CONCEPTUAL QUESTIONS

1. How many significant figures does each of the following numbers have?
   a. 9.90 b. 0.99 c. 0.099 d. 99
2. How many significant figures does each of the following numbers have?
   a. 0.0044 b. 4.40×10^{-4} c. 440 d. 2.90
3. Is the particle in **FIGURE Q1.3** speeding up? Slowing down? Or can you tell? Explain.

FIGURE Q1.3

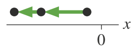
4. Does the object represented in **FIGURE Q1.4** have a positive or negative value of a_x? Explain.
5. Does the object represented in **FIGURE Q1.5** have a positive or negative value of a_y? Explain.

FIGURE Q1.4

FIGURE Q1.5

6. Determine the signs (positive, negative, or zero) of the position, velocity, and acceleration for the particle in **FIGURE Q1.6**.

FIGURE Q1.6



7. Determine the signs (positive, negative, or zero) of the position, velocity, and acceleration for the particle in **FIGURE Q1.7**.

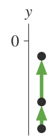


FIGURE Q1.7

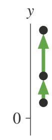


FIGURE Q1.8

8. Determine the signs (positive, negative, or zero) of the position, velocity, and acceleration for the particle in **FIGURE Q1.8**.

EXERCISES AND PROBLEMS

Exercises

Section 1.1 Motion Diagrams

1. | A car skids to a halt to avoid hitting an object in the road. Draw a basic motion diagram, using the images from the video, from the time the skid begins until the car is stopped.
2. | A rocket is launched straight up. Draw a basic motion diagram, using the images from the video, from the moment of liftoff until the rocket is at an altitude of 500 m.
3. | You are watching a jet ski race. A racer speeds up from rest to 70 mph in just a few seconds, then continues at a constant speed. Draw a basic motion diagram of the jet ski, using images from the video, from 10 s before reaching top speed until 10 s afterward.

Section 1.2 Models and Modeling

4. | a. Write a paragraph describing the particle model. What is it, and why is it important?
   b. Give two examples of situations, different from those described in the text, for which the particle model is appropriate.
   c. Give an example of a situation, different from those described in the text, for which it would be inappropriate.

Section 1.3 Position, Time, and Displacement

Section 1.4 Velocity

5. | You drop a soccer ball from your third-story balcony. Use the particle model to draw a motion diagram showing the ball's position and average velocity vectors from the time you release the ball until the instant it touches the ground.
6. | A baseball player starts running to the left to catch the ball as soon as the hit is made. Use the particle model to draw a motion diagram showing the position and average velocity vectors of the player during the first few seconds of the run.
7. | A softball player slides into second base. Use the particle model to draw a motion diagram showing his position and his average velocity vectors from the time he begins to slide until he reaches the base.

Section 1.5 Linear Acceleration

8. | a. **FIGURE EX1.8** shows the first three points of a motion diagram. Is the object's average speed between points 1 and 2 greater than, less than, or equal to its average speed between points 0 and 1? Explain how you can tell.
   b. Use Tactics Box 1.3 to find the average acceleration vector at point 1. Draw the completed motion diagram, showing the velocity vectors and acceleration vector.

FIGURE EX1.8

FIGURE EX1.9

9. | **FIGURE EX1.9** shows five points of a motion diagram. Use Tactics Box 1.3 to find the average acceleration vectors at points 1, 2, and 3. Draw the completed motion diagram showing velocity vectors and acceleration vectors.

10. ‖ FIGURE EX1.10 shows two dots of a motion diagram and vector $\vec{v}_1$. Copy this figure, then add dot 3 and the next velocity vector $\vec{v}_2$ if the acceleration vector $\vec{a}$ at dot 2 (a) points up and (b) points down.

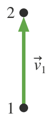


FIGURE EX1.10

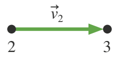


FIGURE EX1.11

11. ‖ FIGURE EX1.11 shows two dots of a motion diagram and vector $\vec{v}_2$. Copy this figure, then add dot 4 and the next velocity vector $\vec{v}_3$ if the acceleration vector $\vec{a}$ at dot 3 (a) points right and (b) points left.
12. | A speed skater accelerates from rest and then keeps skating at a constant speed. Draw a complete motion diagram of the skater.
13. | A car travels to the left at a steady speed for a few seconds, then brakes for a stop sign. Draw a complete motion diagram of the car.
14. | A goose flies toward a pond. It lands on the water and slides for some distance before it comes to a stop. Draw the motion diagram of the goose, starting shortly before it hits the water and assuming the motion is entirely horizontal.
15. | You use a long rubber band to launch a paper wad straight up. Draw a complete motion diagram of the paper wad from the moment you release the stretched rubber band until the paper wad reaches its highest point.
16. | A roof tile falls straight down from a two-story building. It lands in a swimming pool and settles gently to the bottom. Draw a complete motion diagram of the tile.
17. | Your roommate drops a tennis ball from a third-story balcony. It hits the sidewalk and bounces as high as the second story. Draw a complete motion diagram of the tennis ball from the time it is released until it reaches the maximum height on its bounce. Be sure to determine and show the acceleration at the lowest point.

Section 1.6 Motion in One Dimension

18. ‖ FIGURE EX1.18 shows the motion diagram of a drag racer. The camera took one frame every 2 s.

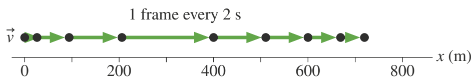


FIGURE EX1.18

a. Measure the x-value of the racer at each dot. List your data in a table similar to Table 1.1, showing each position and the time at which it occurred.
b. Make a position-versus-time graph for the drag racer. Because you have data only at certain instants, your graph should consist of dots that are not connected together.

19. | Write a short description of the motion of a real object for which FIGURE EX1.19 would be a realistic position-versus-time graph.

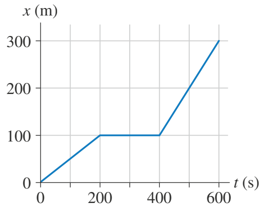


FIGURE EX1.19

20. | Write a short description of the motion of a real object for which FIGURE EX1.20 would be a realistic position-versus-time graph.

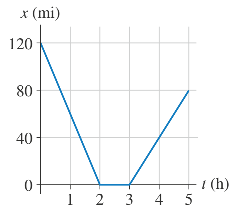


FIGURE EX1.20

Section 1.7 Solving Problems in Physics

21. ‖ Draw a pictorial representation for the following problem. Do *not* solve the problem. The light turns green, and a bicyclist starts forward with an acceleration of 1.5 m/s^2. How far must she travel to reach a speed of 7.5 m/s?
22. ‖ Draw a pictorial representation for the following problem. Do *not* solve the problem. What acceleration does a rocket need to reach a speed of 200 m/s at a height of 1.0 km?

Section 1.8 Units and Significant Figures

23. | How many significant figures are there in the following values?
    a. 0.05×10^{-4} b. 0.00340
    c. 7.2×10^{4} d. 103.00
24. ‖ Convert the following to SI units:
    a. 4.0 in b. 33 ft/s
    c. 30 mph d. 7 in^2
25. | Convert the following to SI units:
    a. 60 in b. 1.45×10^{6} yr
    c. 50 ft/day d. 2.0×10^{4} mi^2
26. ‖ Using the approximate conversion factors in Table 1.5, convert the following SI units to English units *without* using your calculator.
    a. 30 cm b. 25 m/s
    c. 5 km d. 0.5 cm
27. | Using the approximate conversion factors in Table 1.5, convert the following to SI units *without* using your calculator.
    a. 20 ft b. 60 mi
    c. 60 mph d. 8 in

28. | Compute the following numbers, applying the significant figure rules adopted in this textbook.
   a. 33.3×25.4 b. $33.3 - 25.4$
   c. $\sqrt{33.3}$ d. $333.3 \div 25.4$
29. | Perform the following calculations with the correct number of significant figures.
   a. 159.31×204.6 b. $5.1125 + 0.67 + 3.2$
   c. $7.662 - 7.425$ d. $16.5/3.45$
30. | Estimate (don't measure!) the length of a typical car. Give your answer in both feet and meters. Briefly describe how you arrived at this estimate.
31. | Estimate the height of a telephone pole. Give your answer in both feet and meters. Briefly describe how you arrived at this estimate.
32. | Estimate the average speed with which the hair on your head BIO grows. Give your answer in both m/s and μm/hour. Briefly describe how you arrived at this estimate.
33. | Motor neurons in mammals transmit signals from the brain BIO to skeletal muscles at approximately 25 m/s. Estimate how long in ms it takes a signal to get from your brain to your hand.

Problems

For Problems 34 through 43, draw a complete pictorial representation. **Do *not* solve these problems or do any mathematics.**

34. | A Porsche accelerates from a stoplight at $5.0\ \text{m/s}^2$ for five seconds, then coasts for three more seconds. How far has it traveled?
35. | A jet plane is cruising at 300 m/s when suddenly the pilot turns the engines up to full throttle. After traveling 4.0 km, the jet is moving with a speed of 400 m/s. What is the jet's acceleration as it speeds up?
36. | Sam is recklessly driving 60 mph in a 30 mph speed zone when he suddenly sees the police. He steps on the brakes and slows to 30 mph in three seconds, looking nonchalant as he passes the officer. How far does he travel while braking?
37. | You would like to stick a wet spit wad on the ceiling, so you toss it straight up with a speed of 10 m/s. How long does it take to reach the ceiling, 3.0 m above?
38. | A speed skater moving across frictionless ice at 8.0 m/s hits a 5.0-m-wide patch of rough ice. She slows steadily, then continues on at 6.0 m/s. What is her acceleration on the rough ice?
39. | Santa loses his footing and slides down a frictionless, snowy roof that is tilted at an angle of 30°. If Santa slides 10 m before reaching the edge, what is his speed as he leaves the roof?
40. | A motorist is traveling at 20 m/s. He is 60 m from a stoplight when he sees it turn yellow. His reaction time, before stepping on the brake, is 0.50 s. What steady deceleration while braking will bring him to a stop right at the light?
41. | A car traveling at 30 m/s runs out of gas while traveling up a 10° slope. How far up the hill will the car coast before starting to roll back down?
42. || Ice hockey star Bruce Blades is 5.0 m from the blue line and gliding toward it at a speed of 4.0 m/s. You are 20 m from the blue line, directly behind Bruce. You want to pass the puck to Bruce. With what speed should you shoot the puck down the ice so that it reaches Bruce exactly as he crosses the blue line?
43. || David is driving a steady 30 m/s when he passes Tina, who is sitting in her car at rest. Tina begins to accelerate at a steady $2.0\ \text{m/s}^2$ at the instant when David passes. How far does Tina drive before passing David?

Problems 44 through 48 show a motion diagram. For each of these problems, write a one or two sentence "story" about a *real object* that has this motion diagram. Your stories should talk about people or objects by name and say what they are doing. Problems 34 through 43 are examples of motion short stories.

44. |

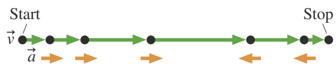


FIGURE P1.44

45. |

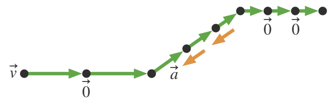


FIGURE P1.45

46. |

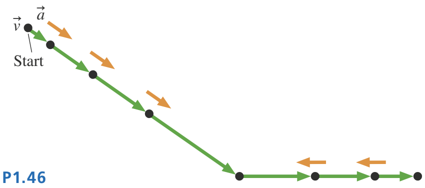


FIGURE P1.46

47. |

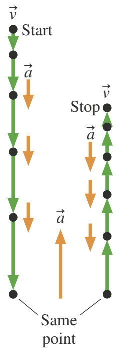


FIGURE P1.47

48. |

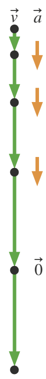


FIGURE P1.48

Problems 49 through 52 show a partial motion diagram. For each:

a. Complete the motion diagram by adding acceleration vectors.

b. Write a physics *problem* for which this is the correct motion diagram. Be imaginative! Don't forget to include enough information to make the problem complete and to state clearly what is to be found.

c. Draw a pictorial representation for your problem.

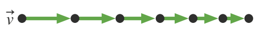
49. 

FIGURE P1.49

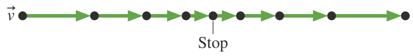
50. 

FIGURE P1.50

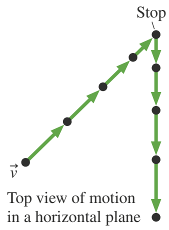
51. 

FIGURE P1.51

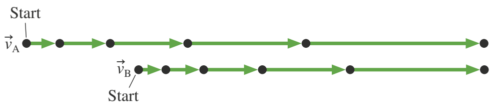
52. 

FIGURE P1.52

53. | A regulation soccer field for international play is a rectangle with a length between 50 m and 55 m and width between 32 m and 37.5 m. What are the smallest and largest areas that the field could be?

54. | As an architect, you are designing a new house. A window has a height between 100 cm and 120 cm and width between 70 cm and 60 cm. What are the smallest and largest areas that the window could be?

55. || A cylinder 5 cm in diameter has a length of 12 cm. What is the cylinder's volume in SI units?

56. | An intravenous saline drip has 9.0 g of sodium chloride per liter of water. By definition, 1 mL = 1 cm^3. Express the salt concentration in kg/m^3.
BIO

57. || The quantity called mass density is the mass per unit volume of a substance. What are the mass densities, in SI units, of the following objects?

a. A 210 m^3 solid with a mass of 0.15 kg.

b. 90 m^3 of a liquid with a mass of 70 g.

58. | FIGURE P1.58 shows a motion diagram of a car traveling down a street. The camera took one frame every 10 s. A distance scale is provided.

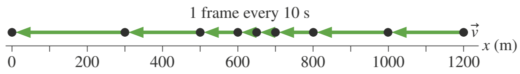


FIGURE P1.58

a. Measure the x-value of the car at each dot. Place your data in a table, similar to Table 1.1, showing each position and the instant of time at which it occurred.

b. Make a position-versus-time graph for the car. Because you have data only at certain instants of time, your graph should consist of dots that are not connected together.

59. | Write a short description of a real object for which FIGURE P1.59 would be a realistic position-versus-time graph.

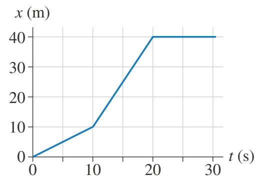


FIGURE P1.59

60. | Write a short description of a real object for which FIGURE P1.60 would be a realistic position-versus-time graph.

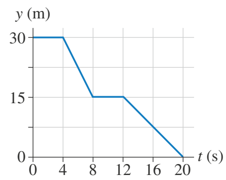


FIGURE P1.60