Understanding Concepts

1. Describe the differences between uniform and non-uniform motion. Give a specific example of each type of motion.
2. Laser light, which travels in a vacuum at 3.00×10^8 m/s, is used to measure the distance from Earth to the Moon with great accuracy. On a clear day, an experimenter sends a laser signal toward a small reflector on the Moon. Then, 2.51 s after the signal is sent, the reflected signal is received back on Earth. What is the distance between Earth and the Moon at the time of the experiment?
3. The record lap speed for car racing is about 112 m/s (or 402 km/h). The record was set on a track 12.5 km in circumference. How long did it take the driver to complete one lap?
4. A fishing boat leaves port at 04:30 A.M. in search of the day's catch. The boat travels 4.5 km [E], then 2.5 km [S], and finally 1.5 km [W] before discovering a large school of fish on the sonar screen at 06:30 A.M.
   (a) Draw a vector scale diagram of the boat's motion.
   (b) Calculate the boat's average speed.
   (c) Determine the boat's average velocity.
5. State what is represented by each of the following calculations:
   (a) the slope on a position-time graph
   (b) the area on a velocity-time graph
   (c) the area on an acceleration-time graph
6. Table 1 shows data recorded in an experiment involving motion.

Table 1

Time (s)	0.00	0.10	0.20	0.30	0.40	0.50	0.60
Position (cm [W])	0	25	50	75	75	75	0

   (a) Use the data to plot a position-time graph of the motion. Assume that the lines between the points are straight.
   (b) Use the graph from (a) to find the instantaneous velocity at times 0.10 s, 0.40 s, and 0.55 s.
   (c) Plot a velocity-time graph of the motion.
   (d) Find the total area between the lines and the time-axis on the velocity-time graph. Does it make sense that this area indicates the resultant displacement?
7. A ferry boat is crossing a river that is 8.5×10^2 m wide. The average velocity of the water relative to the shore is 3.8 m/s [E] and the average velocity of the boat relative to the water is 4.9 m/s [S].
   (a) Determine the velocity of the ferry boat relative to the shore.
   (b) How long does the crossing take?
   (c) Determine the displacement of the boat as it crosses from the north shore to the south shore.
8. (a) Is it possible to have zero velocity but non-zero acceleration at some instant in a motion? Explain.
   (b) Is it possible to have zero acceleration but non-zero velocity at some instant in a motion? Explain.
9. A ball is thrown vertically upward. What is its acceleration
   (a) after it has left the thrower's hand and is travelling upward?
   (b) at the instant it reaches the top of its flight?
   (c) on its way down?
10. (a) If the instantaneous speed of an object remains constant, can its instantaneous velocity change? Explain.
   (b) If the instantaneous velocity of an object remains constant, can its instantaneous speed change? Explain.
   (c) Can an object have a northward velocity while experiencing a southward acceleration? Explain.
11. Show that (cm/s)/s is mathematically equivalent to cm/s^2.
12. A cyclist on a ten-speed bicycle accelerates from rest to 2.2 m/s in 5.0 s in third gear, then changes into fifth gear. After 10.0 s in fifth gear, the cyclist reaches 5.2 m/s. Assuming that the direction of travel remains the same, calculate the magnitude of the average acceleration in the third and fifth gears.
13. For the graph shown in Figure 1, determine the following:
   (a) velocity at 1.0 s, 3.0 s, and 5.5 s
   (b) acceleration at 1.0 s, 3.0 s, and 5.5 s

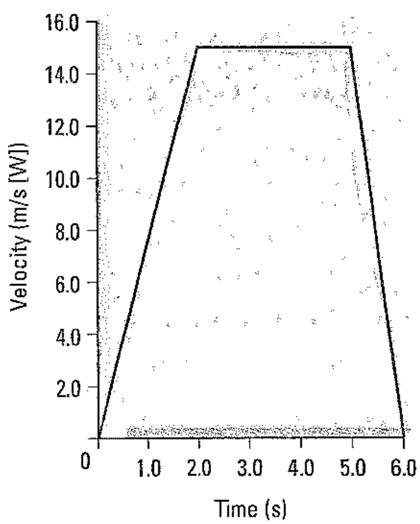
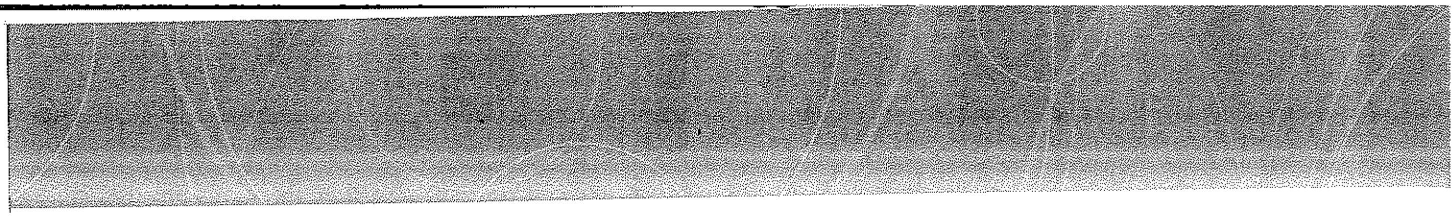


Figure 1



14. A student throws a baseball vertically upward, and 2.8 s later catches it at the same level. Neglecting air resistance, calculate the following:
    (a) the velocity at which the ball left the student's hand (*Hint:* Assume that, when air resistance is ignored, the time it takes to rise equals the time it takes to fall for an object thrown upward.)
    (b) the height to which the ball climbed above the student's hand.
15. An arrow is accelerated for a displacement of 75 cm [fwd] while it is on the bow. If the arrow leaves the bow at a velocity of 75 m/s [fwd], what is its average acceleration while on the bow?
16. An athlete in good physical condition can land on the ground at a speed of up to 12 m/s without injury. Calculate the maximum height from which the athlete can jump without injury. Assume that the takeoff speed is zero.
17. Two cars at the same stoplight accelerate from rest when the light turns green. Their motions are shown by the velocity-time graph in **Figure 2**.
    (a) After the motion has begun, at what time do the cars have the same velocity?
    (b) When does the car with the higher final velocity overtake the other car?
    (c) How far from the starting position are they when one car overtakes the other?

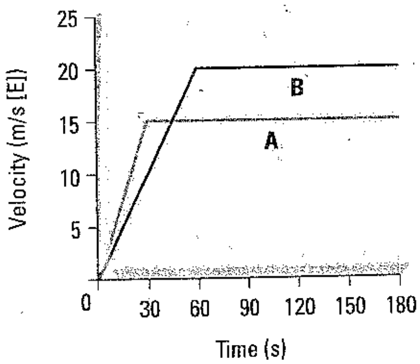


Figure 2

18. (a) Discuss the factors that likely affect the terminal speed of an object falling in Earth's atmosphere.
    (b) Is there a terminal speed for objects falling on the Moon? Explain.

19. Describe the motion represented by each graph in Figure 3.

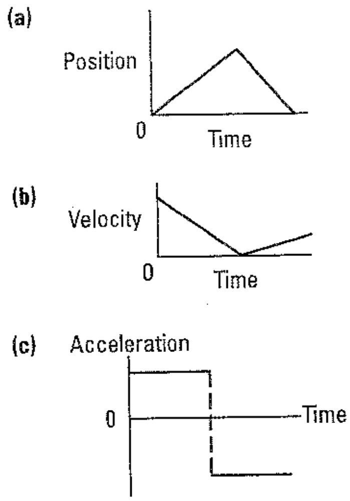


Figure 3
(a) Position-time graph
(b) Velocity-time graph
(c) Acceleration-time graph

20. At a certain location the acceleration due to gravity is 9.82 m/s^2 [down]. Calculate the percentage error of th following experimental values of $\vec{g}$ at that location:
    (a) 9.74 m/s^2 [down]
    (b) 9.95 m/s^2 [down]
21. You can learn to estimate how far light travels in your classroom in small time intervals, such as 1.0 ns, 4.5 ns, etc.
    (a) Verify the following statement: "Light travels the length of a 30.0 cm ruler (about one foot in the Imperial system) in 1.00 ns."
    (b) Estimate how long it takes light to travel from the nearest light source in your classroom to your eye
22. The results of an experiment involving motion are sui marized in **Table 2**. Apply your graphing skills to generate the velocity-time and acceleration-time graphs c the motion.

Table 2

Time (s)	0.0	1.0	2.0	3.0	4.0
Position (m [S])	0	19	78	176	315

23. In a certain acceleration experiment, the initial velocity is zero and the initial position is zero. The acceleration is shown in **Figure 4**. From the graph, determine the information needed to plot a velocity-time graph. Then, from the velocity-time graph, find the information needed to plot a position-time graph. (*Hint:* You should make at least four calculations on the velocity-time graph to be sure you obtain a smooth curve on the position-time graph.)

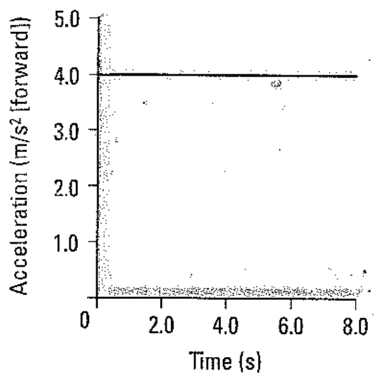


Figure 4

Applying Inquiry Skills

24. For experiments involving motion, state
    (a) examples of random error
    (b) examples of systematic error
    (c) an example of a measurement that has a high degree of precision but a low degree of accuracy (Make up a specific example.)
    (d) an example of when you would calculate the percentage error of a measurement
    (e) an example of when you would find the percentage difference between two measurements

25. Small distances in the lab, such as the thickness of a piece of paper, can be measured using instruments with higher precision than a millimetre ruler. Obtain a vernier caliper and a micrometer caliper. Learn how to use them to measure small distances. Then compare them to a millimetre ruler, indicating the advantages and disadvantages.

Making Connections

26. Car drivers and motorcycle riders can follow the two-second rule for following other vehicles at a safe distance. But truck drivers have a different rule. They must maintain a distance of at least 60.0 m between their truck and other vehicles while on a highway at any speed above 60.0 km/h (unless they are overtaking and passing another vehicle). In this question, assume two significant digits.
    (a) At 60.0 km/h, how far can a vehicle travel in 2.0 s?
    (b) Repeat (a) for a speed of 100.0 km/h.
    (c) Compare the two-second rule values in (a) and (b) to the 60-m rule for trucks. Do you think the 60-m rule is appropriate? Justify your answer.
    (d) Big, heavy trucks need a long space to slow down or stop. One of the dangerous practices of aggressive car drivers is cutting in front of a truck, right into the supposed 60.0-m gap. Suggest how to educate the public about this danger.

27. Describe why the topic of acceleration has more applications now than in previous centuries.

Exploring

28. In this chapter, several world records of sporting and other events are featured in questions and sample problems. But records only stand until somebody breaks them. Research the record times for various events of interest to you. Follow the links for Nelson Physics 11, Chapter 1 Review. Calculate and compare the average speeds or accelerations of various events.

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29. Critically analyze the physics of motion in your favourite science fiction movie. Describe examples in which the velocities or accelerations are exaggerated.