**Chapter 1**

1. The number 342000 expressed in proper scientific form is
2. 3420x102
3. 342x103
4. 34.2x104
5. 3.42x105
6. 3.42x106
7. Which of the following is the greatest distance?
8. km
9. m
10. in
11. yd
12. ft
13. How many significant figures are in the number 342000?
14. 2
15. 3
16. 4
17. 5
18. 6
19. A rectangle measures 4.78 m by 6.7 m. What is the area of this rectangle expressed in the proper number of significant figures?
20. 32.026 m2
21. 32.02 m2
22. 32.03 m2
23. 32.0 m2
24. 32 m2
25. The distance 0.00000458 m expressed in proper scientific form is
26. 458x10–8 m
27. 45.8x10–5 m
28. 4.58x10–6 m
29. 4.58x106 m
30. 4.58x10–7 m
31. The number of meters contained in 1.00 mm is
32. 1.00x103 m
33. 1.00x10–3 m
34. 1.00x102 m
35. 1.00x10–6 m
36. 1.00x106 m
37. If 12 chads constitute a gram and if 6.2 million people in a state properly voted for a slate of 14 candidates, what order of magnitude, expressed in kilograms, of chads were generated?
38. 106
39. 104
40. 103
41. 102
42. 10
43. The average impulse delivered to a body is defined as the product of the force and the time interval over which the force acts. If a force of 120 N acts for 0.21 s, the impulse should be expressed as
44. 25 Ns
45. 25.2 Ns
46. 2.52x101 Ns
47. 25.20 Ns
48. 25.200 Ns
49. Which of the following best represents a value of time expressed to five significant figures?
50. 14.82x101 s
51. 9.0x105 s
52. 0.00308 s
53. 1.856x104 s
54. 32.200 s
55. What is the order of magnitude of the number of cubic feet contained in a cubic kilometer?
56. 106
57. 108
58. 109
59. 1010
60. 1011

answers: 1 (d), 2 (a), 3 (b), 4 (e), 5 (c), 6 (b), 7 (c), 8 (a), 9 (e), 10 (d)

**Chapter 2**

1. The displacement of a body is
2. its position in a frame of reference
3. equal to the distance between the body and the origin
4. equal to the difference between the final position of the body and its initial position
5. its location on a given axis in a reference frame
6. the sum of the final position and the initial position
7. Acceleration may be defined as
8. time rate of change of position
9. time rate of change of location
10. time rate of change in displacement
11. time rate of change of velocity
12. time rate of change of speed
13. A particle moving in a straight line has a constant acceleration of 2.00 m/s2. The velocity vs. time graph for this motion
14. has a slope that decreases with time
15. has a slope that increases with time
16. has a constant negative slope
17. has a constant positive slope
18. has a straight line that is parallel to the time-axis
19. The velocity vs. time graph for the motion of a particle moving in a straight line is a linear with a positive slope. This indicates that the particle
20. has a constant positive slope
21. has a constant negative slope
22. experiences a constant positive acceleration
23. has zero velocity
24. is at rest
25. A particle travels from an initial position x0 = 30 m to final position x = –40 m in 5 s. The average velocity of this particle during the time interval is
26. –2 m/s
27. 2 m/s
28. –14 m/s
29. 14 m/s
30. –10 m/s
31. The displacement of a particle making a round trip between two locations
32. can have any value
33. can be greater than or less than but not zero
34. is always less than zero
35. is always greater than zero
36. is zero
37. A particle has an initial velocity of 5.0 m/s and undergoes a constant acceleration of 2.0 m/s2. What is the final velocity of the particle after 6.0 s?
38. 12 m/s
39. 16 m/s
40. 17 m/s
41. 18 m/s
42. 19 m/s
43. A ball is thrown vertically upward. At the very peak of its motion
44. its velocity is downward and its acceleration is upward
45. its velocity is downward and its acceleration is downward
46. its velocity is zero and its acceleration is zero
47. its velocity is zero and its acceleration is downward
48. its velocity is downward and its acceleration is zero
49. For an object moving in a straight line the area under a velocity vs. time graph gives the
50. value of the acceleration due to gravity
51. acceleration
52. displacement
53. change in velocity
54. slope of the curve
55. At the peak of its motion for a body thrown vertically upward the acceleration is
56. zero
57. changing from 9.8 m/s2 upward to 9.8 m/s2 downward
58. changing from 9.8 m/s2 downward to 9.8 m/s2 upward
59. 9.8 m/s2 upward
60. 9.8 m/s2 downward

answers: 1 (c), 2 (d), 3 (d), 4 (a), 5 (c), 6 (e), 7 (c), 8 (d), 9 (c), 10 (e)

**Chapter 3: Kinematics in Two Dimensions**

1. A pair of simultaneous forces that act 180° apart are called
   1. vector sum
   2. resultant
   3. unit vectors
   4. parallel vectors
   5. antiparallel vectors
2. A passenger airliner travels 400 km due east and turns and flies 300 km due north. The magnitude of its displacement is
   1. 100 km
   2. 500 km
   3. 600 km
   4. 700 km
   5. 1000 km
3. At what angle should a projectile be projected into 2-dimensional space to reach maximum range?
   1. 30°
   2. 45°
   3. 54°
   4. 60°
   5. either 30° or 60°
4. A football, after being kicked, leaves a kicking tee with a velocity v at angle theta. The horizontal component of its velocity is
   1. v sin theta – gt
   2. v cos theta – gt
   3. v cos theta
   4. v2 + 2gy
   5. v2 – 2gy
5. Of the following, which set of angles will give the same range?
   1. 0° and 90 °
   2. 0° and 45°
   3. 30° and 45°
   4. 30° and 60°
   5. 45° and 60°
6. A batter hits a towering home run. At maximum altitude, the baseball's
   1. acceleration and velocity are nonzero
   2. acceleration is zero but its velocity is nonzero
   3. acceleration is nonzero but its velocity is zero
   4. acceleration and velocity are both zero
   5. acceleration and velocity are both positive
7. When the initial speed of a projectile is doubled, its range
   1. does not change
   2. doubles
   3. decreases by one-half
   4. increases by a factor of four
   5. decreases by a factor of four
8. A ball is thrown with a speed of 100 ft/s at an angle of 60° with respect to the horizontal. After 1.50 seconds, the horizontal component of its velocity is
   1. 32 ft/s
   2. 50 ft/s
   3. 75 ft/s
   4. 87 ft/s
   5. 100 ft/s
9. A red ball is thrown horizontally and a blue one is dropped at the same instant. Which statement best describes what happens?
   1. The blue ball impacts the ground first.
   2. The red ball impacts the ground first.
   3. The blue ball has the greater velocity on impact.
   4. The red ball has greater velocity on impact.
   5. Both balls have the same velocity on impact.
10. A baseball rolls across a horizontal roof with a speed of 3 m/s. The ball rolls over the edge and falls 20 meters to the ground below. Approximately when does the ball impact the ground?
    1. 0.5 s
    2. 1 s
    3. 2 s
    4. 3 s
    5. 4 s

answers: 1 (e), 2 (b), 3 (b), 4 (c), 5 (d), 6 (a), 7 (d), 8 (b), 9 (d), 10 (c)

**Chapter 4: Motion and Force; Dynamics**

**Chapter 5: Circular Motion, Gravitation**

1. The coefficient of static friction is the
   1. ratio of the static frictional force to the weight of the body
   2. ratio of the normal force to the static frictional force
   3. ratio of the static frictional force to the normal force
   4. ratio of the kinetic frictional force to the static frictional force
   5. ratio of the static frictional force to the kinetic frictional force
2. For most surface-to-surface contacts,
   1. the coefficient of static friction is greater than the coefficient of kinetic friction
   2. the coefficient of kinetic friction is greater than the coefficient of static friction
   3. the coefficient of static friction will equal the coefficient of kinetic friction
   4. the static frictional force will exceed the normal force
   5. the kinetic frictional force will exceed the normal force
3. A block is placed at the top of an inclined plane that is inclined at 37°. The coefficient of static friction for the surfaces is 0.21 and the coefficient of kinetic friction for the surfaces is 0.20. When released from rest, the block
   1. remains at rest on the inclined plane
   2. slides down the plane with constant velocity
   3. accelerates down the plane
   4. none of the above statements are true
   5. not enough information is presented to make a judgment
4. A wooden crate sits on an inclined plane without slipping. As the angle of inclination is increased, the normal force
   1. increases
   2. decreases
   3. does not change
   4. is directed downward
   5. is directed upward
5. A ball tied to a string is swung in a horizontal circle. If the string breaks the ball, the ball will follow a path that is
   1. tangent to the circular path
   2. normal to the circular path
   3. toward the center of the circle
   4. away from the center of the circle
   5. parallel to the radius of the circular path
6. A body traveling in a horizontal, circular path at constant speed
   1. has an outward acceleration antiparallel to the radius of the circle
   2. has an acceleration perpendicular to the radius of the circle
   3. has an acceleration parallel to the velocity of the body
   4. has an acceleration parallel to the radius of the circle
   5. has an acceleration independent of the radius of the circle
7. A mass undergoing uniform circular motion
   1. moves with constant velocity
   2. moves with constant speed
   3. moves with constant acceleration
   4. undergoes a change in speed
   5. undergoes a change in acceleration
8. If the speed of a body in uniform circular motion is doubled while the radius remains constant, the centripetal force increases by a factor of
   1. 0.25
   2. 0.5
   3. 1
   4. 2
   5. 4
9. A body moves uniformly in a circle of radius 0.50 m. The magnitude of the linear velocity is 0.60 m/s. The magnitude of the acceleration of the body is
   1. zero
   2. 0.72 m/s2
   3. 3.6 m/s2
   4. 18 m/s2
   5. 36 m/s2
10. A 2.0 kg ball at the end of a 0.70 m long string is swung in a horizontal circle. The string has a breaking strength of 40.0 N. The maximum speed of the ball is approximately
    1. 1.9 m/s
    2. 3.7 m/s
    3. 6.8 m/s
    4. 11.5 m/s
    5. 16.6 m/s

answers: 1 (c), 2 (a), 3 (c), 4 (b), 5 (a), 6 (d), 7 (b), 8 (e), 9 (b), 10 (b)

**Chapter 5: Circular Motion: Gravitation**

1. The Universal Law of Gravitation shows that the attractive force between two bodies
   1. is independent on the mass of the bodies
   2. depends on the differences between the masses of the bodies
   3. depends on the sum of the masses of the bodies
   4. depends on the ratio of the masses of the bodies
   5. depends on the product of the masses of the bodies
2. The Universal Law of Gravitation shows that the attractive force between two bodies
   1. is independent of the distance between the two bodies
   2. increases as the distance between the bodies increases
   3. increases as the square of the distance between the bodies
   4. is inversely proportional to the distance between the bodies
   5. is inversely proportional to the square of the distance between the bodies
3. The Universal Gravitational Constant G
   1. is a constant of nature
   2. is an expression of the acceleration due to gravity for a given planet
   3. has a greater value closer to the surface of the earth than at great altitudes
   4. is dependent on the mass of a planet
   5. is dependent on the distance from the center of a planet
4. According to the Universal Law of Gravitation, when the distance between the centers-of-mass of two bodies is doubled the gravitational force between the bodies is multiplied by a factor of:
   1. 1/4
   2. 1/2
   3. 1
   4. 2
   5. 4
5. Kepler's Third Law of Planetary Motion deals with
   1. gravitation
   2. periods and orbits of planets
   3. areas of orbits
   4. shapes of orbits
   5. eccentricity of orbits
6. The relationship expressed in Kepler's Third Law of Planetary Motion is
   1. formula
   2. formula
   3. formula
   4. formula
   5. formula
7. If the mass of the planet Mercury is 3.18x1023 kg and its radius is 2.43x106 m, the acceleration due to gravity at the surface of the planet is:
   1. 1.87 m/s2
   2. 2.42 m/s2
   3. 3.02 m/s2
   4. 3.59 m/s2
   5. 3.98 m/s2
8. A communications satellite is in an elliptical orbit about the earth. It has its greatest speed when it
   1. is nearest the earth
   2. farthest from the earth
   3. moving toward the earth
   4. moving away from the earth
   5. between the earth and the sun
9. A body orbits the earth at an altitude of 3.0 earth radii as measured from the center of the earth. If the body experiences a weight of 1.00 N, its mass is
   1. 0.092 kg
   2. 0.102 kg
   3. 0.333 kg
   4. 0.918 kg
   5. 1.00 kg
10. There is a point between the earth and the moon where the gravitational attraction of the earth is "canceled" by the gravitational attraction of the moon. If the mass of the earth is 81 times greater than the mass of the moon, how far from the center-of-mass of the earth is this point?
    1. 1/9 of the way to the moon
    2. 8/9 of the way to the moon
    3. 9/81 of the way to the moon
    4. 19/81 of the way to the moon
    5. 9/10 of the way to the moon

answers: 1 (e), 2 (e), 3 (a), 4 (a), 5 (b), 6 (c), 7 (d), 8 (a), 9 (d), 10 (e)

**Chapter 6: Work and Energy**

1. The SI unit of work can be expressed as:
   1. kg m/s
   2. kg m/s2
   3. kg/m/s2
   4. kg m2/s2
   5. (kg m/s)2
2. A body of mass m is moved a distance s along a horizontal surface by a force F. How much work is done by gravity?
   1. msF
   2. mg
   3. zero
   4. Fs
   5. Mgs
3. On a force vs. distance graph, the work done is:
   1. the slope of the curve
   2. the area beneath the curve
   3. the vertical intercept
   4. the horizontal intercept
   5. the maximum point on the curve
4. Kinetic energy is defined as
   1. *K* = *mv*
   2. *K* = *mv*2
   3. *K* = one half*mv*
   4. *K* = one half*m*2*v*
   5. *K* = one half*mv*2
5. If the velocity of a body is doubled, its kinetic energy is multiplied by
   1. 1/4
   2. 1/2
   3. 1
   4. 2
   5. 4
6. The Work-Energy Theorem states that the
   1. work done equals the change in the net force
   2. work done equals the change in kinetic energy
   3. work done equals the net force divided by the net kinetic energy
   4. work done equals the product of the net force and the net kinetic energy
   5. work done equals the product of the mass and the velocity
7. A bullet with a kinetic energy of 400 J strikes a wooden block where a 8.00x103 N resistive force stops the bullet. The penetration of the bullet in the block is:
   1. 0.050 m
   2. 0.500 m
   3. 0.200 m
   4. 2.00 m
   5. 20.0 m
8. A body is lowered into a hole. Which of the following is true with regard to the gravitational potential energy of the body?
   1. The potential energy is positive.
   2. The potential energy is negative.
   3. The potential energy is zero.
   4. The potential energy is a constant.
   5. None of the choices is valid.
9. A 2.00 kg ball has a potential energy of 6.40x103 J at a point above the surface of the earth. The ball is released from rest and strikes the ground. What is its velocity on impact?
   1. 20.0 m/s
   2. –20.0 m/s
   3. 80 m/s
   4. –80 m/s
   5. 800 m/s
10. The total mechanical energy of a system is determined by
    1. the sum of the kinetic and potential energies in the system
    2. the product of the net force in the system and the displacement
    3. the sum of the kinetic and potential energies in the system and the work done by friction
    4. the sum of the kinetic and potential energies in the system minus the work done by friction
    5. the difference in the kinetic and potential energies

answers: 1 (d), 2 (c), 3 (b), 4 (e), 5 (e), 6 (b), 7 (a), 8 (b), 9 (d), 10 (a)

**Chapter 6: Work and Energy**

**Chapter 7: Linear Momentum**

1. The reference point for a gravitational potential system
   1. is the initial position of the body
   2. is the final position of the body
   3. is arbitrarily chosen
   4. is at ground level
   5. is at the lowest point reached by the body
2. A student late for class runs a flight of stairs. The gain in potential energy is U. If the student runs the same stairs at twice the speed, what is the gain in potential energy?
   1. U
   2. 2U
   3. 0.5U
   4. 4U
   5. 0.25U
3. Of the following statements which is true?
   1. The kinetic and potential energies of a body are both always positive.
   2. The kinetic and potential energies of a body are both always negative.
   3. Kinetic energy can be negative and potential energy can be positive.
   4. Potential energy can be negative but kinetic energy cannot.
   5. None of the statements is true.
4. Two unequal masses hang from the ends of a massless cord that passes over a frictionless pulley. The masses are released from rest. Which of the following statements is true about the kinetic energy K and the potential energy U of the system?
   1. deltaU = 0 and deltaK = 0
   2. deltaU = 0 and deltaK > 0
   3. deltaU < 0 and deltaK > 0
   4. deltaU > 0 and deltaK < 0
   5. deltaU < 0 and deltaK = 0
5. Power P is required to do work W in a time interval t. How much work is required to do 5W in the time interval 3t?
   1. P
   2. 3P
   3. 5P
   4. 5P/3
   5. 3P/5
6. A golf club exerts an average force of 4.00x103 N while it makes contact with a golf ball. If the impulse is 80.0 N s, the duration of the collision between the golf club and golf ball is:
   1. 0.002 s
   2. 0.020 s
   3. 0.200 s
   4. 2.00 s
   5. 20.0 s
7. Impulse depends upon
   1. force and velocity
   2. force and mass
   3. mass and velocity
   4. mass and time interval
   5. force and time interval
8. A body with momentum also has
   1. kinetic energy
   2. potential energy
   3. acceleration
   4. impulse
   5. force
9. When the kinetic energy of a body changes by a factor of 4 its momentum changes by a factor of:
   1. 4
   2. 2
   3. 1
   4. 0.5
   5. 0.25
10. A perfectly elastic collision is one where
    1. kinetic energy is conserved
    2. kinetic energy is not conserved
    3. there are no forces on either body during collision
    4. the colliding bodies each have the same mass
    5. momentum is not conserved

answers: 1 (c), 2 (a), 3 (d), 4 (c), 5 (d), 6 (b), 7 (e), 8 (a), 9 (b), 10 (a)

**Chapter 7: Linear Momentum**

1. If the velocity of a body is doubled, its momentum is multiplied by a factor of
   1. 4
   2. 2
   3. 1
   4. 0.5
   5. 0.25
2. A 40.0 kg mass traveling along the +x-axis with a speed of 3.00 m/s undergoes a head-on collision with a 20.0 kg mass which is at rest. If the collision is completely inelastic, what is the velocity of the composite mass immediately after collision?
   1. 2.00 m/s
   2. –2.00 m/s
   3. 6.00 m/s
   4. 20.0m/s
   5. 0.500 m/s
3. A 4.00 kg mass traveling along the +x-axis at 10.0 m/s undergoes a perfectly elastic head-on collision with an equal mass but traveling with a velocity of –6.00 m/s. Immediately after this collision the first mass has a velocity of
   1. 2.00 m/s
   2. 6.00 m/s
   3. –6.00 m/s
   4. 10.0 m/s
   5. –10.0 m/s
4. A 1.00 MT cannon fires a 10 kg shell with a velocity of 380 m/s. What is the recoil velocity of the cannon?
   1. 3.8 m/s
   2. –3.8 m/s
   3. 5.4 m/s
   4. –5.4 m/s
   5. 7.4 m/s
5. A pool ball of mass 0.30 kg traveling at 4.0 m/s strikes an identical pool ball that is at rest. After collision the first pool ball is observed to be scattered at an angle of 30°. What is the scattering angle of the second ball?
   1. 30°
   2. 45°
   3. –30°
   4. 60°
   5. –60°
6. Of all of the following, momentum is conserved for
   1. totally inelastic collisions
   2. partially elastic collisions
   3. perfectly elastic collisions
   4. explosions
   5. all of these
7. A boy and a girl on ice skates face one another. The boy has a mass of 30 kg and the girl has a mass of 20 kg. The boy pushes the girl backward with a speed of 3.0 m/s. Ignoring friction, what is the recoil speed of the boy?
   1. 2.0 m/s
   2. 3.0 m/s
   3. zero
   4. 4.0 m/s
   5. 5.0 m/s
8. The earth and moon are separated by 3.84x108 m. The earth has a mass of 5.89x1024 kg and the moon has a mass of 7.36x1022 kg. Where is the center-of-mass for the earth-moon system relative to the center of the earth?
   1. 3.8x106 m
   2. 4.7x106 m
   3. 7.4x106 m
   4. 1.0x108 m
   5. 2.1x108 m
9. Three identical 10.0 kg masses are positioned along the x-axis with positions of 1.0 m, 5.0 m, and 6.0 m from the origin. What is the location of the center-of-mass of the system?
   1. 1.0 m
   2. 2.0 m
   3. 3.4 m
   4. 4.0 m
   5. 5.6 m
10. A 0.015 kg bullet is fired into a ballistic pendulum initially at rest. The center-of-mass of the pendulum rises a vertical distance of 10.0 cm. The initial velocity of the bullet was
    1. 100 m/s
    2. 275 m/s
    3. 375 m/s
    4. 425 m/s
    5. 525 m/s

answers: 1 (c), 2 (a), 3 (c), 4 (b), 5 (d), 6 (e), 7 (a), 8 (b), 9 (d), 10 (c)

**Chapter 8: Rotational Motion**

1. The number of radians in a circle is
   1. pi
   2. pi/2
   3. 2pi
   4. 2/pi
   5. pi/4
2. The arc length of a sector is related to the radius by
   1. *s* = theta*R*2
   2. *s* = theta*R*
   3. *s* = theta over R
   4. *s* = R over theta
   5. *s* = one halftheta*R*
3. The correct SI units for angular velocity are
   1. revolutions per second
   2. revolutions per minute
   3. radians per second
   4. radians per minute
   5. degrees per second
4. The rotational kinetic energy of a body expressed in terms of its moment of inertia and angular velocity is
   1. *K* = one half*I*2*w*2
   2. *K* = *Iw*
   3. *K* = one half*Iw*
   4. *K* = one half*Iw*2
   5. *K* = 2*Iw*2
5. In rotational dynamics, the moment of inertia plays a role analogous to what quantity in linear motion?
   1. momentum
   2. impulse
   3. mass
   4. torque
   5. moment of force
6. A skater can control the rate of her spin by pulling in her arms to her body. In the process
   1. her angular momentum remains constant
   2. her angular velocity remains constant
   3. she is subject to a constant non-zero torque
   4. her moment of inertia remains constant
   5. she is subject to a constant non-zero moment of force
7. A skater draws in her arms to her body to increase her rate of spin. In the process her rotational kinetic energy increases. Why?
   1. Her angular moment increases.
   2. She does work in drawing her arms against her body.
   3. She develops a constant non-zero torque.
   4. Her mass is reduced.
   5. She develops a constant non-zero moment of force.
8. A sphere and a hoop are released from rest from the top of an inclined plane. If they roll without slipping, which one reaches the bottom first?
   1. the hoop
   2. the sphere
   3. they both reach the bottom at the same time
   4. the one with the greatest mass
   5. the one with the smaller radius
9. The angular acceleration experienced by a body is directly proportional to
   1. the radius of the body
   2. the mass of the body
   3. the moment of inertia
   4. the net applied torque
   5. choices (a), (b), and (c) are all valid
10. A baseball is thrown with a spinning motion. Its total kinetic energy is a function of
    1. its linear velocity only
    2. its angular velocity only
    3. both its linear and angular velocities
    4. the induced torque
    5. neither the linear or rotational velocities

answers: 1 (c), 2 (b), 3 (c), 4 (d), 5 (c), 6 (a), 7 (b), 8 (b), 9 (d), 10 (c)

**Chapter 9: Equilibrium**

1. To apply the second condition of equilibrium to problem situations, the axis of rotation
   1. must be at the center-of-mass of the body
   2. must be at the center-of-gravity of the body
   3. may be at an end of the body
   4. may be at the center of the body
   5. may be positioned anywhere
2. If the resultant of a set of concurrent forces acting on a body is zero, the net torque
   1. is zero
   2. is dependent on the location of the axis of rotation
   3. is not zero
   4. will rotate the body
   5. gives the body both a linear and an angular acceleration
3. A net torque acting on a body tends to cause the body to
   1. remain in a state of static equilibrium
   2. remain in a state of translational equilibrium
   3. undergo an increase in linear velocity
   4. undergo a decrease in linear velocity
   5. rotate
4. The magnitude of torque acting on a body is calculated as the
   1. product of the mass of the body and the applied force
   2. product of the applied force and the moment arm
   3. product of the moment of inertia and the angular velocity
   4. product of the moment of inertia and the applied force
   5. product of the mass and the angular acceleration
5. To calculate torque, one must know
   1. the magnitude of the applied force
   2. the moment arm
   3. the direction of the applied force
   4. (a) and (b) only
   5. (a), (b), and (c)
6. A uniform steel beam has one end embedded in a wall at a construction site. The length of the beam that protrudes beyond the wall is 3.0 m long and weighs 2000 N. The magnitude of the torque acting to break the beam at the wall is
   1. 6000 Nm
   2. 4000 Nm
   3. 3000 Nm
   4. 2000 Nm
   5. zero
7. A 10 m long plank of negligible mass is supported on each end by vertical ropes. An unknown weight is placed on the plank somewhere between the ropes. The tension in the left rope is 300 N and the tension in the rope at the right end is 200 N. How far from the left end is the weight positioned?
   1. 7.0 m
   2. 6.0 m
   3. 4.0 m
   4. 3.0 m
   5. 2.0 m
8. An 80 kg man rests one-fourth of the way up a 10 m ladder that leans against a vertical wall. The ladder is uniform, has a mass of 20 kg, and makes an angle of 60° with the ground. What is the frictional force between the ground and the foot of the ladder?
   1. 52 N
   2. 138 N
   3. 198 N
   4. 228 N
   5. 788 N
9. An 800 N painter stands on a 4 m long uniform scaffold that weighs 500 N. The scaffold is supported by vertical ropes at each end. Where should the painter stand from one of the support ropes to produce a tension of 550 N in that rope?
   1. 1.0 m
   2. 1.6 m
   3. 2.2 m
   4. 2.5 m
   5. 2.8 m
10. A body will be in translational equilibrium when
    1. it has constant velocity
    2. it has constant acceleration
    3. no frictional forces act upon the body
    4. no external forces act upon the body
    5. it is acted upon by a constant force

answers: 1 (e), 2 (a), 3 (e), 4 (b), 5 (e), 6 (c), 7 (c), 8 (b), 9 (d), 10 (a)

**Chapter 10: Fluids**

1. A coin has a mass of 3.0 g, a radius of 9.5 mm, and a thickness of 1.5 mm. What is the specific gravity of the coin?
   1. 1.8
   2. 3.4
   3. 3.5
   4. 4.5
   5. 7.1
2. If the atmosphere were compressed so it had the density of water, it would cover the earth to a depth of approximately
   1. 0.76 m
   2. 10 m
   3. 14.7 m
   4. 76 m
   5. 100 m
3. A solid has a density rho. If a second solid having the same volume has three times the mass of the first, what is the density of the second solid?
   1. rho
   2. rho/3
   3. 3rho
   4. 6rho
   5. 9rho
4. A tube with a radius of 42 mm holds an organic fluid that has a specific gravity of 0.92. The tube has a depth of 640 mm. What is the pressure at the bottom of the tube?
   1. 100 Pa
   2. 580 Pa
   3. 1.7 kPa
   4. 5.8 kPa
   5. 1.0 MPa
5. When a solid is submerged beneath the surface of a liquid, the buoyant force acting on the solid is equal to the
   1. viscosity of the liquid
   2. the surface tension of the liquid displaced
   3. the weight of the liquid displaced
   4. the weight of the liquid directly above the surface of the solid
   5. the density of the liquid
6. The two pistons in a hydraulic lift have radii of 26.7 mm and 200 mm respectively. What force must be applied to the 26.7 mm piston so that a 19.6kN weight resting on the 200 mm piston is lifted?
   1. 35 N
   2. 0.27 kN
   3. 0.35 kN
   4. 1.5 kN
   5. 3.0 kN
7. Which of the following is independent of the density of a liquid in a cylinder?
   1. the total force at the bottom of the cylinder
   2. the pressure at the surface of the liquid
   3. the pressure at the bottom of the cylinder
   4. the force on the sides of the cylinder
   5. the pressure on the sides of the cylinder
8. The ratio of an object's weight density to its mass density is
   1. less than 1
   2. is greater than 1
   3. unitless
   4. equal to g
   5. the absolute pressure
9. A cube of cork weighs 2 N. When placed in water exactly half of its volume is submerged. The weight of the displaced water is
   1. 0.5 N
   2. 1 N
   3. 2 N
   4. 4 N
   5. 9.8 N
10. If the flow rate of a liquid moving through a 40 mm diameter pipe is 0.008 m3/s, the average fluid speed in the pipe is
    1. 0.064 m/s
    2. 0.640 m/s
    3. 1.00 m/s
    4. 2.42 m/s
    5. 3.20 m/s

answers: 1 (e), 2 (b), 3 (c), 4 (d), 5 (c), 6 (c), 7 (b), 8 (d), 9 (c), 10 (b)

**Chapter 11: Vibrations and Waves**

1. In a simple harmonic motion the magnitude of the maximum acceleration occurs when
   1. the displacement is a maximum
   2. the displacement is a minimum
   3. momentum is a maximum
   4. velocity is a maximum
   5. the force of restitution is a minimum
2. In simple harmonic motion, the velocity is
   1. constant
   2. always positive
   3. always negative
   4. always changing
   5. related to the displacement
3. The bob on a pendulum has its greatest kinetic energy
   1. at the amplitude positions
   2. throughout its entire motion
   3. at the bottom of its swing
   4. midway between the amplitude positions and the bottom of the swing
   5. as it approaches the amplitude positions
4. The total mechanical energy of a harmonic oscillator is
   1. proportional to the square of the amplitude of motion
   2. inversely proportional to the square of the amplitude of motion
   3. a function of the amplitude of the oscillator
   4. an inverse function of the amplitude of oscillation
   5. directly proportional to the square of the period
5. In a longitudinal wave, the particles of the medium move
   1. perpendicular to the direction of wave propagation
   2. parallel to the direction of wave propagation
   3. in an undefined pattern
   4. elliptically
   5. circular
6. Two particles along a wave train are in phase if both have the same
   1. amplitude of motion
   2. wave speed
   3. amplitude
   4. energy
   5. displacement
7. For a vibrating string, the third overtone is the same as the
   1. second harmonic
   2. third harmonic
   3. fourth harmonic
   4. nodal harmonic
   5. resonance harmonic
8. A longitudinal wave traveling a length of string at 300 m/s has a wavelength of 2.00 m. The frequency is
   1. 100 Hz
   2. 150 Hz
   3. 200 Hz
   4. 300 Hz
   5. 450 Hz
9. The distance between adjacent nodes in a standing wave is
   1. 3 lambda over 2
   2. lambda over 4
   3. lambda over 2
   4. lambda
   5. 2lambda
10. If the tension in a violin string is doubled, the frequency of a standing wave is multiplied by
    1. 0.5
    2. 1/1.414
    3. 1.414
    4. 2
    5. 4

answers: 1 (a), 2 (d), 3 (c), 4 (a), 5 (b), 6 (e), 7 (c), 8 (b), 9 (c), 10 (c)

**Chapter 12: Sound**

1. The speed of sound in air at 0°C is 331 m/s. The speed of sound in air at –40°C is
   1. 238 m/s
   2. 296 m/s
   3. 306 m/s
   4. 310 m/s
   5. 327 m/s
2. When the frequency of a source is doubled, the resultant sound
   1. is improved in quality
   2. has twice the initial wavelength
   3. has half the initial wavelength
   4. travels at twice its initial speed
   5. travels at half its initial speed
3. A sound is measured at 80 dB. What is the intensity of this sound?
   1. 1x10–6 W/m2
   2. 2x10–8 W/m2
   3. 1x10–11 W/m2
   4. 1x10–4 W/m2
   5. 1x10–12 W/m2
4. A wave has an intensity I at a certain point in space. A second wave has twice the energy density and three times the speed as the first wave. What is the intensity of the second wave?
   1. 2I/3
   2. I
   3. 2I
   4. 3I
   5. 6I
5. Two sounds differ by 30 dB. The intensity ratio of the louder sound to the softer one is
   1. 9
   2. 30
   3. 100
   4. 300
   5. 1000
6. A car horn has a frequency of 200 Hz. The frequency heard when the car approaches the observer at 31 m/s when the temperature is 0°C is
   1. 181 Hz
   2. 183 Hz
   3. 217 Hz
   4. 220 Hz
   5. 223 Hz
7. Two tuning forks have frequencies of 340 Hz and 343 Hz. When the forks are sounded together, the resulting number of beats per second heard is
   1. 1
   2. 2
   3. 3
   4. 4
   5. 5
8. The physical property most responsible for resonance is
   1. intensity
   2. frequency
   3. wavelength
   4. amplitude
   5. quality
9. When two identical waves in phase with one another are added, the result is a new wave
   1. with the same frequency but twice the amplitude
   2. with the same amplitude but twice the frequency
   3. with zero amplitude
   4. with zero frequency
   5. the question cannot be answered without knowing the wavelength
10. Two tones having equal amplitude but slightly different frequencies are generated by a sound source. The result is
    1. a standing wave pattern
    2. destructive interference
    3. constructive interference
    4. beats
    5. phase shift of 180°

answers: 1 (c), 2 (c), 3 (d), 4 (e), 5 (e), 6 (a), 7 (c), 8 (b), 9 (a), 10 (d)

**Chapter 13: Temperature and Kinetic Theory**

1. The coefficient of linear expansion will only vary with a change in
   1. temperature
   2. initial length
   3. final length
   4. thermal energy
   5. material
2. Charles' Law states that when other parameters remain constant,
   1. pressure varies directly with volume
   2. pressure varies directly with temperature
   3. pressure varies inversely with volume
   4. pressure varies inversely with temperature
   5. pressure varies directly with the number of moles present
3. If the mass and pressure of a gas remain constant as its volume doubles, the temperature changes by a factor of
   1. 1/4
   2. 1/2
   3. 1
   4. 2
   5. 4
4. It is possible for a substance to exist in the solid, liquid, and gaseous phases in equilibrium when it is at its
   1. triple point
   2. critical temperature
   3. critical pressure
   4. dew point
   5. boiling point
5. A 273 K, 1.0 atmosphere of pressure, 1.0 mol of a gas will occupy a volume of
   1. 1.0 L
   2. 0.273 L
   3. 22.4 L
   4. 22.4 m3
   5. 22.4 ft3
6. A sample of gas has a volume of 0.400 m3 at 0°C. If the pressure remains constant, what is the volume of the gas sample at 100°C?
   1. 0.143 m3
   2. 0.246 m3
   3. 0.287 m3
   4. 0.547 m3
   5. 0.644 m3
7. The Fahrenheit and Celsius temperatures are then the same at
   1. –273°
   2. –40°
   3. 0°
   4. 32°
   5. 100°
8. The maximum density of water occurs at
   1. 0°C
   2. 3.98°C
   3. 32°C
   4. 40°C
   5. –273°C
9. Hydrogen gas, H2, has a molecular weight of 2.00 g/mol. How many molecules of hydrogen are contained in 4.00 g of H2?
   1. 2.00x1023 molecules
   2. 4.01x1023 molecules
   3. 6.02x1023 molecules
   4. 9.03x1023 molecules
   5. 12.04x1023 molecules
10. A circular hole is cut in a sheet of aluminum. When the sheet is heated, the area of the hole
    1. remains constant
    2. decreases
    3. increases
    4. decreases only if the hole was located at the exact center of the sheet
    5. increases only if the hole was located at the exact center of the sheet

answers: 1 (e), 2 (b), 3 (d), 4 (a), 5 (c), 6 (d), 7 (b), 8 (b), 9 (e), 10 (c)

**Chapter 14: Heat**

1. An aluminum alloy has a specific heat twice that of a copper alloy. Identical masses of each alloy initially at 25°C are simultaneously dropped into a container of boiling water. Once the system has reached equilibrium,
   1. the aluminum has a higher temperature than the copper alloy
   2. the copper alloy is at a higher temperature than the aluminum
   3. both alloys are at the same temperature
   4. the difference in the temperatures between the aluminum and the copper alloy is dependent upon the time to reach equilibrium
   5. the difference in the temperatures between the aluminum and the copper alloy is dependent upon the atmospheric pressure
2. Sample A has twice the mass and four times the specific heat as sample B. Both samples are supplied with equal quantities of heat. If sample A experiences a temperature change deltaT, what change in temperature does sample B experience?
   1. delta*T*
   2. one halfdelta*T*
   3. 2delta*T*
   4. 8delta*T*
   5. one eighthdelta*T*
3. The process of going into the gaseous phase directly from the solid phase skipping the liquid phase is called
   1. vaporization
   2. evaporation
   3. sublimation
   4. condensation
   5. plasma
4. When liquids freeze they
   1. decrease in temperature
   2. evolve heat
   3. sublime
   4. absorb heat
   5. none of these answers
5. Of the following, which represents the greatest transfer of heat?
   1. 0.600 kcal
   2. 600 cal
   3. 3 BTU
   4. 2200 ft lb
   5. they are all identical
6. If the absolute temperature of a lamp filament were doubled, the energy radiated each second by the bulb would
   1. remain constant
   2. double
   3. quadruple
   4. increase by a factor of 8
   5. increase by a factor of 16
7. If the thickness of a wall is doubled, the rate of conduction through the wall
   1. doubles
   2. increases by a factor of 4
   3. decreases by a factor of 4
   4. is cut in half
   5. remains constant
8. Heat transfer that involves direct transfer of kinetic energy from more energetic molecules to less energetic molecules is called
   1. conduction
   2. radiation
   3. sublimation
   4. convection
   5. condensation
9. One calorie is equal to
   1. 1.000 J
   2. 4.186 J
   3. 1055 J
   4. 1000 J
   5. 1/4.186 J
10. To increase the temperature of 100 g of pure water by 20 C° requires
    1. 10 cal
    2. 20 cal
    3. 100 cal
    4. 200 cal
    5. 2000 cal

answers: 1 (c), 2 (d), 3 (c), 4 (b), 5 (3), 6 (e), 7 (d), 8 (a), 9 (b), 10 (e)

**Chapter 15: The Laws of Thermodynamics**

1. An adiabatic process is a process where
   1. no heat enters or leaves the system
   2. the temperature of the system is constant
   3. the pressure of the system is constant
   4. the volume of the system is constant
   5. the mass of the system is constant
2. The net work that is done by an engine undergoing adiabatic compression is
   1. deltaU
   2. –deltaU
   3. deltaQ
   4. –deltaQ
   5. deltaQ–deltaU
3. If the compression ration in a gasoline engine is 6 and the adiabatic constant is 1.4, then the efficiency of the engine is
   1. 27%
   2. 45%
   3. 51%
   4. 54%
   5. 57%
4. In order for a Carnot engine to operate at 100% efficiency, the exhaust temperature is
   1. 0° C
   2. 0 K
   3. 100 K
   4. infinite
   5. equal to the input temperature
5. A heat engine absorbs heat at 600 K and expels heat at 200 K. The efficiency of the engine is
   1. 31%
   2. 43%
   3. 50%
   4. 67%
   5. 82%
6. The work done by an ideal gas can be found from a P vs. V graph as the
   1. slope of the curve at a given point
   2. area beneath the curve
   3. intercept of the P-axis
   4. intercept of the V-axis
   5. logarithm of the slope at a given point
7. The work done by a system is
   1. a variable dependent on the state of the system
   2. zero for a cyclic process
   3. equal to the heat added to the system
   4. dependent on the path taken by the process
   5. equal to the change of the internal energy in the system
8. When a total of 60.0 J of heat is added to a thermodynamic system that does 25.0 J of work, the net change in the internal energy of the system is
   1. +35 J
   2. zero
   3. –35 J
   4. +85 J
   5. –85 J
9. The First Law of Thermodynamics is a statement of the conservation of
   1. temperature
   2. heat
   3. energy
   4. work
   5. reversibility
10. The amount of work that is done by a system during an isobaric process is
    1. PdeltaV
    2. VdeltaP
    3. zero
    4. –Q
    5. +Q

answers: 1 (a), 2 (b), 3 (c), 4 (b), 5 (d), 6 (b), 7 (d), 8 (a), 9 (c), 10 (a)

**Chapter 16: Electric Charge and Electric Field**

1. Of the following, which represents the larger charge?
   1. 1x1012 e
   2. 1x10–8 C
   3. 1 µC
   4. 1 nC
   5. 1 pC
2. Decreasing the separation of two identical negative charges by a factor of one-half causes the force of repulsion to change by a factor of
   1. 4
   2. 2
   3. zero
   4. 0.5
   5. 0.25
3. As a negatively charged rod is brought very close to a negatively charged electroscope, the leaves
   1. diverge
   2. converge
   3. are neutralized
   4. are unaffected
   5. leak charge
4. Charging a particle by induction leaves a charge on the particle that is
   1. deficient in electrons
   2. of the same sign as the charging body
   3. an excess of electrons
   4. of the opposite sign than the charging body
   5. greater in charge than the charging body
5. The electrical field is zero
   1. between two equally charged particles
   2. at a point equal distances from two identical charges
   3. between two unequal charges
   4. midway between two equal charges of like sign
   5. midway between two equal charges of unlike sign
6. The elementary charge has a magnitude of
   1. 1.60x1019 C
   2. 1.60x10–19 C
   3. 9x109 C
   4. 9x10–9 C
   5. 6.26x10–18 C
7. The units of Coulomb's constant are
   1. *C*
   2. formula
   3. formula
   4. formula
   5. formula
8. A pith ball holds a charge of –3.8 µC. What total number of electrons does this charge represent?
   1. 1.6x1014 e
   2. 4.2x1014 e
   3. 6.1x1013 e
   4. 2.4x1013 e
   5. 3.2x1013 e
9. An electron is placed in an electric field of strength 300 N/C. What is the magnitude of the force the electron experiences?
   1. 1.6x1013 N
   2. 2.4x1013 N
   3. 3.2x1014 N
   4. 4.8x1014 N
   5. 6.4x1014 N
10. A particle of mass 0.005 kg is given a charge of +4.0 µC and is placed in an electrical field that is directed antiparallel to the earth's gravitational field. What is the field strength, expressed in N/C, if it balances the weight of the particle?
    1. 1.6 x106
    2. 2.4 x106
    3. 3.2 x106
    4. 4.4 x106
    5. 4.7 x106

answers: 1 (c), 2 (a), 3 (a), 4 (d), 5 (e), 6 (b), 7 (e), 8 (d), 9 (b), 10 (e)

**Chapter 17: Electric Potential and Electric Energy: Capacitance**

1. As a negatively charged particle is moved from a point of low electrical potential to one of high electrical potential,
   1. its potential energy increases
   2. its potential energy decreases
   3. no work is done in the process
   4. its charge increases
   5. its charge decreases
2. The potential energy of a charged particle in an electrostatic field is independent of
   1. the part taken to reach the point
   2. the work required to transfer the particle
   3. the strength of the electrical field
   4. the magnitude of the charge at the point
   5. charges creating the field
3. Inside a spherical conductor, the electrical field is
   1. a function of the radius
   2. independent of the electrical potential within the conductor
   3. zero
   4. constant
   5. a function of the permittivity constant
4. Inside a spherical conductor, the electrical potential is
   1. a function of the radius
   2. independent of the electrical potential within the conductor
   3. zero
   4. constant
   5. a function of the permittivity constant
5. The capacitance of a parallel plate capacitor increases with a decrease in
   1. plate area
   2. plate separation
   3. dielectric constant
   4. permittivity
   5. all of the above
6. Which of the following expressions is not equal to the dielectric constant?
   1. formula
   2. formula
   3. formula
   4. formula
   5. formula
7. If a 6.0 µF capacitor is to be given a charge of 24 µC, what potential difference is required?
   1. 0.25 V
   2. 4.0 V
   3. 40 V
   4. 80 V
   5. 144 V
8. What energy, in J, is stored in an 8.00 µF capacitor that was placed across a potential difference of 12.0 V?
   1. 4.80 x10–4
   2. 5.76 x10–4
   3. 48.0 x10–4
   4. 57.6 x10–4
   5. 9.60 x10–4
9. Increasing the potential difference across the two plates of a parallel plate capacitor causes what effect?
   1. there is no change
   2. the capacitance increases
   3. the capacitance decreases
   4. charge on the plates increases
   5. charge on the plates decreases
10. Placing a dielectric between the plates of a charged parallel plate capacitor causes what change in the capacitor?
    1. there is no change
    2. the potential difference across the plates increases
    3. the capacitance increases
    4. charge on the plates increases
    5. the dielectric constant increases

answers: 1 (b), 2 (a), 3 (c), 4 (d), 5 (d), 6 (c), 7 (d), 8 (b), 9 (d), 10 (c)

**Chapter 18: Electric Currents**

1. One ohm (ohm) is equal to
   1. the product of one ampere and one volt
   2. the product of one ampere and one coulomb
   3. the ratio of one volt to one ampere
   4. the ratio of one ampere to one volt
   5. the ration of one coulomb to one ampere
2. Material that show zero resistivity below a certain temperature are called
   1. ohmic materials
   2. conductors
   3. superconductors
   4. non-conductors
   5. resistors
3. The power drop in an ohmic material can be expressed as
   1. *P = IR*
   2. *P = I2R*
   3. *P = IR*2
   4. formula
   5. formula
4. A wire of length L and diameter D has a resistance of 1.00 ohm. If a wire made of the same material and length but three times the diameter replaces the first wire, its resistance changes by what factor?
   1. 1/3
   2. 1/9
   3. 1
   4. 3
   5. 9
5. A wire carries a current of 0.10 A for 20 seconds. What charge passes through the wire?
   1. 2.0 C
   2. 20 C
   3. 200 C
   4. 0.005 C
   5. 0.50 C
6. A 120 V heating coil has a resistance of 600 ohm. What quantity of heat is developed in the coil in 1.0 minute?
   1. 24 J
   2. 120 J
   3. 144 J
   4. 240 J
   5. 1440 J
7. A 100 W light bulb has a hot resistance of 120 ohm. What is the potential difference across the bulb?
   1. 90 V
   2. 110 V
   3. 120 V
   4. 160 V
   5. 220 V
8. An 1100 W heating element operates at a line voltage of 110 V. What is the resistance of the element?
   1. 8 ohm
   2. 9 ohm
   3. 10 ohm
   4. 11 ohm
   5. 12 ohm
9. Which of the following expressions is an expression for power?
   1. ampere-ohm
   2. watt per second
   3. joule per second
   4. kilowatt-hour
   5. ohm-second
10. That property of a conductor to cause it to generate heat when a potential difference is applied to its ends is called
    1. current
    2. resistance
    3. emf
    4. power
    5. potential difference

answers: 1 (c), 2 (c), 3 (b), 4 (b), 5 (a), 6 (e), 7 (b), 8 (d), 9 (c), 10 (b)

**Chapter 19: DC Circuits**

1. We may define the emf of a battery as the
   1. maximum current the battery can deliver to a circuit
   2. power per unit charge that is stored in the battery
   3. total energy stored in the battery
   4. work that is done per unit charge by the battery
   5. power the battery is designed to provide to the circuit
2. The SI unit of emf is
   1. coulomb
   2. volt
   3. ampere
   4. watt
   5. ohm
3. Resistors that are all connected in parallel have
   1. the same potential difference
   2. the same charge
   3. the same current
   4. the same power loss
   5. different potential differences
4. The variance between the emf and the terminal potential difference of a battery in a circuit is due to
   1. power output of the battery
   2. the external resistance of the circuit
   3. the internal resistance
   4. the current delivered to the circuit
   5. the power drop across the external circuit
5. Three resistors are all connected in parallel and each carries currents I1, I2, and I3. Which equation allows for the total current through the resistor combination?
   1. formula
   2. formula
   3. formula
   4. formula
   5. formula
6. A 6.0 ohm and a 12 ohm resistor are connected in parallel which are in turn connected in series to a 2.0 ohm resistor and a 24 V battery. What current will exist in the 2 ohm resistor?
   1. 4.0 A
   2. 6.0 A
   3. 8.0 A
   4. 10.0 A
   5. 12.0 A
7. The property of a conductor of electricity that causes heat when a potential difference is applied across its ends is called
   1. power
   2. emf
   3. current
   4. voltage
   5. resistance
8. The rate at which total charge passes through a given cross-sectional area in a conductor is called
   1. power
   2. emf
   3. current
   4. voltage
   5. resistance
9. If two identical resistors are connected in series across a battery, the power dissipated by them is 20 W. When they are arranged in parallel across the same battery the power dissipated is
   1. 10 W
   2. 20 W
   3. 40 W
   4. 60 W
   5. 80 W
10. The power supplied by a seat of emf can be calculated by
    1. *emf* ÷ *I*
    2. *emf* ÷ *r*
    3. *emf* X *r*
    4. *emf* X *I*
    5. *emf* X *I*2

answers: 1 (d), 2 (b), 3 (a), 4 (c), 5 (c), 6 (a), 7 (e), 8 (c), 9 (e), 10 (d)

**Chapter 19: DC Circuits/Chapter 20: Magnetism**

1. According to Kirchhoff's first rule
   1. the sum of the currents entering a junction equal the sum of the currents leaving a junction
   2. all junctions in a circuit have the same potential
   3. the sum of all the potentials around a closed loop is zero
   4. the sum of all the currents around a closed loop is zero
   5. the sum of the charges stored at all junctions in a closed loop of a circuit is zero
2. If a circuit has three loops, how many simultaneous equations must be written to use with Kirchhoff's two rules?
   1. two
   2. three
   3. four
   4. five
   5. six
3. Across a Wheatstone Bridge, the quantity that is balanced is
   1. voltage
   2. current
   3. resistance
   4. power
   5. emf
4. An ideal voltmeter has
   1. zero resistance
   2. very low resistance
   3. infinite resistance
   4. resistance equal to the current for which the voltage is to be measured
   5. a resistance equal to the galvanometer movement
5. What maximum number of 100 W lights can be arranged in parallel on a 120 V line without blowing a 20 A fuse?
   1. 11
   2. 17
   3. 21
   4. 23
   5. 27
6. Four fresh, AA 1.5 V batteries are used in series to operate a CD player. If the CD player has a total resistance of 200 ohm and the batteries each have a charge of 60 C, approximately, how long will they last?
   1. 130 min
   2. 180 min
   3. 240 min
   4. 480 min
   5. 600 min
7. Kirchhoff's first rule is a statement of the conservation of
   1. electrical potential
   2. electrical force
   3. electrical energy
   4. charge
   5. emf
8. A potentiometer is a device used to measure the
   1. resistance of a bank of resistors
   2. power drop across a resistor
   3. potential difference across a resistance
   4. current through a resistance
   5. electrical charge through a resistance
9. The direction of a magnetic field is
   1. perpendicular to the direction of the magnetic field line
   2. parallel to the direction of the magnetic field line
   3. antiparallel to the direction of the magnetic field line
   4. perpendicular to the plane of the magnetic field lines
   5. along the path of a positive charge moving through the magnetic field
10. The fundamental SI unit of the magnetic field is
    1. gauss
    2. newton
    3. gauss/m
    4. tesla
    5. joule

answers: 1 (a), 2 (c), 3 (a), 4 (c), 5 (b), 6 (a), 7 (d), 8 (c), 9 (b), 10 (d)

**Chapter 21: Electromagnetic Induction and Faraday’s Law**

1. According to Faraday's Law, the magnitude of the induced emf in a loop is proportional to the rate of change in the
   1. current
   2. electrical flux
   3. magnetic field
   4. magnetic flux
   5. electrical field
2. The basic function of an electric generator is for the conversion of
   1. mechanical energy into thermal energy
   2. mechanical energy into electrical energy
   3. low voltage into high voltage
   4. high voltage into low voltage
   5. thermal energy into electrical energy
3. The back emf of an electric motor has a maximum value when the
   1. current through the motor is at a maximum
   2. current is a minimum
   3. motor speed is zero
   4. voltage is a maximum
   5. motor speed is a maximum
4. The energy stored in a current-carrying inductor that is related to the self-inductance relates as
   1. inversely proportional to *L*
   2. inversely proportional to *L*2
   3. directly proportional to *L*
   4. directly proportional to *L*2
   5. directly proportional to formula
5. The emf across a coil of N turns is subjected to a change in magnetic flux over a time interval equals
   1. –formula
   2. formula
   3. –formula
   4. formula
   5. –formula
6. A loop of N turns is rotated in a uniform magnetic field about an axis normal to the field. The direction of the induced current induced in the loop reverses every
   1. 1/4 revolution
   2. 1/2 revolution
   3. full revolution
   4. 1.5 revolutions
   5. 2 revolutions
7. Two different circular loops are concentric and lie in the same plane. The current in the outer loop is increasing with time and runs clockwise. The induced current in the inner loop is
   1. zero
   2. clockwise
   3. counterclockwise
   4. alternating
   5. depends upon the ratio of the radii of the loops
8. An emf can be induced in a loop in a magnetic field by
   1. increasing the magnetic field strength
   2. decreasing the magnetic field strength
   3. increasing the area of the loop
   4. decreasing the area of the loop
   5. all of the above
9. When the south pole bar magnet approaches a loop, an emf is induced so that the magnetic field of the loop
   1. increases as the magnet gets closer
   2. decreases as the magnet gets closer
   3. points away from the south pole of the approaching magnet
   4. points toward the south pole of the approaching magnet
   5. none of the above statements is correct
10. The SI unit of inductance is the
    1. gauss
    2. henry
    3. weber
    4. lenz
    5. tesla

answers: 1 (c), 2 (b), 3 (e), 4 (c), 5 (a), 6 (b), 7 (c), 8 (e), 9 (c), 10 (b)

**Chapter 23: Light – Geometric Optics**

*Key to choices for multiple choice questions 1 to 7:*  
I. real  
II. virtual  
III. upright  
IV. inverted  
V. smaller than the object  
VI. same size as the object  
VII. larger than the object

1. The image formed by a plane mirror is
   1. II, III, and VI
   2. I, III, and VI
   3. II, III, and V
   4. I, III, and V
   5. II, III, and VII
2. The image formed by a concave mirror of an object that is located between the focus and the surface of the mirror is
   1. I, III, and VII
   2. I, IV, and V
   3. II, III, and VII
   4. II, IV, and V
   5. I, IV, and VII
3. The image formed by a convex mirror of an object is
   1. I, III, and V
   2. I, IV, and VI
   3. II, III, and V
   4. II, III, and VI
   5. II, IV, and VII
4. The image formed by a concave mirror of an object that is located at the center of curvature of the mirror is
   1. I, III, and V
   2. I, III, and VI
   3. I, III, and VII
   4. II, IV, and V
   5. I, IV, and VI
5. For an object located at a distance beyond twice the focal length of a lens, the image is
   1. I, III, and V
   2. I, IV, and V
   3. II, III, and VI
   4. II, III, and VII
   5. I, IV, and VII
6. For an object located at a distance between one and two focal lengths from a lens, the image is
   1. I, III, and V
   2. II, IV, and V
   3. I, III, and VI
   4. II, III, and VII
   5. I, IV, and VII
7. For an object located between the focal point and a lens, the image is
   1. I, III, and V
   2. II, IV, and V
   3. I, III, and VI
   4. II, III, and VII
   5. I, IV, and VII
8. A beam of light traveling in air is incident on a transparent medium at an angle of 35° with the normal. If the angle of refraction is measured to be 22°, the index of refraction of the medium is
   1. 0.65
   2. 0.92
   3. 1.23
   4. 1.53
   5. 1.65
9. A transparent plastic has an index of refraction of 1.5. The velocity of light in this material is
   1. 1.5 x108 m/s
   2. 2.0 x108 m/s
   3. 2.5 x108 m/s
   4. 2.8 x108 m/s
   5. 3.0 x108 m/s
10. A thin converging lens has a focal point of 30 cm. An object is located 10 cm from the lens. The image distance is
    1. –15 cm
    2. 15 cm
    3. –30 cm
    4. 30 cm
    5. –7.5 cm

answers: 1 (a), 2 (c), 3 (c), 4 (b), 5 (b), 6 (e), 7 (d), 8 (d), 9 (b), 10 (a)

**Chapter 24: The Wave of Nature of Light**

1. The phenomenon of light spreading around an obstruction is called
   1. diffraction
   2. interference
   3. polarization
   4. scattering
   5. refraction
2. Evidence of the transverse wave nature of light comes from experiments on
   1. diffraction
   2. interference
   3. polarization
   4. scattering
   5. refraction
3. Oil slicks, when viewed with white light, show
   1. a diffraction pattern
   2. alternate bright and dark rings
   3. varying patterns of color
   4. red and green concentric rings
   5. a scattering pattern
4. The advantage of using a diffraction grating over Young's apparatus is
   1. a greater scattering pattern
   2. a more diffuse pattern
   3. absence of dark fringes
   4. absence of bright fringes
   5. sharper bright lines
5. When light shows interference, the dark fringes are due to
   1. constructive interference
   2. destructive interference
   3. an overlap due to scattering
   4. diffraction
   5. Newton's rings
6. The blue color of our sky is due to
   1. water vapor in the atmosphere
   2. optical activity
   3. diffraction as light filters through the atmosphere
   4. scattering of light
   5. interference of spectral lines
7. For a thin film bounded on both sides by media each of lower index of refraction, maximum constructive interference occurs if the optical path difference is
   1. 2lambda
   2. 3 lambda over 2
   3. lambda
   4. lambda over 2
   5. lambda over 4
8. The blue tint of coated binocular lenses is due to
   1. interference
   2. diffraction
   3. refraction
   4. polarization
   5. scattering
9. A monochromatic beam of light illuminates a diffraction grating with 15, 000 lines per inch. The first-order image is located 160 mm from the central image on a screen 0.50 m from the grating. The wavelength of the light is approximately
   1. 500 nm
   2. 515 nm
   3. 544 nm
   4. 568 nm
   5. 589 nm
10. In the layout of a Young's experiment, the slit separation is 0.020 nm and the screen is 1.00 meter away. If the slit is illuminated by monochromatic light of 5000 Å, the second fringe will be displaced from the central fringe by approximately
    1. 2 cm
    2. 3 cm
    3. 4 cm
    4. 5 cm
    5. 6 cm

answers: 1 (a), 2 (c), 3 (c), 4 (e), 5 (b), 6 (d), 7 (d), 8 (a), 9 (b), 10 (c)

**Chapter 25: Optical Instruments**

1. What is the f-stop of a camera with a focal length of 3.2 cm and an aperture-opening radius of 2.0 mm?
   1. 0.64
   2. 0.80
   3. 1.00
   4. 1.28
   5. 8.00
2. A converging lens will be prescribed to correct the vision with which of the following vision problems?
   1. nearsightedness
   2. farsightedness
   3. astigmatism
   4. myopia
   5. glaucoma
3. A compound microscope has an objective focal length of 3.00 mm and an eyepiece focal length of 36.0 mm. What is the approximate magnification when the lenses are separated by 20.0 cm?
   1. 14X
   2. 22X
   3. 68X
   4. 220X
   5. 460X
4. By what factor will tripling the focal length of the objective lens change the magnification of a compound microscope?
   1. 1/81
   2. 1/9
   3. 1/3
   4. 3
   5. 9
5. A simple magnifier uses
   1. a converging lens to form a real image
   2. a converging lens to form a virtual image
   3. an objective lens to form a real image
   4. a diverging lens to form a real image
   5. a diverging lens to form a virtual image
6. The focal length of a refracting telescope has a focal length of 100 cm and the eyepiece has a focal length of 50 mm. What is the magnification of the objective-eyepiece combination when the telescope is focused to infinity to view a distant object?
   1. 2X
   2. 20X
   3. 50X
   4. 500X
   5. 2000X
7. A gemstone being examined under a jeweler's loupe appears 7 times larger. If the near point of the observer is 350 mm, what is the focal length of the loupe?
   1. 35 mm
   2. 45 mm
   3. 50 mm
   4. 55 mm
   5. 70 mm

*Questions 8 to 10.* An object 4.0 cm in height is placed 30 cm in front of a lens with a focal length of 100 mm. A second lens with a focal length of 50 mm is placed 25 cm behind the first lens.

1. The image formed by the first lens is
   1. real and upright
   2. real and inverted
   3. virtual and upright
   4. virtual and inverted
   5. no image is formed
2. In reference to the first lens, the image formed by the first lens is located at an image distance of
   1. 9 cm
   2. 10 cm
   3. 12 cm
   4. 15 cm
   5. 18 cm
3. The image formed by the second lens is
   1. real and upright
   2. real and inverted
   3. virtual and upright
   4. virtual and inverted
   5. no image is formed

answers: 1 (e), 2 (b), 3 (e), 4 (c), 5 (b), 6 (b), 7 (c), 8 (b), 9 (b), 10 (a)

**Chapter 27: Early Quantum Theory and Models of the Atom**

1. The first subatomic particle that was discovered was the
   1. electron
   2. proton
   3. neutron
   4. photon
   5. positron
2. As the temperature of a black body emitter increases, the wavelength of the radiation
   1. increases
   2. decreases
   3. remains a constant over the temperature range
   4. is directly proportional to the temperature
   5. is inversely proportional to the temperature
3. According to the de Broglie equation, if the momentum of the particle is tripled, the corresponding change in the wavelength of the matter wave will change by a factor of
   1. 3
   2. 9
   3. 1/3
   4. 1/9
   5. zero change
4. What is the frequency of the associated wave that travels with a photon having an energy of 2.5 eV?
   1. 2.1 x1014 Hz
   2. 3.2 x1014 Hz
   3. 4.4 x1014 Hz
   4. 6.0 x1014 Hz
   5. 7.2 x1014 Hz
5. Which of the following processes cannot take place if only one photon is involved?
   1. photoelectric effect
   2. pair annihilation
   3. pair production
   4. a quantum jump in the Bohr hydrogen atom
   5. x-ray production
6. In the Bohr hydrogen atom, the quantum jump from the n = 4 to n = 2 energy level results in the emission of a photon in what part of the electromagnetic spectrum?
   1. x-ray
   2. ultraviolet
   3. visible
   4. infrared
   5. microwave
7. In the Bohr hydrogen atom, the quantum jump from the n = 6 to n = 1 energy level results in the emission of a photon in what part of the electromagnetic spectrum?
   1. x-ray
   2. ultraviolet
   3. visible
   4. infrared
   5. microwave
8. In the Bohr hydrogen atom, the quantum jump from the n = 4 to n = 3 energy level results in the emission of a photon related to which series?
   1. Lyman
   2. Balmer
   3. Paschen
   4. Brackett
   5. Pfund
9. In the Bohr hydrogen atom, the quantum jump from the n = 6 to n = 2 energy level results in the emission of a photon related to which series?
   1. Lyman
   2. Balmer
   3. Paschen
   4. Brackett
   5. Pfund
10. A photon is associated with a wavelength of 6400 Å. What is its energy?
    1. 3.4 eV
    2. 2.8 eV
    3. 2.5 eV
    4. 1.9 eV
    5. 1.4 eV

answers: 1 (a), 2 (b), 3 (c), 4 (d), 5 (b), 6 (c), 7 (b), 8 (c), 9 (b), 10 (d)

**Chapter 30: Nuclear Physics and Radioactivity**

1. The nuclear radiation having the least penetration power in matter is
   1. alpha
   2. beta
   3. positron
   4. K-capture
   5. gamma
2. The atomic number of a nucleus represents
   1. nucleon population of the nucleus
   2. proton population of the nucleus
   3. neutron population of the nucleus
   4. beta decay mode for the given nucleus
   5. the half-life period for the isotope
3. An unknown radioactive material is observed to have an activity of 2400 counts per second. Three hours later it is observed to have an activity of 300 counts per second. What is the half-life of this material?
   1. 0.5 h
   2. 1.0 h
   3. 1.5 h
   4. 2.0 h
   5. 3.0 hr
4. When an alpha particle is emitted by a nucleus, the atomic number of the nucleus
   1. decreases by 4
   2. increases by 4
   3. does not change
   4. increases by 2
   5. decreases by 2
5. When a negative beta particle is emitted from a radioactive nucleus, the mass number of the nucleus
   1. increases by 1
   2. decreases by 1
   3. does not change
   4. increases by 2
   5. decreases by 2
6. The limiting factor that determines the size of the nucleus is
   1. the range of the weak nuclear force
   2. the weakness of the weak nuclear force
   3. the range of the strong nuclear force
   4. the range of the electrostatic force
   5. all of the above are correct
7. When a positron is emitted from a radioactive nucleus, the atomic number of that nucleus
   1. is increased by 1
   2. is decreased by 1
   3. does not change
   4. is increased by 2
   5. is decreased by 2
8. When a gamma ray is emitted from a radioactive nucleus, the mass number of the nucleus
   1. increases by 1
   2. decreases by 1
   3. does not change
   4. increases by 2
   5. decreases by 2
9. During the radioactive process of K-capture
   1. a proton is absorbed into the nucleus
   2. a neutron is absorbed into the nucleus
   3. a neutrino is absorbed into the nucleus
   4. an electron is absorbed into the nucleus
   5. a positron is absorbed into the nucleus
10. The existence of the neutrino was postulated to account for which of the following during the process of beta decay?
    1. conservation of linear momentum
    2. conservation of spin
    3. conservation of mass-energy
    4. choices (a) and (c)
    5. choices (a), (b), and (c)

answers: 1 (a), 2 (b), 3 (b), 4 (e), 5 (a), 6 (c), 7 (b), 8 (c), 9 (d), 10 (e)

**Chapter 31: Nuclear Energy: Effects and Uses of Radiation**

1. The quantity of fissionable material necessary to make a fission reaction self-sustaining is called the
   1. flash point
   2. critical point
   3. critical mass
   4. reaction mass
   5. multiplication factor
2. The function of breeder reactors is to
   1. generate fast and cheap energy
   2. make Pu-230
   3. make U-235
   4. control nuclear reaction rates
   5. make radioactive tracers
3. A single radioactive disintegration per second is defined as the
   1. curie
   2. roentgen
   3. gray
   4. becquerel
   5. sievert
4. Plasma can be contained in a *magnetic bottle* because
   1. it exists at high temperatures
   2. of its fluid properties
   3. it is made of charged particles
   4. its density is great
   5. all of the above answers
5. To fission nuclei of U-235 in a nuclear reactor, which of the following are used to initiate the fission reaction?
   1. proton
   2. neutron
   3. neutrino
   4. gamma ray
   5. positron
6. The moderator used in a nuclear reactor has what purpose?
   1. coolant
   2. absorb neutrons
   3. accelerate neutrons
   4. decelerate neutrons
   5. trigger a chain-reaction
7. Which of the following particles in the free state is the most unstable?
   1. proton
   2. electron
   3. neutron
   4. neutrino
   5. none of the above because they are all stable
8. A temperature on the order of 108 K is required to drive a fusion reactor. Why is such a high temperature required?
   1. to split electrons from hydrogen atoms
   2. split protons into quarks
   3. to form a plasma
   4. to overcome the coulombic forces of repulsion between the protons
   5. all of the above answers
9. In a chain-reaction involving Pu-239, the nuclide that is both a reactant and a product is
   1. formula
   2. formula
   3. formula
   4. formula
   5. formula
10. The material that serves as both fuel and product in a breeder reactor is
    1. formula
    2. formula
    3. formula
    4. formula
    5. formula

answers: 1 (c), 2 (b), 3 (d), 4 (c), 5 (b), 6 (d), 7 (c), 8 (d), 9 (e), 10 (b)