DATE: NAME: CLASS:

CHAPTER 11
SCIENCE INQUIRY

BLM 11-2

Recognizing Accelerated Motion

Goal • Determine whether an object is accelerating or moving with uniform motion.

What to Do

Answer each question in the space provided.

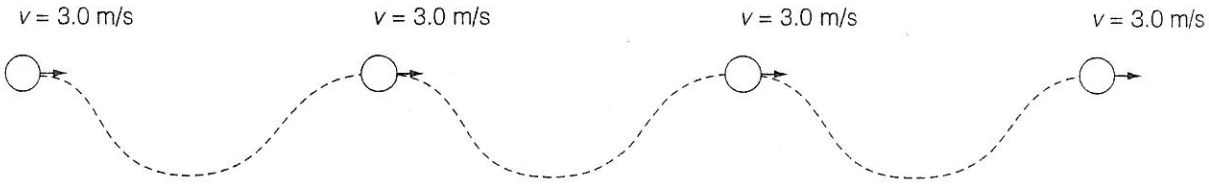
1. Carefully examine each diagram below. Decide whether the diagram represents accelerated or uniform motion, and explain your reasons. Any dotted lines indicate the path of the object.

(a)

Type of motion: Uniform

Explanation: Same speed, same direction

(b)



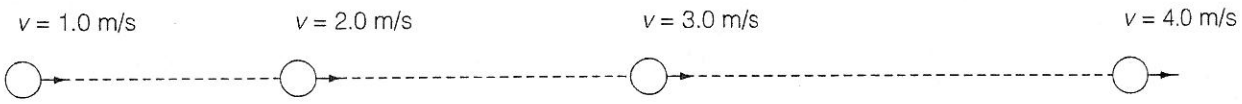
Type of motion: _____

Explanation: _____

_____

Recognizing Accelerated Motion (continued)

(c)

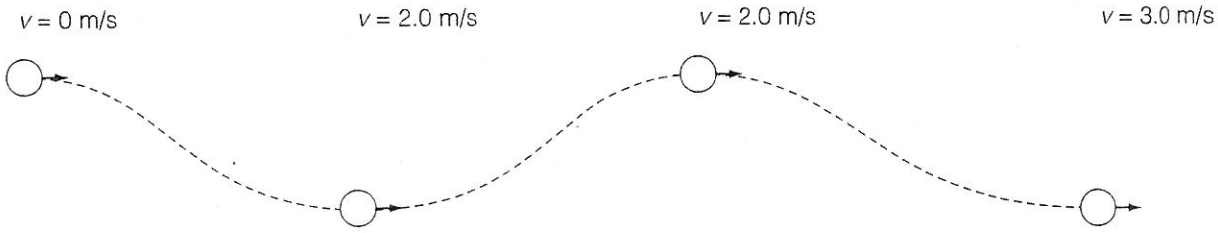


Type of motion: _____

Explanation: _____

_____

(d)

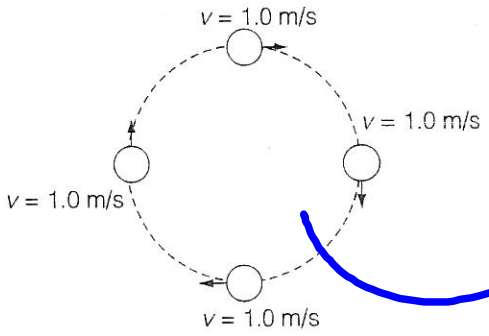


Type of motion: _____

Explanation: _____

_____

(e)



"periodic motion" special type of uniform motion

Type of motion: _____

Explanation: _____

_____

Recognizing Accelerated Motion (continued)

(f)

Type of motion: _____

Explanation: _____

_____

2. (a) Under what conditions is an object moving with uniform motion?

_____

_____

_____

(b) Under what conditions is an object accelerating?

_____

_____

_____

$\vec{a}_{ave} = \frac{\vec{v}_f - \vec{v}_i}{t_f - t_i}$

Calculating Acceleration: $\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$ $\quad \Delta \vec{v} = (\vec{a})(\Delta t)$ $\quad \Delta t = \frac{\Delta \vec{v}}{\vec{a}}$

Example 1: A pool ball traveling at 2.5 m/s, towards the cushion bounces off at 1.5 m/s. If the ball was in contact with the cushion for 0.20 s, what is the ball's acceleration? (Assume towards the cushion is the positive direction.)

Given: $\vec{v}_i = +2.5\ m/s$ Need: $\vec{a}$ $\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$

$\vec{v}_f = -1.5\ m/s$

$\Delta t = 0.20\ s$

$= -20\ m/s^2$

$= -2.0 \times 10^1\ m/s^2$ $\vec{a} = \frac{-1.5\ m/s - (2.5\ m/s)}{0.20\ s}$

Example 2: A car accelerates from rest at 3.0 m/s2 forward for 5.0 s. What is the velocity of the car at the end of 5.0 s?

Given: $\Delta t = 5.0\ s$ Need: $\vec{v}$ $\vec{v} = \vec{a} \cdot \Delta t$

$\vec{a} = 3.0\ m/s^2$

$= \frac{3.0\ m}{s^2} \ 5\ s$

$\vec{v}_f = 15\ m/s\ [fwd]$

Example 3: A train is travelling east at 14 m/s. How long would it take to increase its velocity to 22 m/s east, if it accelerated at 0.50 m/s2 east? (assign east direction positive (+)).

$t = 16\ s$

More Practice:

1. A truck starting from rest accelerates uniformly to 18 m/s [W] in 4.5 s. What is the truck's acceleration?

$\vec{a} = 4.0\ m/s^2\ [W]$

2. A toboggan moving 5.0 m/s forward decelerates backwards at -0.40 m/s2 for 10 s. What is the toboggan's velocity at the end of the 10 s?

$\vec{v}_f = \vec{v}_i + (\vec{a} \cdot \Delta t)$

$= +5\ m/s + \left(-0.4\ \frac{m}{s^2}\right)$

$\vec{v}_f = 1\ m/s\ [fwd]$

$/\Delta t \cdot \vec{a} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t} \times \Delta t$

$\vec{v}_f - \vec{v}_i = \vec{a} \cdot \Delta t + v_i$

3. How much time does it take a car, travelling south at 12 m/s, to increase its velocity to 26 m/s south if it accelerates at 3.5 m/s2 south?

$t = 4.0\ s$

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CHAPTER 11 PROBLEM SOLVING

Acceleration Problems

BLM 11-3

Goal • Calculate the acceleration of objects that are moving in a straight line.

What to Do

Answer each question in the space provided. Assume that motion upward or to the right is positive. Assume that motion downward or to the left is negative.

1. Complete the following table.

t_i (s)	t_f (s)	Δt (s)	$\vec{v}_i$ (m/s)	$\vec{v}_f$ (m/s)	$\Delta\vec{v}$ (m/s)	$\vec{a}_{av}$ (m/s²)
10	25	15s	0	+12	+12m/s	+0.8 m/s
0	40	40s	+50	+10	-40m/s	-1 m/s
12.5	41.6	29.1	-10.1	+32.4	+42.5m/s	4.46m/s
9.70	51.9	42.2	+43.7	-12.6	-56.3 m/s	-1.3 m/s

2. A student starts from rest and reaches a velocity of 7.1 m/s to the right of the observer in 5.2 s. Find the student's average acceleration.

1.4m/s² [R]

3. An airplane is flying at +210 m/s. It slows down to +165 m/s in 12.3 s. Find the acceleration of the airplane.

-3.7m/s² [straight]

4. A puck is moving at +8.2 m/s on the ice. It is hit by a hockey stick for 0.25 s, causing it to move at +21.3 m/s in the same direction. Find the acceleration of the puck.

52m/s² [straight]

end here

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CHAPTER 11
SCIENCE INQUIRY

Velocity-Time Graphs

BLM 11-10

Goal • Examine the relationships between velocity-time graphs and acceleration.

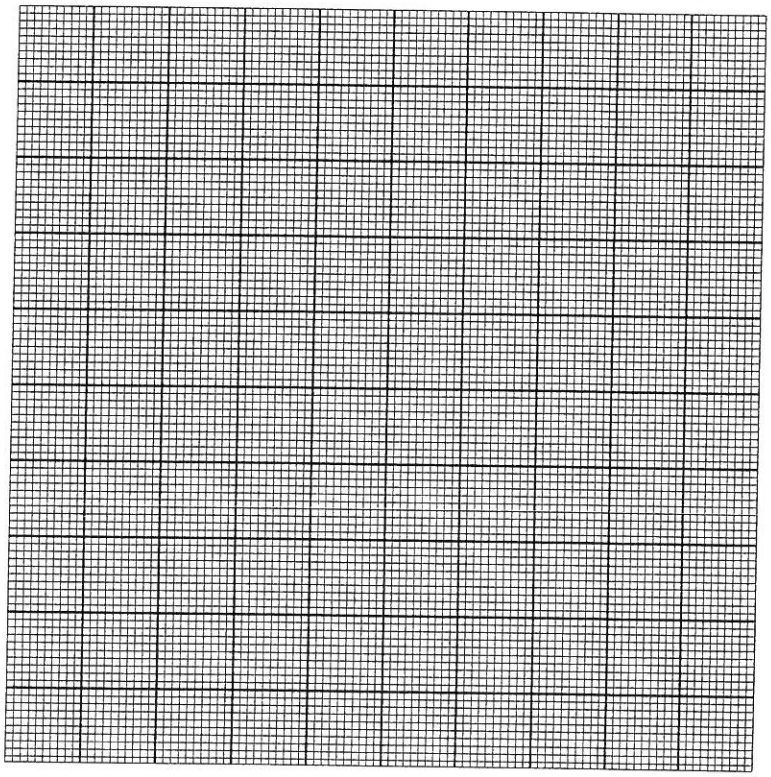
What to Do

Answer each question in the space provided. A motion detector was used to gather all the data in the tables.

1. Use the data in each table to draw a velocity-time graph. Then calculate the slope of the graph.

(a)

t (s)	$\vec{v}$ (m/s)	$\vec{a}$ (m/s²)
0	0	2
1	2	2
2	4	2
3	6	2
4	8	2
5	10	2



Calc + show your work

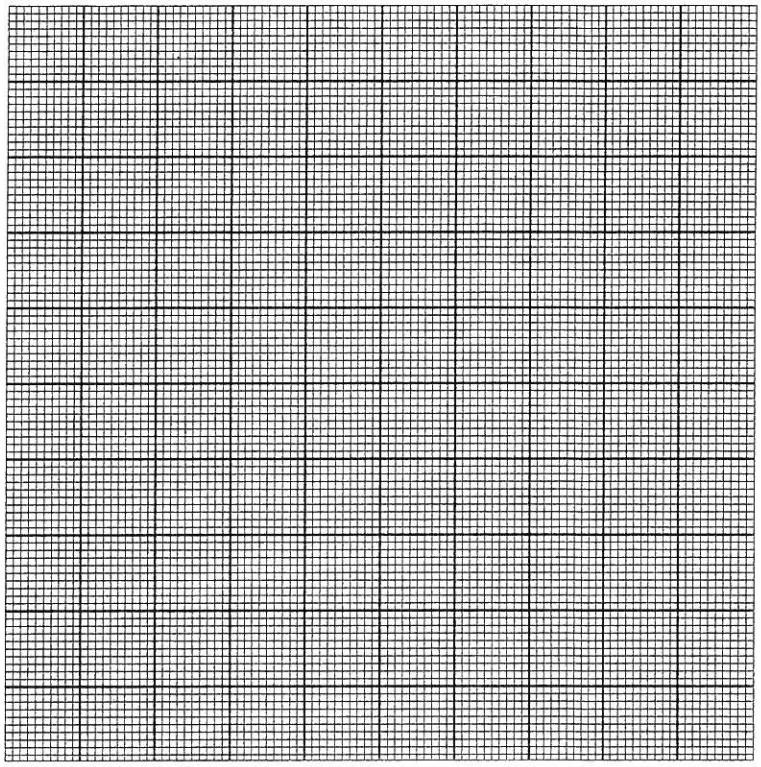
Slope of velocity-time graph =

How does the slope of the line compare with the acceleration of the object?

Velocity-Time Graphs (continued)

(b)

t (s)	$\vec{v}$ (m/s)	$\vec{a}$ (m/s^2)
0	30	–5
1	25	–5
2	20	–5
3	15	–5
4	10	–5
5	5	–5



Slope of velocity-time graph =

How does the slope of the line compare with the acceleration of the object?

Understanding Concepts

1. How can you tell from a speed–time table whether an object is accelerating?
2. How can you tell from a speed–time graph whether an object is accelerating?
3. Sketch a speed–time graph with two separate labelled lines for
   (a) high positive acceleration;
   (b) low negative acceleration.
4. What feature of a speed–time graph communicates
   (a) the acceleration?
   (b) the distance travelled?
5. Two runners, Cathryn and Keir, take part in a fundraising marathon. The graph in **Figure 7** shows how their speeds change for the first 100 s from the start of the marathon.

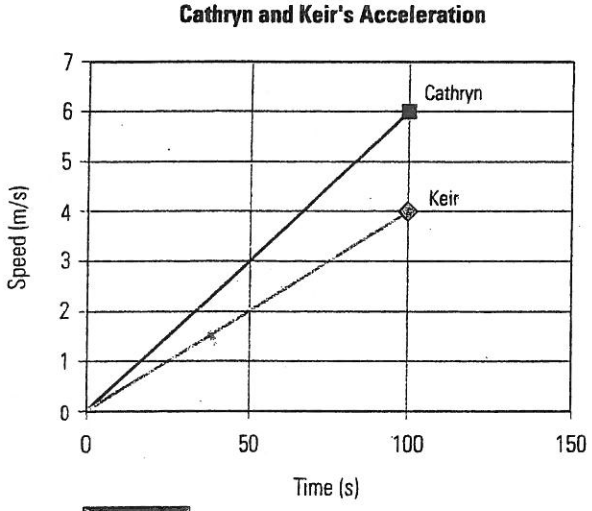


Figure 7

   (a) Which runner has the greater acceleration? Show this by calculating the acceleration of each.
   (b) Which runner is ahead after 100 s? Calculate and compare the distance travelled by each.
6. The cheetah is the fastest land animal and can accelerate rapidly in an attack. **Table 3** shows some typical speeds and times for a cheetah.
   (a) Draw a speed–time graph using the information in **Table 3**.
   (b) Using your graph, calculate the average acceleration of the cheetah.
   (c) Using your graph, calculate the total distance travelled by the cheetah by the end of 2.0 s.

Table 3 Acceleration of Cheetah

Time (s)	Speed (m/s)
0.0	0.0
0.5	5.0
1.0	10.0
1.5	15.0
2.0	20.0

7. Create a scientific question about the acceleration characteristics of different vehicles. State the variables clearly.
8. Sketch and label distance–time and speed–time graphs for constant speed and a speed–time graph for constant acceleration (three graphs in total).
9. Why does $\Delta d = v_{av}\Delta t$ but $A = \frac{1}{2}hb$? Where does the half (1/2) come from? If $\Delta d = A$ and $\Delta t = b$, then why does $v_{av} = \frac{1}{2}h$?
10. Draw a speed–time graph for your movements as you go from your desk in the classroom to the pencil sharpener.
11. Clayton sets out on his motorcycle. His speed at different times is shown on the graph in **Figure 8**.

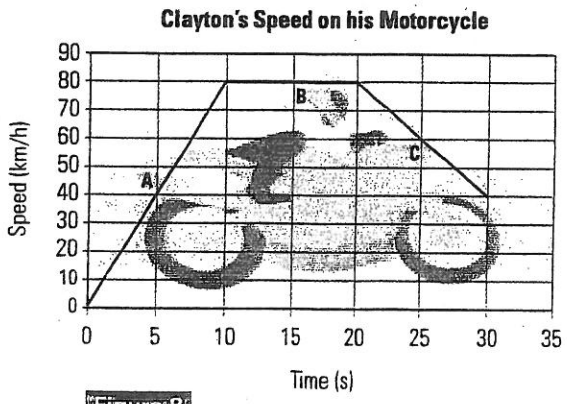


Figure 8

   (a) Calculate the accelerations during each of the time intervals, A, B, and C.
   (b) Without calculating, list the time intervals during which the distances travelled are, in order, from largest to smallest.

Reflecting

12. What assumption have you been making about acceleration in this chapter?

Acceleration Assignment

Equations:

$$\text{Acceleration} = \frac{\text{Final velocity} - \text{Initial velocity}}{\text{Time}} \qquad \text{Time} = \frac{\text{Final Velocity} - \text{Initial Velocity}}{\text{Acceleration}}$$

1. The Concorde jetliner achieves a lift-off speed of 112m/s in 20.0s, starting from rest. What is the acceleration?

2. A motorboat accelerated from rest to a final speed of 6.0m/s in a time of 3.0s. What is the acceleration of the motorboat?

3. A bottle-nosed dolphin is cruising along at 2.2m/s, and accelerates to 9.7m/s in 15s. What is the dolphin's acceleration?

4. A driver is traveling at 12.0m/s, and sees a light turn red. The driver applies the brakes, and the car accelerates at $-6.20 m/s^2$ until it stops. How long does it take the car to stop?

5. The velocity of a train is 26.4m/s. At an acceleration of $-1.50 m/s^2$, how much time is required for the train to decrease its velocity to 9.72m/s?

6. A skier, starting from rest, accelerates at $1.6 m/s^2$. How fast is the skier going after 5.0s?

7. A water balloon is dropped from a building. It starts at rest and accelerates at $9.8 m/s^2$ due to gravity. How fast is the balloon going after 3 seconds?

8. A roller coaster car rapidly picks up speed as it rolls down a slope. As it starts down the slope, its speed is 4 m/s. But 3 seconds later, at the bottom of the slope, its speed is 22 m/s. What is its average acceleration?

9. A cyclist accelerates from 0 m/s to 8 m/s in 3 seconds. What is his acceleration ? Is this acceleration higher than that of a car which accelerates from 0 to 30 m/s in 8 seconds?

10. A car advertisement states that a certain car can accelerate from rest to 70 km/h in 7 seconds. Find the car's average acceleration.

14. A lizard accelerates from 2 m/s to 10 m/s in 4 seconds. What is the lizard's average acceleration?

12. If a Ferrari, with an initial velocity of 10 m/s, accelerates at a rate of 50 m/s/s for 3 seconds, what will its final velocity be?