Chapter 1—Space, Time, and Mass

MULTIPLE CHOICE

1. To describe the motion of a particle, one needs to specify
   a. its position.
   b. the time at which the particle has a certain position.
   c. its position and the time at which it has this position.
   d. its position in a certain reference frame and the time at which it has this position.

   ANS: D DIF: 1

2. Two witnesses to a car accident are asked to testify in court. Here are their statements:

   Witness 1: I was standing at the pedestrian crossing at Blue Square when the car in question was moving at high speed toward the left.

   Witness 2: I was standing at the pedestrian crossing at Blue Square when the car in question was moving at high speed toward the right.

   Do the witnesses contradict each other?
   a. Definitely yes.
   b. Definitely no.
   c. It depends on the reference frame adopted by each of the witnesses.

   ANS: C DIF: 2

3. Two physics students carefully measure the position of an object and report the following results:

   Student 1: To get to the object, one should go 3.0 m north and then 4.0 m east.

   Student 2: To get to the object, one should go 6.0 m south.

   Which one of the students is correct?
   a. Student 1 only.
   b. Student 2 only.
   c. Either student 1 or student 2, but not both, depending on the reference frame chosen by each of the students.
   d. Both student 1 and student 2 could be right, depending on the reference frame chosen by each of the students.
   e. Neither student 1 nor student 2, irrespective of the choice of the reference frames.

   ANS: D DIF: 2

4. In the international system of units (SI), the official unit of length is the
   a. millimeter.
   b. centimeter.
   c. meter.
   d. kilometer.
   e. none of the above.

ANS: B DIF: 1

5. Which of the following units is not a fundamental unit in the international system of units?
   a. meter
   b. kilogram
   c. hour
   d. all of the above
   e. none of the above

   ANS: C DIF: 1

6. In the British system of units, used in the United States, the official unit of length is the
   a. inch.
   b. foot.
   c. mile.
   d. yard.
   e. none of the above.

   ANS: B DIF: 1

7. In the international system of units (SI), the official unit of mass is the
   a. atomic mass unit.
   b. gram.
   c. milligram.
   d. kilogram.
   e. none of the above.

   ANS: D DIF: 1

8. In the British system of units, used in the United States, the official unit of mass is the
   a. atomic mass unit.
   b. pound.
   c. ton.
   d. gram.
   e. none of the above.

   ANS: B DIF: 1

9. An acceptable (though perhaps unusual) unit for density is
   a. kilogram/liter.
   b. gram/centimeter^3.
   c. pound/gallon.
   d. kilogram/meter^3.
   e. all of the above.

   ANS: E DIF: 2

10. Assume the following relationship between these two hypothetical volume units: 2 "squirts" = 7 "drips." The number of "squirts" in one "drip" is
    a. 1/7.
    b. 2/7.
    c. 7.

d. 7/2.
e. 7/1.

ANS: B DIF: 2

11. Assume the following relationship between two hypothetical volume units: 2 "squirts" = 7 "drips." The number of "drips" in one "squirt" is
a. 1/7.
b. 2/7.
c. 7.
d. 7/2.
e. 7/1.

ANS: D DIF: 2

12. The number of angstroms (1 angstrom = 10^{-10} m) in 5 fermi (1 fermi = 10^{-15} m) is
a. 5×10^{-5}.
b. 5×10^{-4}.
c. 2×10^{-5}.
d. $2 \times 10^{+4}$.
e. $5 \times 10^{+5}$.

ANS: A DIF: 1

13. *20/20 vision* is a term used to express normal visual acuity (the clarity or sharpness of vision) measured at a distance of 20 feet. If you have 20/20 vision, you can see clearly at 20 feet what should normally be seen at that distance. In European countries (that use the international system of units), the equivalent of 20/20 vision is
a. 6/6 vision.
b. 7/7 vision.
c. 10/10 vision.
d. 40/40 vision.
e. 60/60 vision.

ANS: A DIF: 1

14. Pararescue jumpers leave the helicopter when it is flying “10 and 10,” meaning that the helicopter is 10 ft above the water and moving at a speed of 10 knots (1 knot = 1 nautical mi/h = 1.852 km/h). The international system of units equivalent of “10 and 10” is
a. 3 and 5.
b. 3 and 19.
c. 10 and 19.
d. 30 and 31.
e. 30 and 37.

ANS: A DIF: 1

15. The maximum speed limit on certain highways is 70 mi/h in the United States and 120 km/h in Europe. The highest speed limit is
a. in Europe.
b. in the United States.

c. the same in both regions.

ANS: A DIF: 1

16. All of the following inequalities for length units are correct *except*
    a. 1 yard > 1 meter.
    b. 1 mile > 1 kilometer.
    c. 1 inch > 1 centimeter.
    d. 1 foot > 10 centimeters.
    e. 1 meter > 1 foot.

ANS: A DIF: 1

17. All of the following inequalities for time units are correct *except*
    a. 1 millisecond > 1 nanosecond.
    b. 1 nanosecond > 1 microsecond.
    c. 1 second > 1 millisecond.
    d. 1 hour > 1000 seconds.
    e. 1 minute > 10 seconds.

ANS: B DIF: 1

18. All of the following inequalities for length units are correct *except*
    a. 1 millimeter > 1 centimeter.
    b. 1 meter > 1 millimeter.
    c. 1 kilometer > 1 meter.
    d. 1 centimeter > 1 micron.
    e. 1 picometer > 1 nanometer.

ANS: A DIF: 1

19. The most precise scientific standard of mass is based on
    a. a specified fraction of the mass of the Earth.
    b. the mass of a specific piece of material kept at special conditions.
    c. a property of a particular kind of atom.
    d. the speed of light.
    e. an iron atom.

ANS: B DIF: 1

20. All of the following "equalities" are approximately true (that is, are within a factor of two of being exact) *except*
    a. 2 centimeters = 1 inch.
    b. 2 kilometers = 1 mile.
    c. 2 meters = 1 foot.
    d. 2 liters = 1 gallon.
    e. 2 pounds = 1 kilogram.

ANS: C DIF: 1

21. The official unit of time in the international system of units (SI) is the
    a. second.

b. minute.
c. hour.
d. day.
e. year.

ANS: A DIF: 1

22. The official unit of time in the British system is the
a. second.
b. minute.
c. hour.
d. day.
e. year.

ANS: A DIF: 1

23. The most precise scientific standard of length is based on
a. a specified fraction of the distance from the pole to the equator on Earth.
b. the distance separating two marks on a bar carefully kept at special conditions.
c. a property of a particular kind of atom.
d. the diameter of our Galaxy.
e. the speed of light in a vacuum.

ANS: E DIF: 1

24. The most precise scientific standard of time is based on
a. a specified fraction of the mean solar day.
b. the time taken for a specific "seconds" pendulum kept at special conditions to complete one oscillation.
c. a property of a particular kind of atom.
d. the speed of light.
e. the travel time of light from the nearest star.

ANS: C DIF: 1

25. Which mass is the largest?
a. 0.0231 kg
b. 2.31×10^{-2} kg
c. 231×10^{-4} kg
d. 23.1 g
e. They all represent the same mass.

ANS: E DIF: 1

26. If 1 in. is approximately equal to 2.5 cm, then 1.0 $in.^2$ of surface area is approximately
a. $1/(6.3)$ cm^2.
b. $1/(2.5)$ cm^2.
c. 1.0 cm^2.
d. 2.5 cm^2.
e. 6.3 cm^2.

ANS: D DIF: 1

27. If 1 in. is approximately equal to 2.5 cm, then 1.0 cm^2 of surface area is approximately
    a. 1/(6.3) in^2.
    b. 1/(2.5) in^2.
    c. 1.0 in^2.
    d. 2.5 in^2.
    e. 6.3 in^2.

    ANS: A DIF: 1

28. If 1/3 yard is equal to 1 foot, then 1 cubic yard of volume is equal to
    a. 1 cubic foot.
    b. 3 cubic feet.
    c. 9 cubic feet.
    d. 27 cubic feet.
    e. 81 cubic feet.

    ANS: D DIF: 1

29. A box is 1.5 yard wide, 1.2 feet wide and 3.5 in. high. Its volume in SI units is
    a. 4.5×10^{-2} m^3.
    b. 4.5 m^3.
    c. 1.5×10^{-2} m^3.
    d. 1.5×10^{-1} m^3.
    e. 3.0×10^{3} m^3.

    ANS: A DIF: 1

30. The position of an object as a function of time is given by the equation $x(t) = at^2 + bt + c$. The dimensions of a, b, and c are
    a. distance, distance, and distance.
    b. distance/time, distance/time, and distance/time.
    c. distance, distance/time, and distance/$time^2$.
    d. distance·$time^2$, distance·time, distance.
    e. distance/$time^2$, distance/time, distance.

    ANS: E DIF: 2

31. The position of an object as a function of time is given by the equation $x(t) = asin(bt^2 + c)$. The dimensions of a, b, and c are
    a. distance, angle, and angle.
    b. distance, angle/time, and angle.
    c. distance, angle/$time^2$, and angle/$time^2$.
    d. distance, angle/$time^2$, and angle.
    e. angle, angle/$time^2$, and angle.

    ANS: D DIF: 2

32. The speed of an object as a function of time is given by the equation $v(t) = at^2 - be^{-ct}$. The dimensions of a, b, and c are
    a. distance/time, distance/time, and 1/time.
    b. distance/time, distance/time, and time.

c. distance, distance/time, and 1/time.
d. distance/time^3, distance/time, 1/time.
e. distance/time^3, distance/time, time.

ANS: D DIF: 2

33. If in the international system of units the variables a, b, and c are related to each other through the equation $a^x = b^y c^z$, and $[c]_{SI}$ = s, $[b]_{SI}$ = m/s, and $[a]_{SI}$ = m/s^2, the powers x, y, and z that make the equation dimensionally consistent are
a. 1, 1, and -1.
b. -1, -1, and 1.
c. 2, 2, and -2.
d. all of the above.
e. none of the above.

ANS: D DIF: 2

34. If in the international system of units $[x]_{SI}$ = m, $[t]_{SI}$ = s, $[v]_{SI}$ = m/s, and $[a]_{SI}$ = m/s^2, and (i) $x = vt+a$, (ii) $x = \frac{1}{2}at^2$, and (iii) $t = \left(\frac{2x}{a}\right)^{\frac{1}{2}}$, the dimensionally consistent equation(s) is(are):
a. (i), (ii), and (iii).
b. (i) and (iii).
c. (i) and (ii).
d. (ii) and (iii).
e. only (i).

ANS: D DIF: 2

35. The number of significant figures in 23.410 kg is
a. 2.
b. 3.
c. 4.
d. 5.
e. none of the above.

ANS: D DIF: 1

36. The number of significant figures in 0.0213 kg is
a. 1.
b. 2.
c. 3.
d. 4.
e. 5.

ANS: C DIF: 1

37. Which of the following represents a measurement with four significant figures?
a. 0.0231 kg
b. 1.2249 kg
c. 2256.23 kg

d. 11.40 kg
e. 1154.0 kg

ANS: D DIF: 1

38. The volume of a cube of side 4.26 cm is
a. $77.308 \times 10^{+6}$ m^3.
b. $77.3 \times 10^{+6}$ m^3.
c. 77 m^3.
d. 77.3×10^{-6} m^3.
e. 77.308×10^{-6} m^3.

ANS: D DIF: 1

39. The sum of 1.00 m + 1531 mm + 2.54×10^{-2} km, with the correct number of significant figures is
a. 0.3×10^{2} m.
b. 27 m.
c. 27.9 m.
d. 27.93 m.
e. 27.931 m.

ANS: C DIF: 1

40. The difference between 134.2 km and 4.782 km is
a. 129.4180 km.
b. 129.418 km.
c. 129.42 km.
d. 129.4 km.
e. 129 km.

ANS: D DIF: 1

41. The density of a block is defined as the ratio of the block's mass to its volume. If the mass and the volume of a block were measured to be 123.34 kg and 2.4 m^3 respectively, its density is
a. 51.0 kg/m^3.
b. 51.4 kg/m^3.
c. 51.39 kg/m^3.
d. 5.14×10 kg/m^3.
e. 5.1×10 kg/m^3.

ANS: E DIF: 1

42. A rectangle is 4.55 m long and 2.3 m wide. The area of the rectangle is
a. 10.46 m^2.
b. 10.5 m^2.
c. 10 m^2.
d. 10.50 m^2.
e. 10.460 m^2.

ANS: C DIF: 1

43. A thunderstorm drops 1/4 in. of rain on a 50 mi^2 area. The estimated number of fallen raindrops is
    a. 10^{17}.
    b. 10^7.
    c. 10^6.
    d. 100,000.
    e. 10^{-6}.

    ANS: B DIF: 2

44. A student measures the length of an object five times, each time using a different instrument.

Measurement	1	2	3	4	5
Length (m)	74.14	74	75	74.2	73.9

    The least precise measurement is
    a. 1.
    b. 2.
    c. 3.
    d. 4.
    e. 5.

    ANS: C DIF: 2

45. The best estimate of the volume of your body is
    a. 10^3 l.
    b. 10^2 l.
    c. 10 l.
    d. 10^{-1} l.
    e. 10^{-2} l.

    ANS: B DIF: 2

46. A good estimate of the speed of a cliff diver entering the water is
    a. 10^{-1}m/s.
    b. 1 m/s.
    c. 10 m/s.
    d. 10^2 m/s.
    e. 10^3 m/s.

    ANS: C DIF: 2

47. A good estimate of the number of cars stuck in traffic on a four-lane freeway in one mile is
    a. 10.
    b. 10^3.
    c. 10^5.
    d. 10^7.
    e. 10^{10}.

ANS: C DIF: 2

48. A good estimate of the number of cans of soda needed to fill an Olympic-size swimming pool is

a. 10^3.
b. 10^5.
c. 10^7.
d. 10^9.
e. 10^{11}.

ANS: C DIF: 2

49. To estimate the height of a pillar, you walk about 70 steps from the pillar. At this point, the angle made by the line of sight to the top of the pillar with the horizontal is 30^o. The height of the pillar is

a. 10 m.
b. 20 m.
c. 50 m.
d. 80 m.
e. 100 m.

ANS: B DIF: 3

50. The Roosevelt Island Tramway in New York City spans the East River and connects Roosevelt Island to Manhattan. It is the only commuter aerial tramway in North America. Between two particular points, the altitude change is 50 ft when the horizontal distance between them is 100 ft. The grade (the steepness) of this portion of the path is

a. 0.35.
b. 0.50.
c. 1.0.
d. 2.0.
e. 4.0.

ANS: B DIF: 2