Knowledge

For each question, select the best answer from the four alternatives.

1. What is your displacement if you walk 50 m east and then 15 m west? (1.1) K/U
   (a) 75 m west
   (b) 65 m west
   (c) 35 m east
   (d) 65 m east
2. Which of the following situations most accurately demonstrates an object moving with uniform velocity? (1.2) K/U
   (a) a bungee jumper
   (b) a dribbling basketball
   (c) a sailboat in a steady wind
   (d) the Moon orbiting Earth
3. What is the average speed of a jaguar that runs 252 m in 40.0 s? (1.2) T/I
   (a) 5.95 m/s
   (b) 6.30 m/s
   (c) 6.75 m/s
   (d) 7.12 m/s
4. Which of the following formulas would you use to calculate acceleration? (1.3) K/U
   (a) $\frac{\Delta \vec{d}}{\Delta t}$
   (b) $\frac{\Delta t}{\Delta \vec{v}}$
   (c) $\frac{\Delta \vec{d}}{\Delta \vec{v}}$
   (d) $\frac{\Delta \vec{v}}{\Delta t}$
5. A girl drops a penny off a bridge. The penny lands in the water after 1.2 s. What is the speed of the penny just before it hits the water? (1.6) T/I
   (a) 10 m/s
   (b) 12 m/s
   (c) 13 m/s
   (d) 14 m/s
6. Speed limiters are devices that
   (a) monitor the speed of cars during inclement weather
   (b) are put on the road to slow cars above a certain speed
   (c) are put in cars to electronically limit teen drivers to a maximum speed
   (d) monitor the overall traffic patterns for a city and set speed limits accordingly (1.7) K/U
7. For a diagram scale of 1 cm : 25 km, what is the actual distance represented by a 3.0 cm diagram measurement? (2.1) T/I
   (a) 0.75 km
   (b) 3.0 km
   (c) 25 km
   (d) 75 km
8. What is the x-component of the displacement vector $\Delta \vec{d}_T = 36.0$ m [S 38° E]? (2.2) T/I
   (a) 11.4 m [E]
   (b) 22.2 m [E]
   (c) 28.5 m [E]
   (d) 34.4 m [E]
9. Four students travelling to a sporting event make a mistake with their directions and end up travelling out of their way. They are able to use a map to get themselves back on track, but their mistake caused them to travel 15 km [N] and then 5.3 km [W]. What displacement resulted from their wrong directions? (2.2) T/I
   (a) 22 km [N 18° W]
   (b) 20 km [W 16° N]
   (c) 18 km [N 74° W]
   (d) 16 km [N 16° W]
10. A rocket is launched from the ground with an initial horizontal velocity of 4.8 m/s [right] and an initial vertical velocity of 9.5 m/s [up]. At what angle from the horizontal is it launched? (2.2, 2.3) T/I
    (a) 72°
    (b) 63°
    (c) 39°
    (d) 27°

11. Before Galileo performed his experiments with falling bodies, which one of Aristotle's theories was considered to be true? (2.4) K/U
    (a) All objects fall at the same constant rate no matter their size.
    (b) Objects fall at a constant rate, with heavier objects falling more quickly than lighter objects.
    (c) All objects accelerate at the same rate when falling.
    (d) Smaller objects fall more quickly than larger objects.

Indicate whether each statement is true or false. If you think the statement is false, rewrite it to make it true.

12. Motion is the change in location of an object, as measured by an observer. (1.1) K/U
13. If a person walks 25 m [E] and then walks 10 m [W], then the total distance travelled by the person is 35 m. (1.1) K/U
14. The average velocity of an object is the change in time divided by the change in displacement. (1.2) K/U
15. An object with non-uniform velocity is either changing speed or changing direction or both. (1.2) K/U
16. A runner that is veering left to pass another runner is not accelerating. (1.3) K/U
17. Since 1987, the annual number of automobile accident fatalities in Canada has increased by 33 %. (1.7) K/U
18. A diagram where 150 m in real life is represented as 1 cm on the diagram has a scale of 150 m : 1 cm. (2.1) K/U
19. When given only the x-component and y-component vectors, trigonometric ratios should be used to determine the magnitude of the displacement vector. (2.2) K/U
20. The resultant vector after travelling 12 km [S] and then 19 km [W] has a direction of W 32° S. (2.2) K/U
21. Vertical and horizontal motions are independent of each other, but they do share the common factor of time. (2.2) K/U
22. If a bowling ball and a feather are dropped at the same time from the same height in a vacuum, then the bowling ball will hit the ground first. (2.3, 2.4) K/U
23. Galileo showed that the distance that falling bodies travelled is proportional to the square of the time measured. (2.4) K/U

Match each term on the left with the most appropriate description on the right.

24. (a) displacement — (i) where the velocity of an object changes at a constant rate
    (b) resultant vector — (ii) a device that measures acceleration
    (c) velocity — (iii) a graph describing the motion of an object with position on the vertical axis
    (d) accelerometers — (iv) the vector given after adding vectors
    (e) position–time graph — (v) an object's total displacement divided by the total time taken for the motion
    (f) motion with uniform acceleration — (vi) a vector along the direction of a coordinate axis
    (g) component vector — (vii) the change in position of an object
    (2.3, 2.5) K/U

Write a short answer to each question.

25. In your own words, describe what position is. Use your description to explain the difference between displacement and distance. Provide an example. (1.1) K/U
26. (a) What is the difference between a scalar and a vector?
    (b) Describe how vectors are drawn and how two vectors are added on a diagram. (1.1) K/U
27. Name one reason for and one reason against requiring speed limiters for teenage drivers. (1.7) K/U

Understanding

Use Figure 1 to answer Questions 28 to 30.

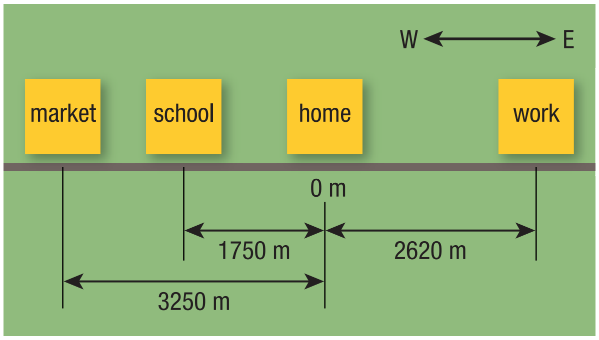


Figure 1

28. Your mom asks you to go to the market after school to pick up some milk. What is your displacement from school when you are at the market? (1.1) T/I
29. After work one day you go to the market to pick up a few things. What is your displacement? (1.1) T/I
30. A girl gets sick in school. Her dad stops at the market first to get medicine, and then picks her up and takes her home. What is the displacement of the girl? (1.1) T/I
31. A bird flying between trees changes its position from 121 m [W] of a flagpole to 64 m [E]. What is the displacement of the bird? (1.1) T/I
32. During a straightaway, a race car travels a distance of 280 m in 4.3 s. What is the average speed of the race car on the straightaway? (1.2) K/U
33. A bird is hunting for food and flies 420 m [E] from its nest in 14.4 s. What is the average velocity of the bird during its flight? (1.2) T/I
34. A car travels from 32 km [W] of a railroad to 27 km [E] of the railroad in 1.8 h. What is the velocity of the car in metres per second? (1.2) T/I
35. A racing team is testing a new design for a car. The car is able to pass through a straight portion of track in 13.7 s when its average speed is 263 km/h. How long is that portion of the track? (1.2) T/I
36. (a) An object moves according to the position–time graph given in **Figure 2**. Does the object have uniform velocity? Explain.
    (b) From the graph, determine whether the object's velocity is positive or negative and how it is changing. (1.2) K/U

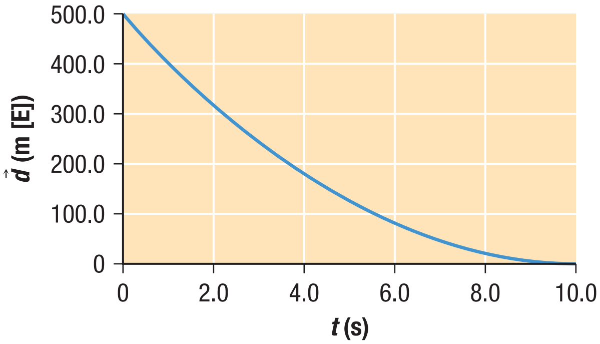


Figure 2

37. (a) Explain the difference between average velocity and instantaneous velocity. Is it possible for these two values to be different?
    (b) Given a position–time graph, describe how you would determine average velocity and instantaneous velocity. (1.2, 1.3) K/U C
38. A runner leaves from his home, and in 1.6 s his speed is 2.8 m/s. Determine the acceleration of the runner. (1.3) T/I
39. A race horse starts running once the gates fall and accelerates at a rate of 7.10 m/s^2 for 2.20 s. What is the final speed of the horse? (1.3) T/I
40. An arrow is shot from a crossbow. How long will it take the arrow to accelerate from rest to a speed of 152 m/s if the crossbow can accelerate the arrow at a rate of 1.35×10^4 m/s^2? (1.3) T/I
41. **Figure 3** is a velocity–time graph for an object under constant acceleration. Determine the displacement of the object over the interval 0 s to 4.0 s. (1.4, 1.5) T/I

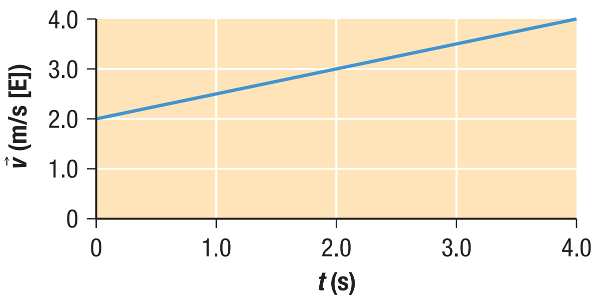


Figure 3

42. To test the durability of a new shock-proof camera, the company has the camera dropped from a height of 15.0 m. Assume air resistance is negligible. (1.6) T/I
   (a) How long does it take for the camera to hit the ground?
   (b) What is the speed of the camera just before it hits the ground?
43. Draw each displacement vector to scale using the scale 1 cm : 100 m. (2.1) K/U
   (a) $\Delta\vec{d} = 710$ m [S 45° E]
   (b) $\Delta\vec{d} = 280$ m [N 20° E]
   (c) $\Delta\vec{d} = 530$ m [W 70° N]
44. Express each vector differently by using an equivalent direction. (2.1) K/U
   (a) $\Delta\vec{d} = 86$ m [E 8° N]
   (b) $\Delta\vec{d} = 97$ cm [E 23° S]
   (c) $\Delta\vec{d} = 3190$ km [S 68° W]
45. A high school student is travelling home after work. She drives her car 850 m due west and then turns right and travels 1150 m before stopping. Use a scale diagram to determine her net displacement. (2.1) T/I
46. The cue ball in billiards is hit for the opening break. It initially travels 2.1 m [N] and then hits the rack of balls and travels a distance of 0.91 m [N 63° E]. Create a scale diagram for the cue ball, and use this to determine the net displacement. (2.1) T/I
47. Copy **Table 1**. Use the given values to solve for and fill in the missing component vectors and magnitudes of the resulting vectors. (2.2) T/I

Table 1

$\vec{d}_x =$	$\vec{d}_y =$	$\vec{d}_T =$
6	8	
5.0		13
	15	17
2.0		7.3
6.0	6.7	

48. Copy **Table 2**. Use the given values to solve for and fill in the missing component vectors and the direction of the resulting vectors. (2.2) T/I

Table 2

$\vec{d}_x =$	$\vec{d}_y =$	ϕ
5.0 [E]	12.0 [N]	
15.00 [W]	8.00 [N]	
91.0 [E]		[E 58.9° S]
	213 [N]	[W 18.4° N]
0.051 [W]		[W 63° S]

49. Determine the magnitude and direction of the *x*-component and *y*-component for each displacement vector. (2.2) K/U
   (a) $\Delta\vec{d}_T = 82$ m [W 76° S]
   (b) $\Delta\vec{d}_T = 34$ m [E 13° N]
   (c) $\Delta\vec{d}_T = 97$ m [S 65° W]
50. For each of the following, add the two component vectors and give the resulting displacement vector: (2.2) K/U
   (a) $\Delta\vec{d}_x = 4.0$ m [W], $\Delta\vec{d}_y = 1.9$ m [S]
   (b) $\Delta\vec{d}_x = 1.9$ m [E], $\Delta\vec{d}_y = 7.6$ m [N]
   (c) $\Delta\vec{d}_x = 72$ m [W], $\Delta\vec{d}_y = 15$ m [N]
51. Three children are throwing a disc in the park. The first child throws the disc 32 m [W 14° S] to the second child, who then throws the disc 15 m [E 62° S]. What is the net displacement of the disc? (2.2) T/I
52. A fish is at the western bank of a river that is 64 m wide and has a current with a velocity of 0.90 m/s [S]. The fish swims directly across the river going due east. The fish can swim at a speed of 0.2 m/s. (2.2) T/I
   (a) How long does it take the fish to get across the river?
   (b) What is the resulting velocity of the fish?
   (c) When the fish arrives on the opposite bank, how far is it from being at the point directly across from where it started?
53. A student drops one pen out a window. At the same time, he throws another pen horizontally with a velocity of 10 m/s. Which pen will hit the ground first? Explain. (2.3) K/U C

54. In a children's soccer game, one of the children kicks the ball from the ground, giving it an initial velocity of 22 m/s at an angle of 62° to the horizontal. Determine the initial vertical and horizontal velocity components. (2.3) T/I

55. A tennis ball machine (**Figure 4**) launches balls horizontally with an initial speed of 5.3 m/s, from a height of 1.2 m. (2.3) T/I

Figure 4

(a) What will the time of flight be for a tennis ball launched by the ball machine?

(b) What will the range of the tennis ball be? (2.3)

Analysis and Application

56. A roller coaster is climbing up a hill on the track at a vertical velocity of 0.60 m/s when it reaches the top and begins to accelerate down the opposite side of the hill. 5.50 s after the roller coaster starts going down the hill, it has a vertical velocity of 27.0 m/s downward. What is the average vertical acceleration of the roller coaster over this portion of the track? (1.3) A

57. Use **Figure 5** to answer the following questions: (1.3) T/I A

(a) Determine the average acceleration over the time interval 0 s to 3.0 s.

(b) Determine the average acceleration over the time interval 2.0 s to 6.0 s.

(c) Determine the total displacement over the time interval 0 s to 6.0 s.

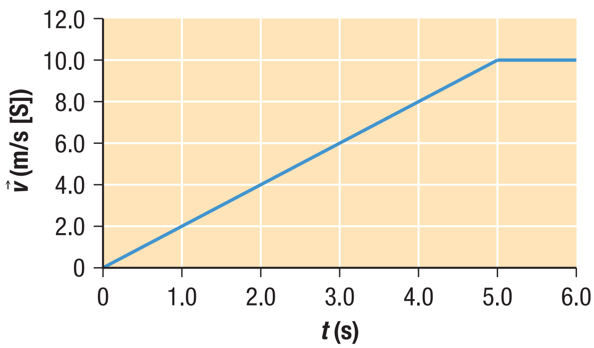


Figure 5

58. Compare the two velocity–time graphs in **Figure 6**. Which one has the greatest acceleration in magnitude? In your own words, explain how you can determine this. (1.3) T/I

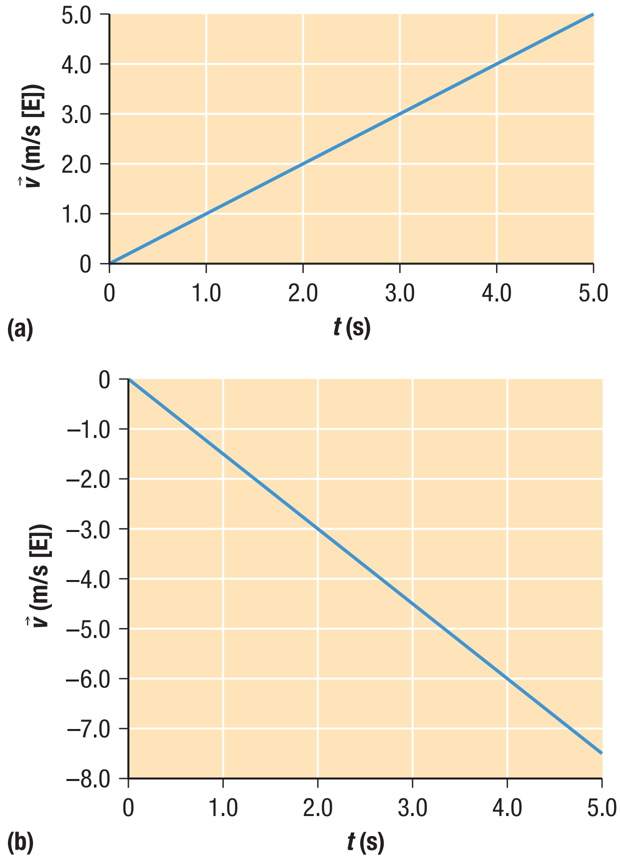


Figure 6

59. Describe what each position-time graph would look like given the initial conditions. Draw a rough sketch for each graph described. (1.4) K/U C

(a) An object has a constant positive acceleration and starts from rest at a zero position reference point.

(b) An object has a constant positive acceleration but initially has a negative velocity and starts at a zero reference point.

(c) An object has a constant negative acceleration but starts with a positive velocity and a positive distance from a given reference point.

(d) An object has zero acceleration, a negative initial velocity, and a positive starting position from a given reference point.

60. A person is driving unsafely on the highway at a speed of 145 km/h and has to slam on his brakes in order to avoid a collision. The brakes can slow down the car at a rate of 10.4 m/s^2. (1.5) T/I
   (a) From the second the car starts to slow down, how long will it take to stop?
   (b) How far will the car travel while slowing down?
61. (a) How far does a vehicle travel if it has an initial speed of 54.0 km/h and accelerates at a rate of 1.90 m/s^2 for 7.50 s?
   (b) What would the final speed of the vehicle in (a) be? (1.5) T/I
62. The five key equations of accelerated motion have a broad range of applications and serve as the basis for understanding kinematics. Copy **Table 3** into your notebook and fill in the missing spaces by describing in what type of situation each equation is useful or what type of problem it can be used to solve. (1.5) K/U C

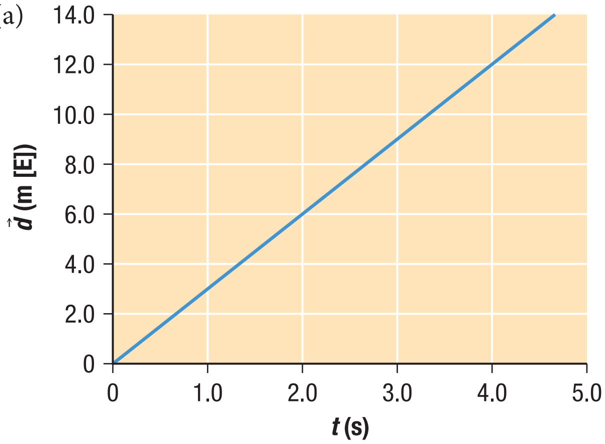
Table 3

	Equation	Uses
Equation 1	$\Delta\vec{d} = \left(\frac{\vec{v}_1 + \vec{v}_2}{2}\right)\Delta t$	
Equation 2	$\vec{v}_f = \vec{v}_i + \vec{a}\Delta t$	
Equation 3	$\Delta\vec{d} = \vec{v}_i\Delta t + \frac{1}{2}\vec{a}_{av}\Delta t^2$	
Equation 4	$\vec{v}_f^2 = \vec{v}_i^2 + 2\vec{a}_{av}\Delta d$	
Equation 5	$\Delta\vec{d} = \vec{v}_f\Delta t - \frac{1}{2}\vec{a}_{av}\Delta t^2$	

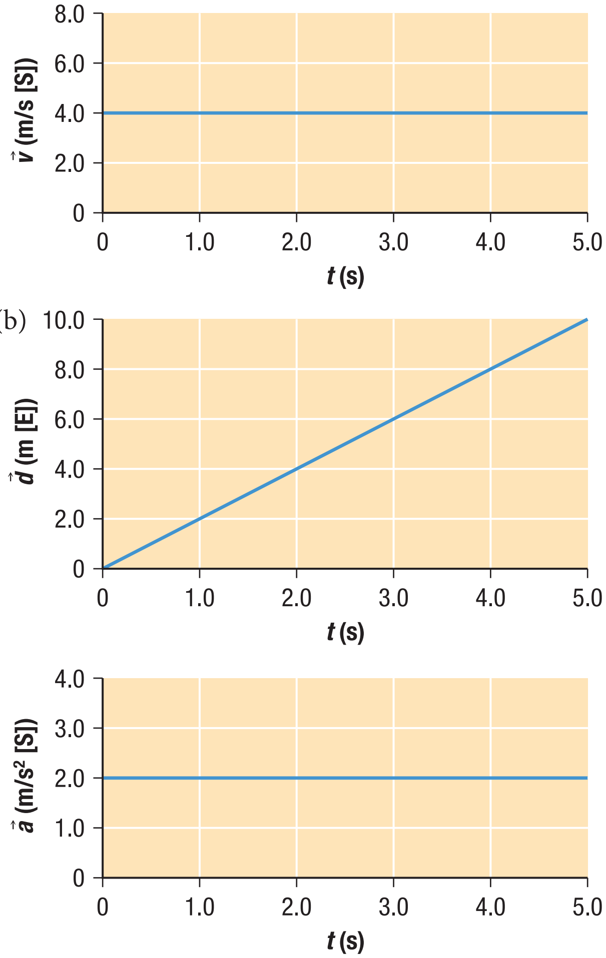
63. A family takes a trip to a beach on Lake Ontario to ride jet skis. The daughter travels a displacement of 240 m [W 11° N] while passing a small island and then turns and travels 330 m [N 20° E]. This takes her 22 s. Create a scale diagram for the daughter and use it to determine her displacement and average velocity. (2.1) T/I
64. In this unit, you learned how to add two vectors by drawing them on a diagram and joining them tip to tail. In your own words, describe how this method can be adapted to subtract two vectors. (2.1) K/U C
65. (a) Vectors have been used throughout this unit to quantify and give direction to real-world motions. Explain in your own words different ways in which vectors are added together for both one and two dimensions.
   (b) How do these methods compare? Try to think of ways in which the methods are similar and ways in which they are different. (1.1, 2.1, 2.2) K/U C
66. A ranger hiking through the woods is trying to determine the direction in which he's travelling. He walks in a roughly northeastern direction for a total distance of 1550 m and uses known landmarks in the distance to determine that he has travelled 1250 m [E]. How far north did he travel and what is his resulting direction? (2.2) T/I
67. An archer is practising on a training course and moves a distance 11 m [E] of her original position, which is due south of her target. She is now firing in a direction of N 28° W. How far is she from her target? (2.2) T/I

68. The same position–time, velocity–time, and acceleration–time graphs you studied in Chapter 1 can also be applied in two dimensions as long as two graphs are given for each component direction. For the following graphs, determine the magnitude and direction of the velocity of an object at time $t = 3.0$ s. If you are finding the velocity from an acceleration–time graph, assume that the initial velocity in that direction is zero. (2.2) T/I A

(a)



(b)



69. (a) During the opening kickoff of a college football game, the kicker kicks a football with an initial velocity of 27.5 m/s at an angle of 41° above horizontal. What is the time of flight for the ball? How far does it travel before hitting the ground? What is the maximum height the football reaches?

(b) After scoring, the kicker makes a mistake when kicking to the other team and kicks the ball too high. The ball stays in the air for 3.2 s and has a range of only 29 m. Determine the initial speed and angle with which the ball was kicked. (2.3) T/I

70. When studying kinematics, the topic of gravitation and projectile motion is unavoidable. Use the knowledge you have gained from Chapters 1 and 2 to answer the following questions about the motion of objects under gravitational acceleration. (2.3) T/I C A

(a) If two objects are dropped from the same height, but one is on the Moon and the other here on Earth, which would hit the ground first?

(b) If a beanbag is launched horizontally and another beanbag with the same mass is dropped straight down from the same height, which would hit the ground first? If this experiment were performed on the Moon, would the results be any different? Explain.

(c) For the horizontally launched beanbag in (b), which beanbag would have the larger range, the one on Earth or the one on the Moon? Explain.

71. In astronaut training it is possible to experience an effectively gravity-free environment in an airplane that is flown in a parabolic path (**Figure 7**). Use your knowledge of projectile motion to explain this experience. (2.3) T/I A

Figure 7

Evaluation

72. In this unit, you learned how to add vectors in one and two dimensions, and in many ways the addition of vectors is the same for both one- and two-dimensional problems. Use the knowledge you gained in this unit to answer the following questions about the properties vectors should have in three dimensions. (1.1, 2.1) T/I C A
    (a) How would drawing a vector in three dimensions be different?
    (b) If you drew a three-dimensional vector diagram to add two vectors, how would it be done and what would the resultant vector be?
    (c) How many component vectors would each three-dimensional vector have? If these were used on a three-dimensional map or image, what directions would they correspond to?
73. Did Galileo's experiments lead to the discovery of modern kinematics? Using what you have learned in Chapters 1 and 2, evaluate the impact Galileo's experiments had on the scientific community. Do you think Newton would have come up with his laws and performed his own experiments without the work of Galileo? Explain. (2.4) T/I
74. Use what you have learned about accelerometers to describe one way in which they could be added to a daily device you use. This should be a device that does not already include accelerometers, but could benefit from this added technology. What could the accelerometer be used for and what would it measure? How would the accelerometer improve your chosen device? (2.5) T/I C A

Reflect on Your Learning

75. (a) Was there any material in this unit that you found particularly illuminating in understanding how objects move?
    (b) Did you realize how useful trigonometry was for real-world applications of direction and projectiles or was this a new concept for you? C
76. How has your understanding of gravity changed after this unit? Do you feel that you have a better understanding of why objects fall and travel the way they do? If you could time travel back to the sixteenth or seventeenth century, do you think you could explain these rules to the scientists of that day? C

Research

GO TO NELSON SCIENCE

77. One of the most important uses for the science of kinematics is transportation. One of the fastest growing technologies is high-speed rails, like the one shown in **Figure 8**. Research this topic and write a few paragraphs on how this transportation method works and how it is used around the world. Predict how common you think this technology will be in the future. In later chapters, you will learn how many of these trains are able to reach such great speeds without the use of wheels. T/I C

Figure 8

78. Pick your favourite sport and research the world record speeds or distances involved. This may include the fastest slapshot in hockey, the fastest baseball pitch, the farthest-hit ball, or the fastest tennis serve. Get in groups of two or three and pick one of your sports and records. Try to reproduce the world record and take measurements on how your values compare to the record. You might have to take distance and time measurements and then perform the required calculations to come up with your values. T/I C
79. One of the biggest achievements in the twentieth century was landing on the Moon; one of the biggest ambitions we still have is to be able to make this travel accessible to everyone and expand the limits of our travel abilities. Research new topics in space travel technologies and write a paper on your favourite findings. This could include ideas about how we could travel between the Earth and space stations or ideas about how we might one day be able to travel to distant galaxies. T/I C