K/U Knowledge/Understanding T/I Thinking/Investigation C Communication A Application

Knowledge

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

1. Which of the following terms refers to the total length of the path travelled by an object in motion? (1.1) K/U
   (a) kinematics
   (b) distance
   (c) direction
   (d) position
2. Which of the following terms means the change in position of an object? (1.1) K/U
   (a) acceleration
   (b) direction
   (c) displacement
   (d) vector
3. What is your displacement if you walk 250 m east and then 100 m west? (1.1) K/U
   (a) 100 m [W]
   (b) 150 m [W]
   (c) 300 m [E]
   (d) 150 m [E]
4. Which of the following describes a vector quantity? (1.1) K/U
   (a) An apple falls 6 m.
   (b) A fish swims at 1 m/s.
   (c) A student solves a puzzle in 10 min.
   (d) A car drives 60 km north.
5. Which of the following describes a line drawn to a specific scale with an arrow head? (1.1) K/U
   (a) directed line segment
   (b) position
   (c) motion
   (d) vector scale diagram
6. What is the correct expression for average velocity? (1.2) K/U
   (a) $\frac{\Delta d}{\Delta t}$
   (b) $\frac{\Delta t}{\Delta d}$
   (c) $\frac{\Delta \vec{d}}{\Delta t}$
   (d) $\frac{\Delta t}{\Delta \vec{d}}$
7. Which of the following terms refers to the change between points on the y-axis? (1.2) K/U
   (a) rise
   (b) run
   (c) slope
   (d) steepness
8. Which of the following objects most accurately demonstrates an object moving with uniform velocity? (1.2) K/U
   (a) a merry-go-round
   (b) a runner racing from start to finish
   (c) a tennis ball during a match
   (d) a car travelling on the highway with cruise control on
9. A car starts from rest and speeds up to 10.0 m/s in 4.0 s. What is the acceleration of the car? (1.3) T/I
   (a) 40 m/s^2
   (b) 25 m/s^2
   (c) 2.5 m/s^2
   (d) 2.0 m/s^2

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

10. Motion is the line an object moves along from a particular starting point. (1.1) K/U
11. A scalar is a quantity that has a magnitude and also direction. (1.1) K/U
12. Kinematics is the term used by physicists and engineers to describe the study of how objects move. (1.1) K/U
13. Vectors are added by joining them tip to tip. (1.1) K/U
14. The difference between speed and velocity is that speed is a vector while velocity is a scalar. (1.2) K/U
15. The slope of a position–time graph gives the velocity of the object. (1.2) K/U
16. Motion in a straight line but with a varying speed is considered motion with uniform velocity. (1.2) K/U
17. The slope of a velocity–time graph gives the displacement of an object. (1.3) K/U
18. Acceleration is measured in metres per second, per second. (1.3) K/U

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

19. (a) distance — (i) a quantity that has a magnitude only
    (b) scalar — (ii) motion at a constant speed in a straight line
    (c) acceleration — (iii) the acceleration of an object in free fall
    (d) uniform velocity — (iv) the steepness of a line or rise over run
    (e) acceleration due to gravity — (v) the total length of the path travelled by an object
    (f) slope — (vi) the rate of change of velocity (1.1, 1.2, 1.3, 1.6) K/U

Write a short answer to each question.

20. In your own words, describe the difference between velocity and speed and how they relate to distance and displacement. (1.1, 1.2) K/U C
21. In your own words, describe what it means for an object to have a negative acceleration. (1.3) K/U C

Understanding

Use **Figure 1** to answer Questions 22 to 25.

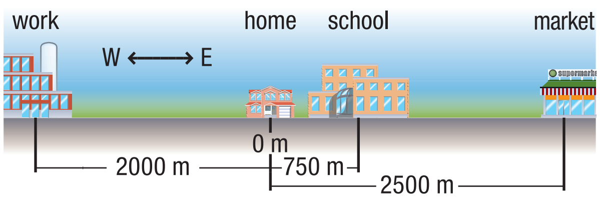


Figure 1

22. If you were to walk from home to work, what would your displacement be? (1.1) T/I
23. What is your displacement if you walk from school to the market? (1.1) T/I
24. You have to go to the market one evening after work to pick up food for supper. What is your displacement from work to the market? (1.1) T/I
25. After school, you have to go to the market before returning home. What is your total displacement? (1.1) T/I
26. A car changes its position from 76 km [W] to 54 km [E]. What is the car's displacement? (1.1) T/I
27. A race car travels a distance of 250 m in 4.0 s. What is the average speed of the car? (1.2) K/U
28. A person throws a baseball with an average speed of 15 m/s. How far will the ball go in 3.0 s? (1.2) K/U
29. A bird flies 310 m [S] of its nest in 8.0 s. What is the velocity of the bird? (1.2) T/I
30. A car starts at 45 km [W] of a railroad crossing and travels to 15 km [E] of the railroad in 1.2 h. What is the velocity of the car in metres per second? (1.2) T/I
31. A bird flies from its nest and lands in a tree that is 2400 m due west. If the bird can fly at an average velocity of 9.0 m/s, for how long, in seconds, is the bird in flight? (1.2) T/I
32. A drag racer completes a race in 14.3 s. If the drag racer has an average speed of 251 km/h, how long is the racetrack? (1.2) T/I
33. (a) For the position–time graph shown in **Figure 2**, explain whether the object being described has uniform or non-uniform velocity.
    (b) Relative to the object's displacement, is the velocity positive or negative? If applicable, how is the velocity changing? Explain. (1.2) K/U

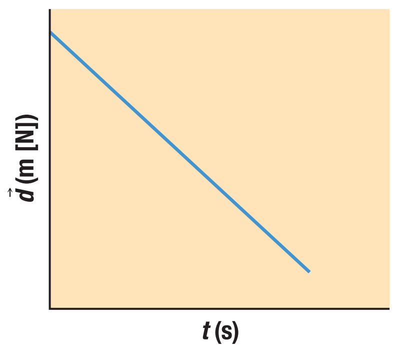


Figure 2

34. (a) For the position–time graph shown in **Figure 3**, explain whether the object being described has uniform or non-uniform velocity.
    (b) Relative to the object's displacement, is the velocity positive or negative? If applicable, how is the velocity changing? Explain. (1.2) K/U

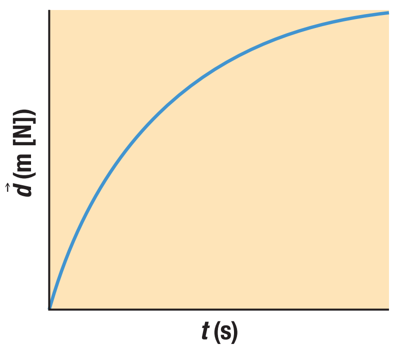


Figure 3

35. A runner starts a race and in 1.25 s has a velocity of 5.0 m/s [E]. Determine the acceleration of the runner. (1.3) T/I

36. A horse starts running and accelerates at a rate of 6.25 m/s^2 [W] for 2.0 s. What is the final velocity of the horse? (1.3) T/I

37. How long does it take a bullet to accelerate from rest to a speed of 343 m/s if the blast from the gun can accelerate the bullet at a rate of 1.25×10^5 m/s^2? (1.3) T/I

38. A race car slows down to make a turn. If it has an initial velocity of 180 km/h [S] and accelerates at a rate of 8.2 m/s^2 [N] for 3.2 s, at what velocity (in kilometres per hour) does the race car make the turn? (1.3) T/I

39. A student riding a bicycle begins to go downhill and accelerates at a rate of 1.8 m/s^2. If the acceleration lasts for 2.4 s, and the final speed of the student on the bicycle is 10.2 m/s, at what speed was he initially travelling? (1.3) T/I

40. **Figure 4** is a velocity–time graph for an object moving with constant acceleration. Determine the displacement of the object over the interval 0 s to 4.0 s. (1.4, 1.5) T/I

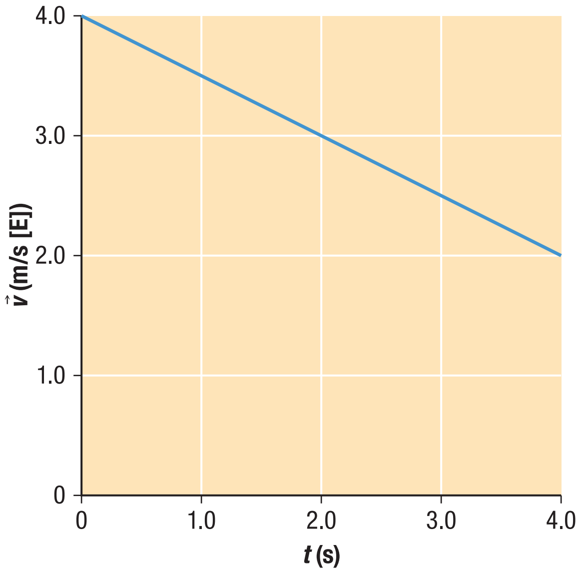


Figure 4

41. An object starts with an initial velocity of 4.0 m/s [W] and has an acceleration of 1.0 m/s^2 [W]. What is the displacement of the object after 3.0 s? (1.5) T/I

42. Students roll a ball down a hill with an initial velocity of 3.0 m/s. The ball accelerates at a rate of 0.80 m/s^2 and rolls a total distance of 6.0 m down the hill. (1.5) T/I
    (a) The students do not have a stopwatch. What formula would be useful to find the final velocity?
    (b) What is the final velocity of the ball?

43. Students performing an experiment for their physics class are dropping balls from a height of 10.0 m. Ignore air resistance. (1.6) T/I
    (a) How long does it take for a ball to hit the ground?
    (b) What is the final velocity of the ball just before it hits the ground?

Analysis and Application

44. A car drives 230 m [E] to a traffic light. It then continues on for another 350 m [E]. (1.1) T/I C
    (a) Draw a vector scale diagram to represent the displacement of the car.
    (b) Calculate the car's total displacement.

45. An eagle perched on a branch flies 54 m [N] to catch a fish and then flies 72 m [S] back to its nest. (1.1) T/I C
    (a) Draw a vector scale diagram to represent the displacement of the eagle.
    (b) Calculate the eagle's total displacement.

46. The position of an object changes from 4.0 m [E] of its starting point to 16 m [E] of its starting point in 6.0 s. What is the velocity of the object? (1.2) T/I

47. Fifteen seconds into a car race, a car runs through a checkpoint that is 250 m [N] from the starting point. Thirty-six seconds into the race it runs through another checkpoint that is 750 m [N] from the starting point. Determine the average velocity of the car between the two checkpoints. (1.2) T/I

48. A motocross racer hits a checkpoint 25 s into a race that is 320 m [E] from the starting point. At the checkpoint, the racer takes a sharp turn, and at 49 s into the race hits another checkpoint that is 140 m [W] from the starting line. What is the average velocity of the racer between the two checkpoints? (1.2) T/I

49. A train starts out at a station that is 450 km west of a city and travels to the next station, which is 920 km west of the city. If the train has an average velocity of 40.0 km/h, how long does it take to travel between the two stations? (1.2) T/I

50. A man has to drive from his job, which is 4.5 km south of his home, to the grocery store, which is 2.5 km north of his home. If he drives with an average speed of 9.7 m/s, how long, in minutes, will the trip take him? (1.2) T/I

51. A deer walking through the forest gets scared and begins to run away. If the walking speed of the deer is 1.0 m/s and its running speed is 7.6 m/s, and it only takes the deer 0.80 s to change its speed, what is the acceleration of the deer? (1.3) T/I

52. How long does it take a motorcycle to change its speed from 7.0 m/s [W] to 12.1 m/s [W] if it can accelerate at a rate of 3.9 m/s^2 [W]? (1.3) T/I

53. A bungee jumper is falling at a velocity of 32.0 m/s when the cord catches and begins to accelerate her upward. Then, 5.30 s after the cord catches, she has a velocity of 24.0 m/s upward. What is the average acceleration due to the pull of the bungee cord and in which direction is it applied? (1.3) T/I

54. The wind is blowing a balloon at a velocity of 4.3 m/s [W]. After 7.2 s, the wind blows the balloon with a velocity of 2.5 m/s [E]. Determine the average acceleration of the balloon. (1.3) T/I

55. Students decide to roll a ball between two hills and take measurements of its velocity. These measurements are plotted in **Figure 5**. (1.3) T/I C

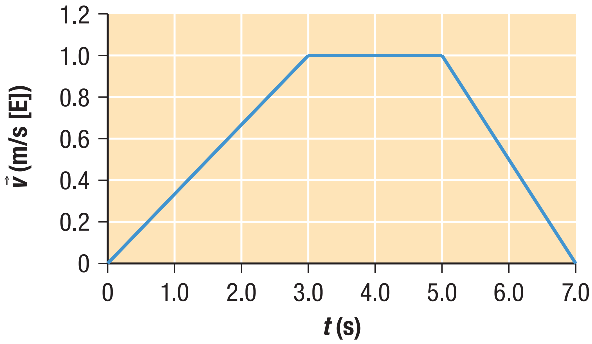


Figure 5

(a) Determine the average acceleration over the following time intervals: 0 s to 3.0 s and 3.5 s to 5.0 s.

(b) Determine the total displacement over the time interval 0 s to 7.0 s.

56. **Figure 6** is an acceleration–time graph for an object. (1.4) T/I

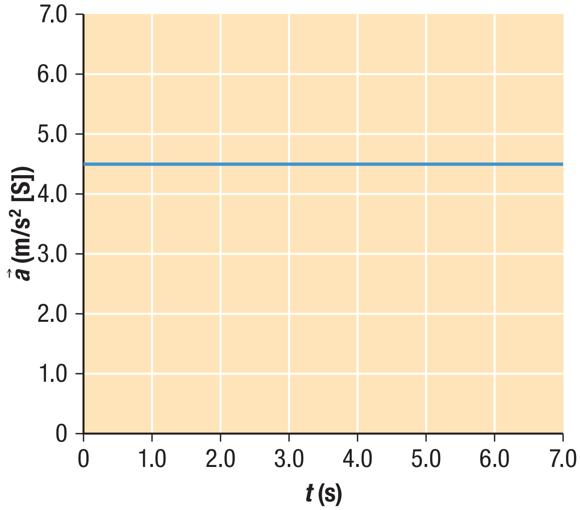


Figure 6

(a) Calculate the change in velocity over the time interval 2.0 s to 5.0 s.

(b) If the starting velocity for the time interval in (a) is 6.0 m/s [S], what is the final velocity of the object at the end of the time interval?

57. (a) Using the acceleration–time graph shown in **Figure 7**, create a table calculating the velocity at 1.0 s intervals given that the initial velocity of the object described is 5.0 m/s [E].

(b) Use what you found in (a) to draw the velocity–time graph. (1.3, 1.4) T/I C

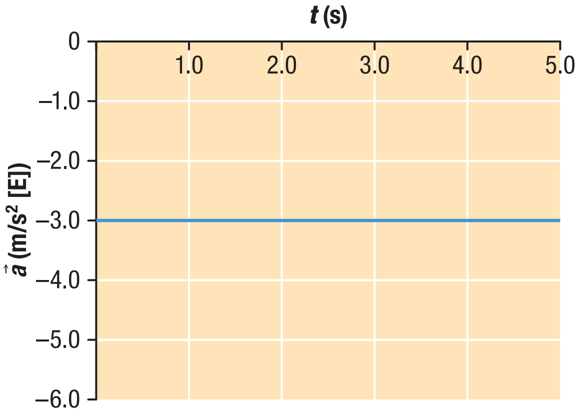


Figure 7

58. Consider the position–time graph shown in **Figure 8**. (1.4) T/I

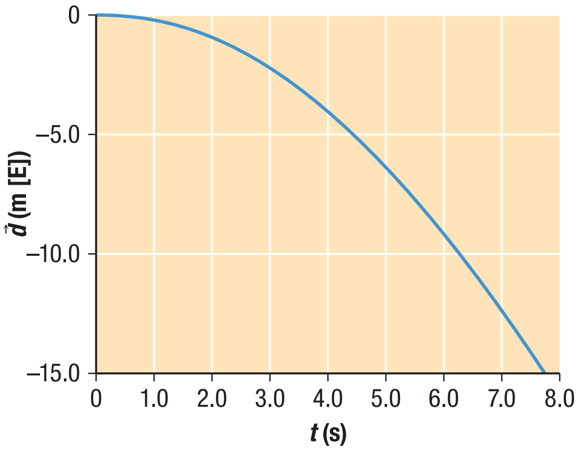


Figure 8

(a) What is the position of the object at $t = 3.0$ s?

(b) Estimate the instantaneous velocity of the object at $t = 2.0$ s.

(c) What is the average velocity for the object from 1.0 s to 5.0 s?

59. A car company is performing brake tests on one of its cars. The car reaches a speed of 160 km/h and then hits the brakes to slow down at a rate of 11.0 m/s^2. (1.5) T/I

(a) How long does it take the car to stop?

(b) How far does the car travel when braking?

60. A sailboat accelerates uniformly from 5.5 m/s to 9.0 m/s over a distance of 32 m. At what rate is the boat accelerating? (1.5) T/I

61. A van merges onto a highway on-ramp with a velocity of 52 km/h and accelerates at a rate of 2.0 m/s^2 for 7.2 s. (1.5) T/I
    (a) What is the displacement of the van over this time?
    (b) What is the final velocity of the van?

62. Draw velocity–time and position–time graphs for the following situations. Use up as positive and ignore air resistance. (1.4, 1.6) T/I C
    (a) A boy throws rocks with an initial velocity of 12 m/s [down] from a 20 m bridge into a river. Consider the river to be at a height of 0 m.
    (b) A baseball player hits a ball straight up with an initial velocity of 32 m/s. Use a time interval from the hit until the ball hits the ground.

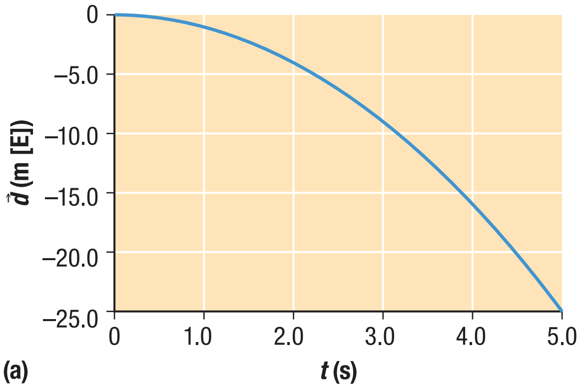
63. A student is throwing rocks off of a bridge straight down into a river below. If he throws a rock with an initial speed of 10.0 m/s and it takes the rock 2.1 s to hit the water, how high is the bridge? Ignore air resistance. (1.6) T/I

64. A baseball player throws a ball into the air with an initial speed of 22 m/s [up]. Ignore air resistance. (1.6) T/I
    (a) How high does the ball go?
    (b) How long is the ball in the air before she catches it?

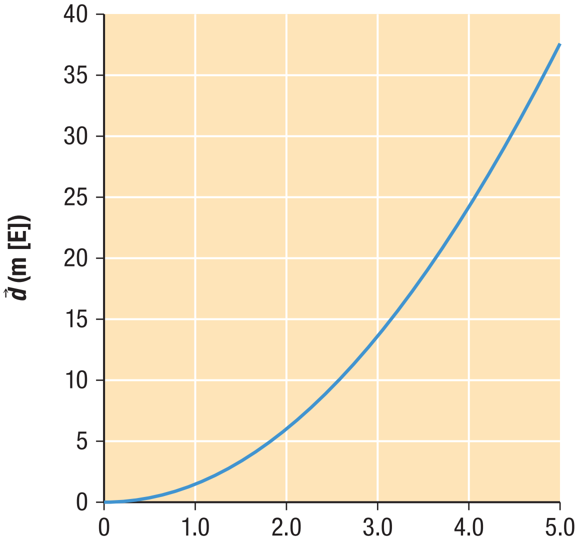
Evaluation

65. (a) Using a metre stick or another suitable measuring device, drop a pencil from 1.0 m and use a stopwatch to time how long it takes to hit the ground. Repeat this three times and create a table of your results. Determine the average velocity in each case.
    (b) Repeat (a), but this time drop the pencil from 2.0 m. Which distance gives the fastest average velocity? Is this what should be expected? Explain. (1.2, 1.3) T/I C A

66. Compare the position–time graphs in **Figure 9.** Which graph has the greatest acceleration in magnitude? Explain how you know. (1.4) T/I C



(a)



(b)

Figure 9

67. An object moves according to the velocity–time graph in **Figure 10**. (1.1, 1.2, 1.3, 1.4) T/I C A

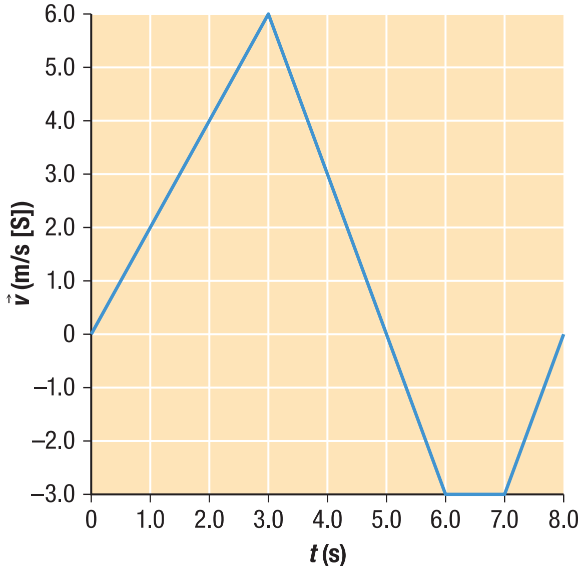


Figure 10

(a) What is the average acceleration over the interval 0 s to 2.0 s? What is the acceleration from 3.0 s to 6.0 s?
(b) In your own words, describe what it means to have a negative velocity. For this object, for what time interval is the velocity negative?
(c) State the intervals for when the motion of the object fits the following categories:
   (i) Positive velocity and negative acceleration
   (ii) Negative velocity and positive acceleration
   (iii) Zero acceleration
(d) Describe in your own words how you would find the total distance that the object travelled from its starting position. How would this differ if you were trying to find the position of the object relative to its starting position?
(e) Calculate both the total distance the object travelled and its position relative to its starting point over the interval 0 s to 8.0 s.

68. Consider the position–time graph shown in **Figure 11**. (1.3, 1.4) T/I C A

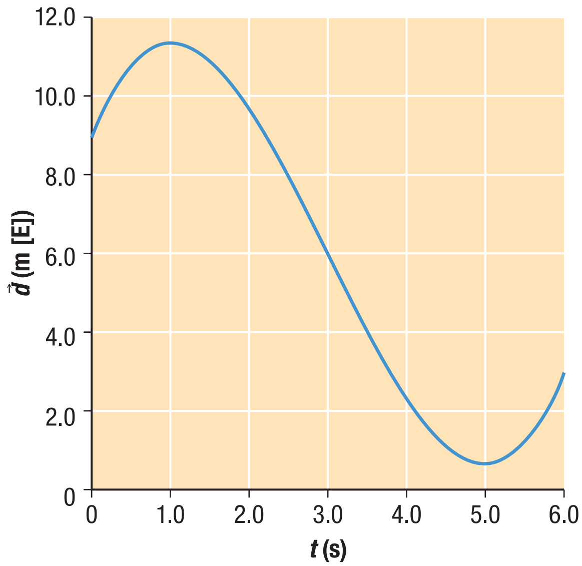


Figure 11

(a) At what times is the instantaneous velocity of the object being described zero? Explain.
(b) Describe how you would determine where the instantaneous acceleration is zero given a velocity–time graph. How would the graph look at these points?
(c) Use the graph to approximate where the instantaneous acceleration is zero. If necessary, sketch a velocity–time graph to help.
(d) What happens to the graph at the point found in (c)? Are there any defining characteristics of the graph at this point?

Reflect on Your Learning

69. When considering velocity–time graphs, we know that the area underneath the line or curve gives the displacement of an object. The slope between two points on the line or curve gives the average acceleration over that time interval. T/I C A
   (a) Using this as an analogy, describe in your own words how to find the velocity from an acceleration–time graph. How would the velocity–time graph look if the acceleration–time graph was not constant?
   (b) What might the slope between two points on the acceleration–time curve represent?

Research

GO TO NELSON SCIENCE

70. Since the beginning of human exploration, leaders, merchants, and adventurers alike have been using evolving methods to determine their relative positions and navigate the land. Research one or two early methods of mapmaking or navigation and write a page describing their history. When writing, consider the following questions to help guide you: What mathematical knowledge was necessary? What devices or instruments were necessary and how were they invented? Were there any devices or discoveries that made this method obsolete? T/I C A

71. (a) Research the world's fastest land animals and write a paragraph or two comparing their speeds, how they move, and any limits on how long this speed can be maintained.
   (b) Research the world's fastest and longest-flying animals and write a paragraph or two comparing their speeds, how they move, and any limits on how long this speed can be maintained.
   (c) Research the world's fastest swimming animals and write a paragraph or two comparing their speeds, how they move, and any limits on how long this speed can be maintained. T/I C A

72. Human innovation is constantly leading to new and improved technology, and this is especially true when it comes to transportation and speed. Write a one-page report or prepare a poster comparing the fastest vehicles in the categories of land speed, air speed, and space shuttle travel. T/I C A

73. Many technologies apply concepts related to kinematics; for example, technologies used to monitor false starts in a sprint competition. Research this technology, and describe how it works. T/I C A