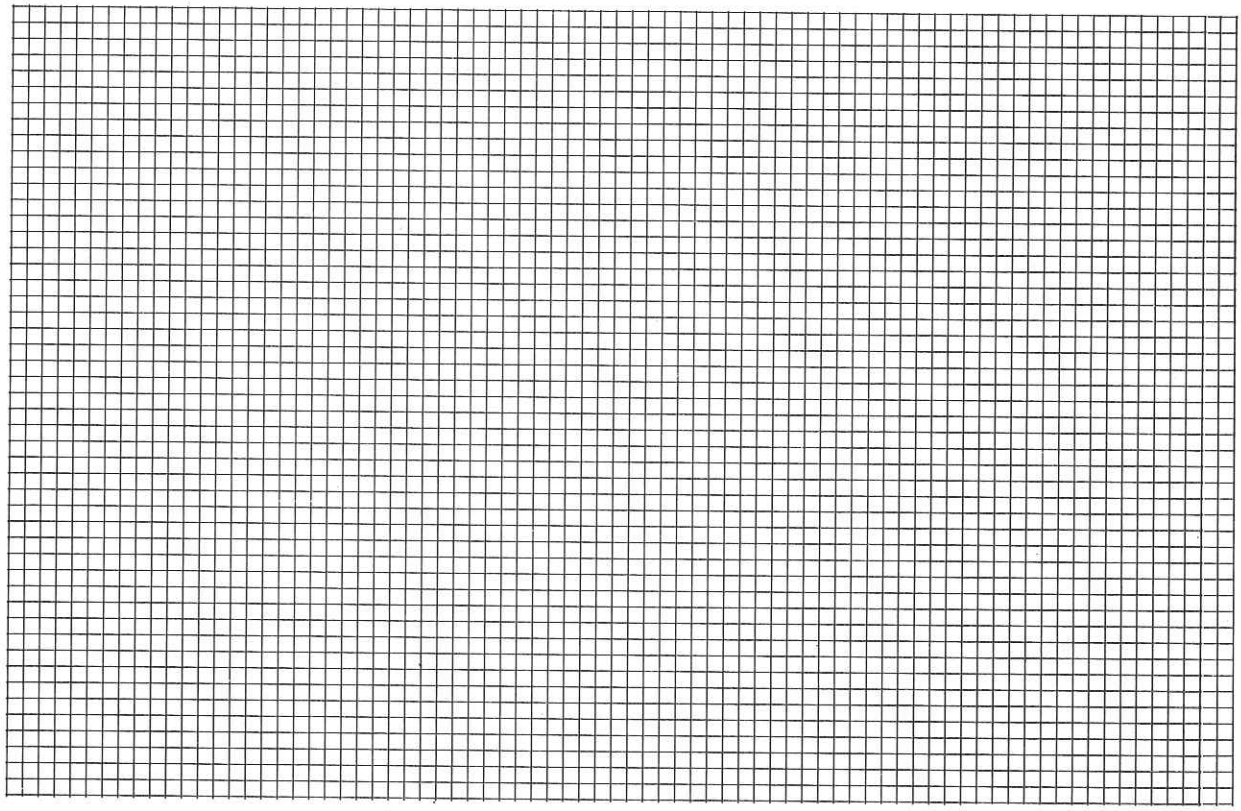


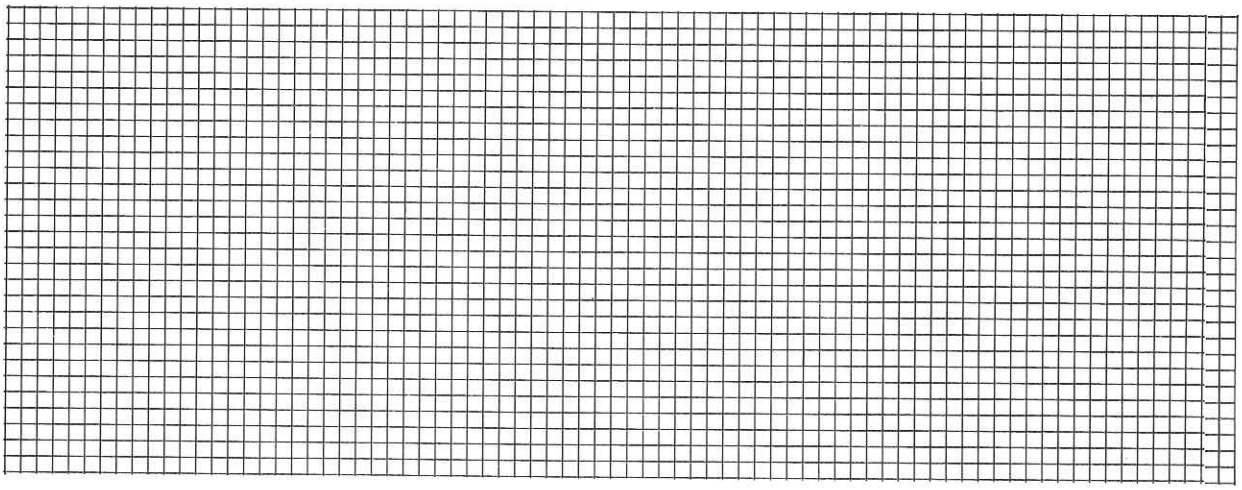
Name _____ Period _____ Date _____

ENRICHMENT — Chapter 4

4–1 Analyzing Motion Graphs

1. Mike drove his car at 40.0 km/h for 15.0 minutes and then quickly accelerated to 60.0 km/h and traveled for 30.0 minutes until he reached the ice cream stand where he stopped to buy an ice cream cone and to talk to his friends for 15.0 minutes. Then he turned around and went back toward his home at 45.0 km/h for 10.0 minutes and quickly accelerated to 65.0 km/h and returned home after 30.0 minutes. On the graph paper provided below, draw graphs of position versus time and velocity versus time for the trip. Use the same scale for the time axis for each graph.





Name _____ Period _____ Date _____

2. A velocity-time graph of a moving car is shown below. Answer the following questions using the graph.

_____ **a.** At what time was the car stopped?

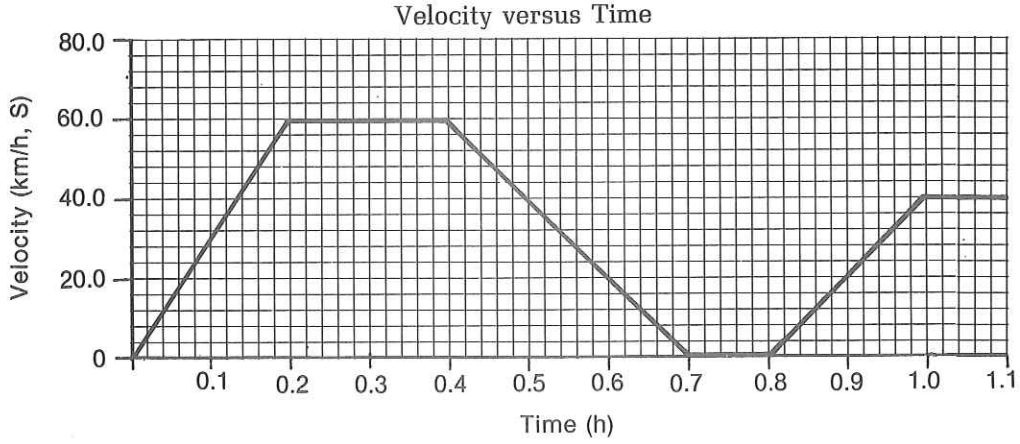
_____ **b.** At what time did the car have the greatest velocity?

_____ **c.** What was the greatest velocity?

_____ **d.** At what time(s) was the car accelerating?

_____ **e.** How fast was the car going at 1.0 h?

_____ **f.** What is the acceleration at 0.9 hr.



3. Car A starts from a corner just as car B goes by at 90.0 km/h. The velocity-time graphs of the cars are shown below. Answer the following questions using the graphs.

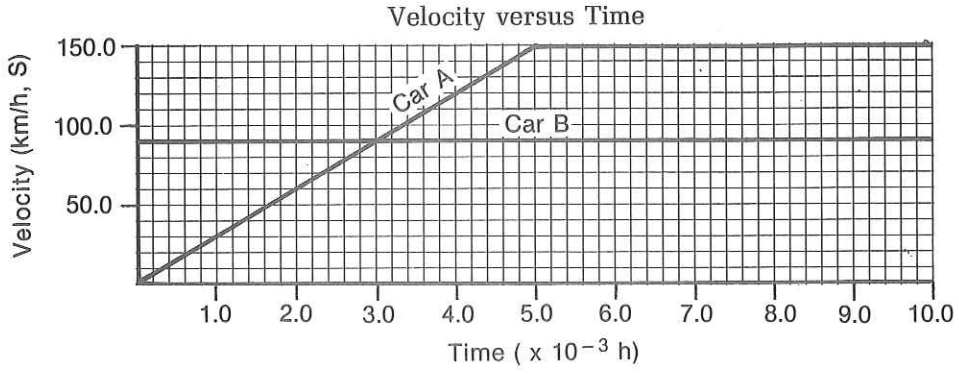
_____ **a.** At what time are the cars going at the same velocity?

_____ **b.** How far has car A traveled when they reach the same velocity?

_____ **c.** At what time does car A reach car B?

_____ **d.** How far have each of the cars traveled when they are side by side?

_____ **e.** Which car is ahead at 0.008 h?



Name _____ Period _____ Date _____

Graphical Analysis of Motion — Chapter 4

A. Completing Concepts

In the space to the left, write the answer that best completes each statement.

_____ 1. For an object moving at a(n) _____ speed, the distance traveled is directly proportional to the elapsed time.

_____ 2. The steepness of a graph line is called the _____ of the graph.

_____ 3. The slope of a position-time graph yields the _____ of the moving object.

_____ 4. The slope of a straight line is _____ .

_____ 5. As the velocity of an object increases, the slope of the line on the position-time graph _____ .

_____ 6. When the slope of the line on a distance-time graph is _____ , the object involved is at rest.

_____ 7. On a(n) _____ -time graph, the area between the line of the graph and the horizontal axis represents the displacement of the object.

_____ 8. With constant acceleration, the curve of a(n) _____ -time graph is a half parabola.

_____ 9. The slope of the line on a velocity-time graph shows the _____ of a moving object.

_____ 10. With constant acceleration, the distance an object travels varies directly with the _____ .

_____ 11. If the position-time graph is a curved line, the slope of the _____ yields the instantaneous speed at the point of the curve it touches.

_____ 12. The area between the graph line and the horizontal axis on a(n) _____ -time graph represents the change of velocity of the object in a given time interval.

_____ 13. A negative acceleration might mean that an object is speeding up while going in the _____ direction.

_____ 14. Straight lines on a position-time graph indicate that no _____ . occurs.

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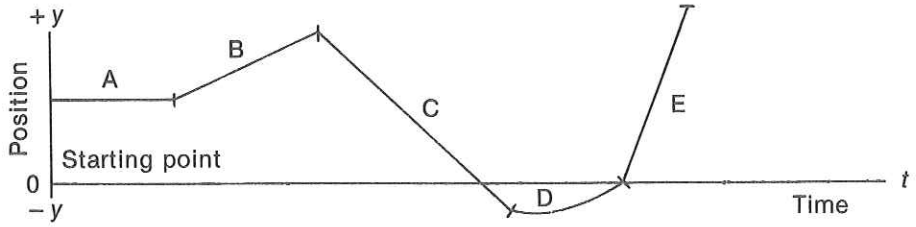
B. Understanding Concepts

In the space to the left, write the letter of the answer to each question.



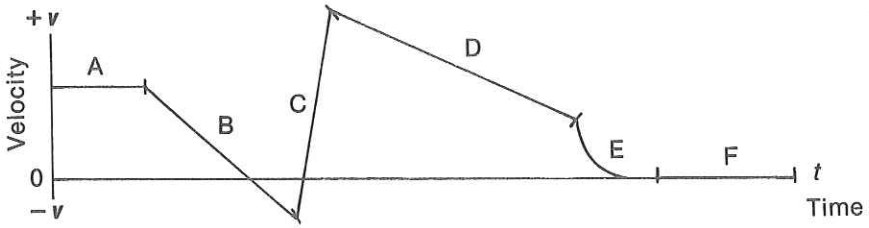
Questions 1 through 4 refer to the position-time graph above.

_____ **1.** Which section represents accelerated motion?

_____ **2.** Which section shows the object at rest?

_____ **3.** The object always moves toward the starting point in section _____ .

_____ **4.** Which section represents a constant negative velocity?



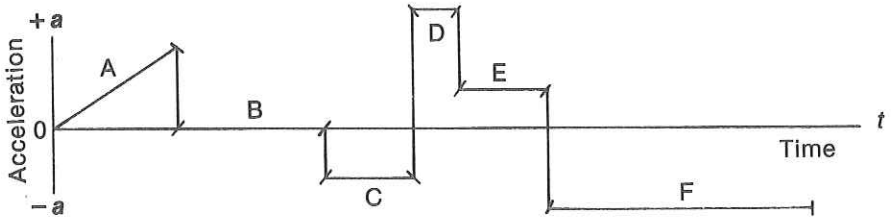
Questions 5 through 8 refer to the velocity-time graph above.

_____ **5.** Which section represents a constant velocity other than zero?

_____ **6.** Which section represents the greatest acceleration?

_____ **7.** Which section represents a changing acceleration?

_____ **8.** Which section represents the greatest displacement?



Questions 9 through 12 refer to the acceleration-time graph above.

_____ **9.** Which section represents the greatest change in velocity?

_____ **10.** Which section represents an acceleration of zero?

_____ **11.** Which section represents the greatest positive acceleration?

_____ **12.** Which section represents a changing acceleration?

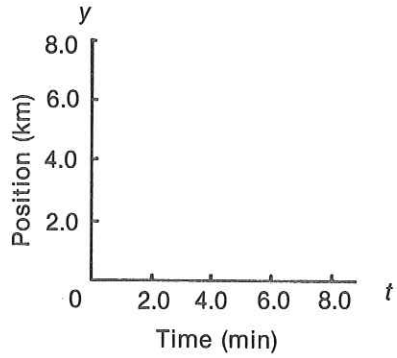
Name _____ Period _____ Date _____

C. Using Concepts

Solve all problems by graphical analysis.

1. The following table shows the positions of two cars at the times indicated. Graph the data for each car on one set of axes and compute the velocity of each car.

TIME	POSITION, 0°	
(min)	CAR A (km)	CAR B (km)
0	0	2
2	2	3.5
4	4	5
6	6	6.5
8	8	8



2. Draw a velocity-time graph for a ball that has been thrown straight up into the air and returns to its original position. (Neglect air friction.)

3. A police car is stopped at a red light. As the light turns green, a diesel truck hurtles past in the next lane traveling at a constant speed of 28.0 m/s. If the police car, sirens blaring and lights flashing, accelerates at 4.0 m/s^2, how many seconds will it take it to catch the truck? *HINT:* On the same set of axes, draw velocity-time graphs for the car and the truck.

4. A student is running at her top constant speed of 4.0 m/s to catch a school bus parked at a bus stop. When she is just 10.0 meters away, the bus leaves the bus stop, accelerating at 1.0 m/s^2. Will the student catch the bus?

Name _____ Period _____ Date _____

D. Extending Concepts

1. Analyze the velocity-time graph below. On separate sheets of graph paper, draw the corresponding acceleration-time and distance-time graphs.