Chapter 1

**Multiple choice questions**

1. (c) A rolling ball is an example of a physical phenomenon. A point-like object is a simplified model of an object. Acceleration is a physical quantity for describing motion, while free fall is a model of a process.

2. (b) Average speed, path length, and clock reading are all scalar quantities. Displacement and acceleration are examples of vector quantity.

3. (b) A time interval is the difference between two times. Both statements, (2) The lesson lasted for 45 minutes and (4) An astronaut orbited Earth in 4 hours, are examples of time interval.

4. (a) The student should have said: “The distance between my dorm and the lecture hall is 1 km.” There is no indication of the direction (needed for indicating displacement). The path length depends on the path followed and that is also not indicated.

5. (b) Withthe corresponding velocity and acceleration are  and  Therefore, we see that the object is accelerating with . The speed of the object first decreases, reaches zero at *t* = 2.0 s, and then increases beyond that. So (b) is not true.

6. (a) The motion of the car is described by graph (a). The non-zero flat part corresponds to the car moving at a constant velocity. The car then begins to slow down (indicated by the negative slope), coming to a stop (*v* = 0, through the *x*-axis), and moves in the opposite direction with the same acceleration.

7. (d) The average velocity and instantaneous velocity are equal when the object moves at a constant velocity or does not move (zero velocity).

8. (c) At the instant the second ball is released, the first ball not only has traveled 3 cm, it also has acquired non-zero velocity. Therefore, the distance between the balls will increase with time. Mathematically, the positions of the two balls can be written as  and where *t* is the time interval between dropping the first ball and the second. The distance between them is given by (taken downward direction to be positive +*y*) , which shows clearly that *y* increases with *t*.

9. (b) The position of the car can be written as where *x*0 = +20 m. Since the car is traveling west (−*x*-axis), With the acceleration *ax* is positive in order to bring the velocity of the car to zero at the stoplight.

10. (c) The velocity-versus-time graph in (c) describes the motion of the car with  *v*0x = − 12m/s, and *ax* > 0.

11. (c) velocity-versus-time graph in (c) can be written as  with *v*0*x* < 0 and *ax* > 0. The velocity remains negative until the object comes to rest.

12. (c) At the moment the sandbag is released, it has the same upward velocity as the hot air balloon, according to the ground observer 2. Therefore, he sees the sandbag going up first then coming down. On the other hand, observer 1 in the hot air balloon sees the sandbag undergo free fall.

13. (b) The height of the tree is  The closest value is (b).

14. (c) Whether you drop the ball or throw it down, the acceleration of the ball is due to gravitational force exerted by Earth, and it remains the same: *ay* = − *g* = − 9.8 m/s2 (where we have taken upward to be +*y*). So statement (c) is incorrect.

15. (c) The total flight time of the ball is which is linear in *v*0. Thus, the second ball, with twice the initial speed of the first one, will spend twice as much time in flight. Note that the maximum height the ball reaches is given by, which is quadratic in *v*0.

16. (a) The total flight time is given by where *v*0 is the initial speed. The fact that *t* is linear in *v*0 means that if it takes twice as much time for the second ball to come back, the initial speed of the second ball must be twice that of the first one.

**Conceptual questions**

17. Both (b) and (e) correctly describe the Armstrong’s motion. Graph (e) corresponds to the fact that his cycling speed is constant, and graph (b) shows that his displacement (from starting point) increases linearly.

18. One scenario is as follows: As the light turns green, the car starts to accelerate from rest. Upon reaching the appropriate speed, the driver stops accelerating and the car moves at a constant speed. Upon seeing a red light some distance ahead, the driver starts to brake. With constant deceleration, the car comes to a complete stop at the light. The velocity-versus-time and acceleration-versus-time graphs are shown below.

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| --- | --- |
| cq1 | cq1 |

Another possibility is that the car starts from rest with constant acceleration. Seeing another traffic light a short distance ahead, the driver abruptly applies the brake and slows the car to a complete stop. The velocity-versus-time and acceleration-versus-time graphs are shown below.

|  |  |
| --- | --- |
| cq1 | cq1  |

19. Speed is a scalar quantity that characterizes how fast an object moves. An example of speed is 55 mi/h. On the other hand, velocity refers to the rate of change of position; it is a vector quantity that has both magnitude and direction. An example of a velocity vector is 55 mi/h, due north.

The path lengthis how far an object moves as it travels from its initial position to its final position. Imagine laying a string along the path the object takes; the length of the string is the path length. On the other hand, distance is the magnitude of displacement. Path length is not necessarily equal to distance. To illustrate the distinction, consider a person running from  to  along the path shown below.

|  |  |
| --- | --- |
| cq1 | The distance the person has run is However, the path length is. |

Displacement is the difference between two positions in space; it is a vector quantity that has both magnitude and direction. For example, if an object moves from its initial position at to its displacement is The displacementis negative since the object moves in the negative *x*-direction. The distance the object has traveled is 3.0 m, the magnitude of the displacement.

