

**SUMMARY OF TERMS (KNOWLEDGE)**

**Speed** How fast an object moves; the distance traveled per unit of time.

**Instantaneous speed** The speed at any instant.

**Average speed** The total distance traveled divided by the time of travel.

**Velocity** An object's speed and direction of motion.

**Vector quantity** A quantity that has both magnitude and direction.

**Scalar quantity** A quantity that has only a magnitude, not a direction.

**Acceleration** The rate at which velocity changes with time; the change in velocity may be in magnitude, or direction, or both.

**Free fall** Motion under the influence of gravity only.

**READING CHECK QUESTIONS (COMPREHENSION)****3.1 Motion Is Relative**

1. As you read this in your chair, how fast are you moving relative to the chair? Relative to the Sun?

**3.2 Speed**

2. What two units of measurement are necessary for describing speed?
3. What kind of speed is registered by an automobile speedometer: average speed or instantaneous speed?
4. What is the average speed in kilometers per hour of a horse that gallops a distance of 15 km in a time of 30 min?
5. How far does a horse travel if it gallops at an average speed of 25 km/h for 30 min?

**3.3 Velocity**

6. What is the main difference between speed and velocity?
7. If a car moves with a constant velocity, does it also move with a constant speed?
8. If a car is moving at 90 km/h and it rounds a corner, also at 90 km/h, does it maintain a constant speed? A constant velocity? Defend your answers.

**3.4 Acceleration**

9. What is the acceleration of a car moving along a straight road that increases its speed from 0 to 100 km/h in 10 s?
10. What is the acceleration of a car that maintains a constant velocity of 100 km/h for 10 s? (Why do some of your classmates who correctly answer the preceding question get this question wrong?)
11. When are you most aware of your motion in a moving vehicle: when it is moving steadily in a straight line or when it is accelerating? If you were in a car that moved with absolutely constant velocity (no bumps at all), would you be aware of motion?
12. Acceleration is generally defined as the time rate of change of velocity. When can it be defined as the time rate of change of speed?

13. What did Galileo discover about the amount of speed a ball gained each second when rolling down an inclined plane? What did this say about the ball's acceleration?

14. What relationship did Galileo discover about a ball's acceleration and the steepness of an incline? What acceleration occurs when the plane is vertical?

**3.5 Free Fall**

15. What exactly is meant by a "freely falling" object?
16. What is the gain in speed per second for a freely falling object?
17. What is the speed acquired by a freely falling object 5 s after being dropped from a rest position? What is the speed 6 s after?
18. The acceleration of free fall is about  $10 \text{ m/s}^2$ . Why does the seconds unit appear twice?
19. When an object is thrown upward, how much speed does it lose each second (ignoring air resistance)?
20. What relationship between distance traveled and time did Galileo discover for freely falling objects released from rest?
21. What is the distance fallen for a freely falling object 1 s after being dropped from a rest position? What is the distance for a 4-s drop?
22. What is the effect of air resistance on the acceleration of falling objects?
23. Consider these measurements: 10 m, 10 m/s, and  $10 \text{ m/s}^2$ . Which is a measure of speed, which of distance, and which of acceleration?

**3.6 Velocity Vectors**

24. What is the speed over the ground of an airplane flying at 100 km/h relative to the air caught in a 100-km/h right-angle crosswind?