普通物理學

(D)1. At time t = 0 a car has a velocity of 16 m/s. It slows down with an acceleration given by –0.50t, in m/s^2 for t in seconds. By the time it stops it has traveled:
(A) 15 m (B) 31 m (C) 62 m (D) 85 m (E) 100 m

(D)2. A stone is tied to the end of a string and is swung with constant speed around a horizontal circle with a radius of 1.5 m. If it makes two complete revolutions each second, its acceleration is:
(A) 0.24 m/s^2 (B) 2.4 m/s^2 (C) 24 m/s^2 (D) 240 m/s^2 (E) 2400 m/s^2

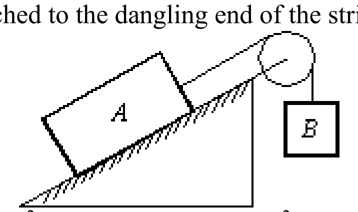
(D)3. A Ferris wheel with a radius of 8.0m makes 1 revolution every 10 s. When he is at the top, essentially a diameter above the ground, he releases a ball. How far from the point on the ground directly under the release point does the ball land?
(A) 0 (B) 1.0 m (C) 8.0 m (D) 9.1 m (E) 16 m

(A)4. A boat is traveling upstream at 14 mph with respect to a river that is flowing at 6 mph (with respect to the ground). A man runs directly across the boat, from one side to the other, at 6 mph (with respect to the boat). The speed of the man with respect to the ground is:
(A) 10 mph (B) 14 mph (C) 18.5 mph (D) 21 mph (E) 26 mph

(B)5. A ferry boat is sailing at 12 km 30° W of N with respect to a river that is flowing at 6.0 km/h E. As observed from the shore, the ferry boat is sailing:
(A) 30° E of N (B) due N (C) 30° W of N (D) 45° E of N (E) none of these

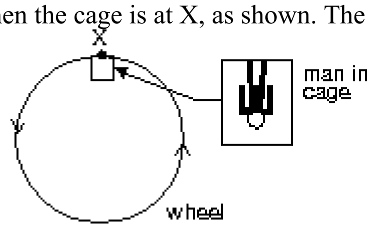
(C)6. When a 40-N force, parallel to the incline and directed up the incline, is applied to a crate on a frictionless incline that is 30° above the horizontal, the acceleration of the crate is 2.0 m/s^2, up the incline. The mass of the crate is:
(A) 3.8 kg (B) 4.1 kg (C) 5.8 kg (D) 6.2 kg (E) 10 kg

(B)7. Block A, with a mass of 10 kg, rests on a 30° incline. The coefficient of kinetic friction is 0.20. The attached string is parallel to the incline and passes over a massless, frictionless pulley at the top. Block B, with a mass of 8.0 kg, is attached to the dangling end of the string. The acceleration of B is:



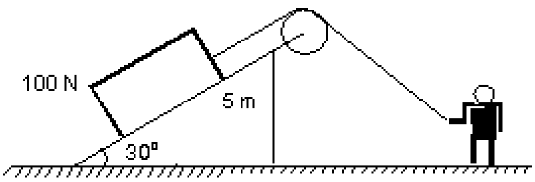
(A) 0.69 m/s^2, up (B) 0.69 m/s^2, down (C) 2.6 m/s^2, up (D) 2.6 m/s^2, down (E) 0

(D)8. A giant wheel, having a diameter of 40 m, is fitted with a cage and platform on which a man of mass *m* stands. The wheel is rotated in a vertical plane at such a speed that the force exerted by the man on the platform is equal to his weight when the cage is at X, as shown. The net force on the man at point X is:



(A) zero (B) *mg*, down (C) *mg*, up (D) 2 *mg*, down (E) 2 *mg*, up

(E)9. A man pulls a 100-N crate up a frictionless 30° slope 5 m high as shown. Assuming that the crate moves at constant speed, the work (in ft ·lb) done by the man is:



(A) –500 J (B) –250 J (C) 0 (D) 250 J (E) 500 J

(A)10. An ideal spring is hung vertically from the ceiling. When a 2.0-kg mass hangs at rest from it the spring is extended 6.0 cm from its relaxed length. A downward external force is now applied to the mass to extend the spring an additional 10 cm. While the spring is being extended by the force, the work done by the spring is:

(A) –3.6 J (B) –3.3 J (C) -3.4×10^{-5} J (D) 3.3 J (E) 3.6 J

(A)11. An ideal spring is hung vertically from the ceiling. When a 2.0-kg mass hangs at rest from it the spring is extended 6.0 cm from its equilibrium length. An upward external force is then applied to the mass to compress the spring so it is 10 cm shorter than its equilibrium length. While the spring is being compressed the work done by the spring is:

(A) –1.0 J (B) –0.52 J (C) –0.26 J (D) 0.52 J (E) 1.0 J

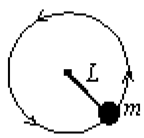
(C)12. A particle starts from rest at time $t = 0$ and moves along the x axis. If the net force on it is proportional to t, its kinetic energy is proportional to:

(A) t (B) t^2 (C) t^4 (D) $1/t^2$ (E) none of the above

(D)13. A 50-N force acts on a 2-kg crate that starts from rest. At the instant the particle has gone 2 m the rate at which the force is doing work is:

(A) 2.5 W (B) 25 W (C) 75 W (D) 100 W (E) 1000 W

(D)14. A ball of mass m, at one end of a string of length L, rotates in a vertical circle just fast enough to prevent the string from going slack at the top of the circle. The speedof the ball at the bottom of the circle is:



(A) $\sqrt{2gL}$ (B) $\sqrt{3gL}$ (C) $\sqrt{4gL}$ (D) $\sqrt{5gL}$ (E) $\sqrt{7gL}$

(B)15. A 640-N hunter gets a rope around a 320-N polar bear. They are stationary, 20 m apart, on frictionless level ice. When the hunter pulls the polar bear to him, the polar bear will move:

(A) 1.0 m (B) 3.3 m (C) 10 m (D) 12 m (E) 17 m

(A)16. A block moves at 5 m/s in the positive x direction and hits an identical block, initially at rest. A small amount of gunpowder had been placed on one of the blocks. The explosion does not harm the blocks but it doubles their total kinetic energy. After the explosion the blocks move along the x axis and the incident block has a speed in m/s of:

(A) 1.8 (B) 5.0 (C) 6.8 (D) 7.1 (E) 11.8

(E)17. If Earth were to rotate only 100 times per year about its axis:

(A) airplanes flying W to E would make better time (B) we would fly off Earth's surface
(C) our weight would slightly increase (D) Earth's atmosphere would float into outer space
(E) our weight would slightly decrease

(C)18. The escape velocity at the surface of Earth is approximately 8 km/s. What is the escape velocity for a planet whose radius is 4 times and whose mass is 100 times that of Earth?

(A) 1.6 km/s (B) 8 km/s (C) 40 km/s (D) 200 km/s (E) none of the above

(B)19. A projectile is fired straight upward from Earth's surface with a speed that is half the escape speed. If R is the radius of Earth, the highest altitude reached, measured from the surface, is:

(A) $R/4$ (B) $R/3$ (C) $R/2$ (D) R (E) $2R$

(B)20. A planet is in circular orbit around the Sun. Its distance from the Sun is four times the average distance of Earth from the Sun. The period of this planet, in Earth years, is:
(A) 4 (B) 8 (C) 16 (D) 64 (E) 2.52

(E)21. Two planets are orbiting a star in a distant galaxy. The first has a semimajor axis of 150×10^6 km, an eccentricity of 0.20, and a period of 1.0 Earth years. The second has a semimajor axis of 250×10^6 km, an eccentricity of 0.30, and a period of:
(A) 0.46 Earth yr (B) 0.57 Earth yr (C) 1.4 Earth yr (D) 1.8 Earth yr (E) 2.2 Earth yr

(B)22. A wheel starts from rest and has an angular acceleration that is given by $\alpha(t) = 6t^2$, where t is in seconds and α is in radians per second-squared. The time it takes to make 10 revolutions is:
(A) 2.8 s (B) 3.3 s (C) 4.0 s (D) 4.7 s (E) 5.3 s

(D)23. A pulley with a radius of 3.0 cm and a rotational inertia of 4.5×10^{-3} kg · m^2 is suspended from the ceiling. A rope passes over it with a 2.0-kg block attached to one end and a 4.0-kg block attached to the other. The rope does not slip on the pulley. When the velocity of the heavier block is 2.0 m/s the total kinetic energy of the pulley and blocks is:
(A) 2.0 J (B) 4.0 J (C) 14 J (D) 22 J

(D)24. The coefficient of static friction between a certain cylinder and a horizontal floor is 0.40. If the rotational inertia of the cylinder about its symmetry axis is given by $I = (1/2)MR^2$, then the maximum acceleration the cylinder can have without slipping is:
(A) 0.1 g (B) 0.2 g (C) 0.4 g (D) 0.8 g (E) 1 g

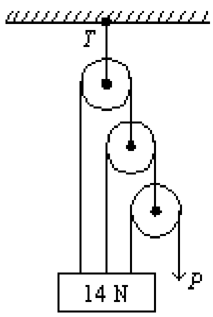
(D)25. A hoop, a uniform disk, and a uniform sphere, all with the same mass and outer radius, start with the same speed and roll without slipping up identical inclines. Rank the objects according to how high they go, least to greatest.
(A) hoop, disk, sphere (B) disk, hoop, sphere (C) sphere, hoop, disk (D) sphere, disk, hoop'
(E) hoop, sphere, disk

(D)26. A cylinder of radius R = 6.0 cm is resting on a rough horizontal surface. The coefficient of kinetic friction between the cylinder and the surface is 0.30 and the rotational inertia for rotation about the axis is given by $MR^2/2$, where M is its mass. Initially it is not rotating but its center of mass has a velocity of 7.0 m/s. After 2.0 s the velocity of its center of mass and its angular velocity about its center of mass, respectively, are:
(A) 1.1 m/s, 0 (B) 1.1 m/s, 19 rad/s (C) 1.1 m/s, 98 rad/s (D) 1.1 m/s, 200 rad/s
(E) 5.9 m/s, 98 rad/s

(C)27. A 2.0-kg block travels around a 0.50 m radius circle with an angular speed of 12 rad/s. The circle is parallel to the xy plane and is centered on the z axis, 0.75 m from the origin. The component in the xy plane of the angular momentum around the origin has magnitude:
(A) 0 (B) 6.0 kg · m^2/s (C) 9.0 kg · m^2/s (D) 11 kg · m^2/s (E) 14 kg · m^2/s

(B)28. A uniform plank is 6.0 m long and weighs 80 N. It is balanced on a sawhorse at its center. An additional 160 N weight is now placed on the left end of the plank. To keep the plank balanced, it must be moved what distance to the right?
(A) 6.0 m (B) 2.0 m (C) 1.5 m (D) 1.0 m (E) 0.50 m

(C)29. The pull P is just sufficient to keep the 14-N block and the weightless pulleys in equilibrium as shown. The tension T in the upper cable is:
(A) 14 N (B) 28 N (C) 16 N (D) 9.33 N (E)18.7 N

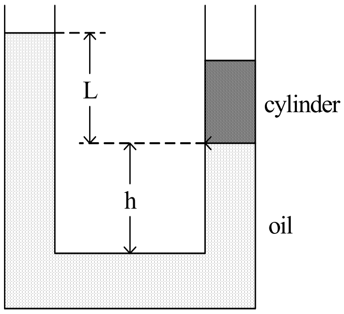


(A)30. A particle is in simple harmonic motion along the x axis. The amplitude of the motion is x_m. When it is at $x = x_1$, its kinetic energy is $K = 5$J and its potential energy (measured with $U = 0$ at $x = 0$) is $U = 3$J. When it is at $x = -1/2x_m$, the kinetic and potential energies are:
(A) $K = 5$J and $U = 3$J (B) $K = 5$J and $U = -3$J (C) $K = 8$J and $U = 0$ (D) $K = 0$ and $U = 8$J (E) $K = 0$ and $U = -8$J

(C)31. The rotational inertia of a uniform thin rod about its end is $ML^2/3$, where M is the mass and L is the length. Such a rod is hung vertically from one end and set into small amplitude oscillation. If $L = 1.0$ m this rod will have the same period as a simple pendulum of length:
(A) 33 cm (B) 50 cm (C) 67 cm (D) 100 cm (E) 150 cm

(E)32. Five particles undergo damped harmonic motion. Values for the spring constant k, the damping constant b, and the mass m are given below. Which leads to the greatest rate of dissipation of mechanical energy?
(A) $k = 100$N/m, $m = 50$g, $b = 5$g/s (B) $k = 150$N/m, $m = 50$g, $b = 5$g/s (C) $k = 150$N/m, $m = 10$g, $b = 8$g/s (D) $k = 200$N/m, $m = 8$g, $b = 6$g/s (E) $k = 100$N/m, $m = 2$g, $b = 4$g/s

(A)33. The diagram shows a U-tube having cross-sectional area A and partially filled with oil of density r. A solid cylinder, which fits the tube tightly but can slide without friction, is placed in the right arm. The system reaches equilibrium. The weight of the cylinder is:
(A) ALrg (B) L3rg (C) Ar(L + h)g (D) Ar(L -h)g (E) none of these



(B)34. An object hangs from a spring balance. The balance indicates 30 N in air, 20 N when the object is submerged in water, and 24 N when the object is submerged in an unknown liquid. The density of the unknown liquid equals the density of water multiplied by:
(A) 10/4 (B) 6/10 (C) 24/20 (D) 4/10 (E) 10/30

(A)35. Water flows from a 6.0-cm diameter pipe into an 8.0-cm diameter pipe. The speed in the 6.0-cm pipe is 5.0 m/s. The speed in the 8-inch pipe is:
(A) 2.8 m/s (B) 3.7 m/s (C) 6.6 m/s (D) 8.8 m/s (E) 9.9 m/s

(B)36. A large water tank, open at the top, has a small hole in the bottom. When the water level is 30 m above the bottom of the tank, the speed of the water leaking from the hole:
(A) is 2.5 m/s (B) is 24 m/s (C) is 44 m/s (D) cannot be calculated unless the area of the hole is given (E) cannot be calculated unless the areas of the hole and tank are given

(B)37. A water line enters a house 2.0 m below ground. A smaller diameter pipe carries water to a faucet 5.0 m above ground, on the second floor. Water flows at 2.0 m/s in the main line and at 7.0 m/s on the second floor. Take the density of water to be 1.0×10^3 kg/m^3. If the pressure in the main line is 2.0×10^5 Pa, then the pressure on the second floor is:
(A) 5.3×10^4 Pa (B) 1.1×10^5 Pa (C) 1.5×10^5 Pa (D) 2.5×10^5 Pa (E) 3.4×10^5 Pa

(D)38. During an adiabatic process an object does 100 J of work and its temperature decreases by 5 K. During another process it does 25 J of work and its temperature decreases by 5 K. Its heat capacity for the second process is:
(A) 20 J/K (B) 0.05 K/J (C) 5 J/K (D) 15 J/K (E) 100 K/J

(D)39.When work W is done on an ideal gas of diatomic molecules in thermal isolation the increase in the total translational kinetic energy of the molecules is:
(A) 0 (B) 2W/3 (C) 2W/5 (D) 3W/5 (E) W

(D)40. An ideal gas, consisting of n moles, undergoes a reversible isothermal process during which the volume changes from V_i to V_f. The change in entropy of the thermal reservoir in contact with the gas is given by:
(A) $nR(V_f - V_i)$ (B) $nR \ln(V_f - V_i)$ (C) $nR \ln(V_i/V_f)$ (D) $nR \ln(V_f/V_i)$ (E) none of the above (entropy can't be calculated for an irreversible process)

(B)41. In a thermally insulated kitchen, an ordinary refrigerator is turned on and its door is left open. The temperature of the room:
(A) remains constant according to the first law of thermodynamics (B) increases according to the first law of thermodynamics (C) decreases according to the first law of thermodynamics (D) remains constant according to the second law of thermodynamics (E) increases according to the second law of thermodynamics

(A)42. A perfectly reversible heat pump supplies heat to a building to maintain its temperature at 27°C. The cold reservoir is a river at 7°C. If work is supplied to the pump at the rate of 1 kW, at what rate does the pump supply heat to the building?
(A) 15 kW (B) 3.85 kW (C) 1.35 kW (D) 1.07 kW (E) 1.02 kW

(D)43. Positive charge Q is distributed uniformly throughout an insulating sphere of radius R, centered at the origin. A positive point charge Q is placed at x = 2R on the x axis. The magnitude of the electric field at x = R/2 on the x axis is:
(A) $Q/4\pi\varepsilon_0 R^2$ (B) $Q/8\pi\varepsilon_0 R^2$ (C) $Q/72\pi\varepsilon_0 R^2$ (D) $17Q/72\pi\varepsilon_0 R^2$ (E) none of these

(A)44. Two identical charges q are placed on the x axis, one at the origin and the other at x = 5 cm. A third charge –q is placed on the x axis so the potential energy of the three-charge system is the same as the potential energy at infinite separation. Its x coordinate is:
(A) 13 cm (B) 2.5 cm (C) 7.5 cm (D) 10 cm (E) –5 cm

(B)45. Pulling the plates of an isolated charged capacitor apart:
(A) increases the capacitance (B) increases the potential difference (C) does not affect the potential difference (D) decreases the potential difference (E) does not affect the capacitance

(A)46. Capacitors C_1 and C_2 are connected in series and a potential difference is applied to the combination. If the capacitor that is equivalent to the combination has the same potential difference, then the charge on the equivalent capacitor is the same as:
(A) the charge on C_1 (B) the sum of the charges on C_1 and C_2 (C) the difference of the charges on C_1 and C_2 (D) the product of the charges on C_1 and C_2 (E) none of the above

(D)47. Capacitors A and B are identical. Capacitor A is charged so it stores 4 J of energy and capacitor B is uncharged. The capacitors are then connected in parallel. The total stored energy in the capacitors is now:
(A) 16 J (B) 8 J (C) 4 J (D) 2 J (E) 1 J

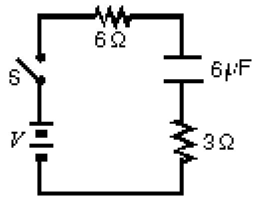
(B)48. A certain capacitor has a capacitance of 5 μF. While it is charged to 5 μC and isolated, the plates are pulled apart so its capacitance becomes 2 μF. The work done by the pulling agent is about:
(A) 0 (B) 4×10^{-6} J (C) 8×10^{-6} J (D) 9×10^{-6} J (E) 18×10^{-6} J

(B)49. The terminal potential difference of a battery is greater than its emf:
(A) under all conditions (B) only when the battery is being charged (C) only when the battery is being discharged (D) only when there is no current in the battery (E) under no conditions

(C)50. The positive terminals of two batteries with emf's of 14 V and 10 V, respectively, are connected together. The circuit is completed by connecting the negative terminals. If each battery has an internal resistance of 1.0 Ω, the rate in watts at which electrical energy is converted to chemical energy in the smaller battery is:
(A) 4 (B) 14 (C) 20 (D) 120 (E) 144

(D)51. A certain ammeter has an internal resistance of 1 Ω and a range from 0 to 50 mA. To make its range from 0 to 5 A, use:
(A) a series resistance of 99 Ω (B) an extremely large (say 10^6 Ω) series resistance (C) a resistance of 99 Ω in parallel (D) a resistance of 1/99 Ω in parallel (E) a resistance of 1/1000 Ω in parallel

(D)52. In the circuit shown, the capacitor is initially uncharged. At time t = 0, switch S is closed. If τ denotes the time constant, the approximate current through the 3Ω resistor when $t = \tau/100$ is:



(A) 3/8 A (B) 1/2 A (C) 3/4 A (D) 1 A (E) 3/2 A

(B)53. A charged capacitor is being discharged through a resistor. At the end of one time constant the charge has been reduced by (1 – 1/e) = 63% of its initial value. At the end of two time constants the charge has been reduced by what percent of its initial value?
(A) 82% (B) 86% (C) 100% (D) between 90% and 100% (E) need to know more data to answer the question

(C)54. A certain capacitor, in series with a 720-Ω resistor, is being charged. At the end of 10 ms its charge is half the final value. The capacitance is about:
(A) 9.6 μF (B) 14 μF (C) 20 μF (D) 7.2 F (E) 10 F

(A)55. A loop of wire carrying a current of 2.0 A is in the shape of a right triangle with two equal sides, each 15 cm long. A 0.7 T uniform magnetic field is parallel to the hypotenuse. The resultant magnetic force on the two sides has a magnitude of:
(A) 0 (B) 0.21 N (C) 0.30 N (D) 0.41 N (E) 0.51 N

(A)56. A circular loop of wire with a radius of 20 cm lies in the xy plane and carries a current of 2 A, counterclockwise when viewed from a point on the positive z axis. Its magnetic dipole moment is:
(A) 0.25 A · m^2, in the positive z direction (B) 0.25 A · m^2, in the negative z direction (C) 2.5 A · m^2, in the positive z direction (D) 2.5 A · m^2, in the negative z direction (E) 0.25 A · m^2, in the xy plane

(B)57. A loop of current-carrying wire has a magnetic dipole moment of 5×10^{-4} A · m^2. The moment initially makes an angle of 90° with a 0.5-T magnetic field. As it turns to become aligned with the field, the work done by the field is:
(A) 0 (B) 2.5×10^{-4} J (C) -2.5×10^{-4} J (D) 1.0×10^{-3} J (E) -1.0×10^{-3} J

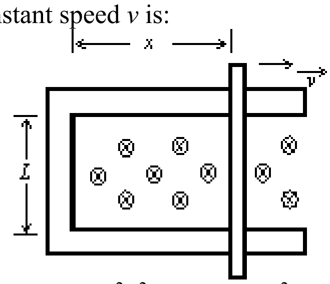
(C)58. The magnetic field (in T) a distance 2 cm from a long straight wire carrying a current of 2 A is about:
(A) 2×10^{-7} (B) 1×10^{-5} (C) 2×10^{-5} (D) 1×10^{-3} (E) 10

(E)59. Two long straight wires are parallel and carry current in opposite directions. The currents are 8.0 A and 12 A and the wires are separated by 0.40 cm. The magnetic field in tesla at a point midway between the wires is:
(A) 0 (B) 4.0×10^{-4} (C) 8.0×10^{-4} (D) 12×10^{-4} (E) 20×10^{-4}

(D)60. A long straight wire carrying a 3.0 A current enters a room through a window 1.5 m high and 1.0 m wide. The path integral $\oint \vec{B} \bullet d\vec{l}$ around the window frame has the value (in T·m):
(A) 0.20 (B) 2.5×10^{-7} (C) 3.0×10^{-7} (D) 3.8×10^{-6} (E) none of these

(C)61. A 10 turn conducting loop with a radius of 3.0 cm spins at 60 revolutions per second in a magnetic field of 0.50 T. The maximum emf generated is:
(A) 0.014 V (B) 0.53 V (C) 5.3 V (D) 18 V (E) 180 V

(D)62. A rod with resistance *R* lies across frictionless conducting rails in a constant uniform magnetic field *B*, as shown. Assume the rails have negligible resistance. The force that must be applied by a person to pull the rod to the right at constant speed *v* is:



(A) 0 (B) *BLv* (C) *BLv*/*R* (D) B^2L^2v/R (E) B^2Lxv/R

(A)63. An 8.0-mH inductor and a 2.0-Ω resistor are wired in series to an ideal battery. A switch in the circuit is closed at time 0, at which time the current is 0. The current reaches half its final value at time:
(A) 2.8 ms (B) 4.0 ms (C) 3 s (D) 170 s (E) 250 s

(D)64. An inductance *L* and a resistance *R* are connected in series to an ideal battery. A switch in the circuit is closed at time 0, at which time the current is zero. The rate of increase of the energy stored in the inductor is a maximum:
(A) just after the switch is closed (B) at the time $t = L/R$ after the switch is closed (C) at the time $t = 2L/R$ after the switch is closed (D) at the time $t = (L/R)\ln 2$ after the switch is closed (E) a long time after the switch is closed

(E)65. A 6.0 mH inductor is in a circuit. At the instant the current is 5.0 A and its rate of change is 200 A/s, the rate at which the energy stored in the inductor is increasing is:
(A) 7.5×10^{-2} W (B) 120 W (C) 240 W (D) 3.0 W (E) 6.0 W

(B)66. A 0.20-cm radius cylinder, 3.0 cm long, is wrapped with wire to form an inductor. At the instant the magnetic field in the interior is 5.0 mT the energy stored in the field is:
(A) 0 (B) 3.8×10^{-6} J (C) 7.5×10^{-6} J (D) 7.5×10^{-4} J (E) 9.9 J

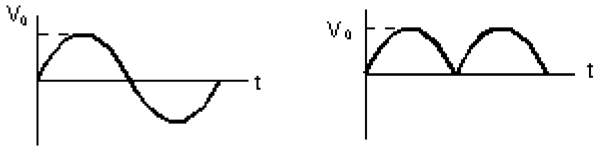
(D)67. A 1.2-m radius cylindrical region contains a uniform electric field that is increasing uniformly with time. At $t = 0$ the field is 0 and at $t = 5.0$ s the field is 200 V/m. The total displacement current through a cross section of the region is:
(A) 4.5×10^{-16} A (B) 2.0×10^{-15} A (C) 3.5×10^{-10} A (D) 1.6×10^{-9} A (E) 8.0×10^{-9} A

(B)68. A 0.70-m radius cylindrical region contains a uniform electric field that is parallel to the axis and is increasing at the rate 5.0×10^{12} V/m · s. The magnetic field at a point 0.25 m from the axis has a magnitude of:
(A) 0 (B) 7.0×10^{-6} T (C) 2.8×10^{-5} T (D) 5.4×10^{-5} T (E) 7.0×10^{-5} T

(C)69. An *RL* series circuit is connected to an ac generator with a maximum emf of 20 V. If the maximum potential difference across the resistor is 16 V, then the maximum potential difference across the inductor is:
(A) 2 V (B) 4 V (C) 12 V (D) 25.6 V (E) 36 V

(E)70. When the amplitude of the oscillator in a series *RLC* circuit is doubled:
(A) the impedance is doubled (B) the voltage across the capacitor is halved (C) the capacitive reactance is halved (D) the power factor is doubled (E) the current amplitude is doubled

(D)71. The rms value of a sinusoidal voltage is $V_0/\sqrt{2}$, where V_0 is the amplitude. What is the rms value of its fully rectified wave? Recall that $\mathrm{Vrec} = |\mathrm{V_0 \sin wt}|$.



(A) $V_0^2/\sqrt{2}$ (B) $V_0^2/2$ (C) $\sqrt{2}V_0$ (D) $V_0/\sqrt{2}$ (E) $V_0/(2\sqrt{2})$

(D)72. An ac generator produces 10 V (rms) at 400 rad/s. It is connected to a series *RL* circuit (R = 17.3 Ω, L = 0.025 H). The rms current is:
(A) 0.50 A and leads the emf by 30° (B) 0.71 A and lags the emf by 30° (C) 1.40 A and lags the emf by 60° (D) 0.50 A and lags the emf by 30° (E) 0.58 A and leads the emf by 90°

(B)73. When a certain string is clamped at both ends, the lowest four resonant frequencies are measured to be 100, 150, 200, and 250 Hz. One of the resonant frequencies (below 200 Hz) is missing. What is it?
(A) 25 Hz (B) 50 Hz (C) 75 Hz (D) 125 Hz (E) 225 Hz

(C)74. Two identical tuning forks vibrate at 256 Hz. One of them is then loaded with a drop of wax, after which 6 beats per second are heard. The period of the loaded tuning fork is:
(A) 0.006 s (B) 0.005 s (C) 0.004 s (D) 0.003 s (E) none of these

(C)75. If the sound level is increased by 10 db the intensity increases by a factor of:
(A) 2 (B) 5 (C) 10 (D) 20 (E) 100

(E)76. A 1024 Hz tuning fork is used to obtain a series of resonance levels in a gas column of variable length, with one end closed and the other open. The length of the column changes by 20 cm from resonance to resonance. From this data, the speed of sound in this gas is:
(A) 20 cm/s (B) 51 cm/s (C) 102 cm/s (D) 205 cm/s (E) 410 cm/s

(B)77. If the speed of sound is 340 m/s, the two lowest frequencies of an 0.5 m organ pipe, closed at one end, are approximately:
(A) 170 and 340 Hz (B) 170 and 510 Hz (C) 340 and 680 Hz (D) 340 and 1020 Hz (E) 57 and 170 Hz

(D)78. A source emits sound with a frequency of 1000 Hz. It is moving at 20 m/s toward a stationary reflecting wall. If the speed of sound is 340 m/s an observer at rest directly behind the source hears a beat frequency of:
(A) 11 Hz (B) 86 Hz (C) 97 Hz (D) 118 Hz (E) 183 Hz

(B)79. The speed of sound is 340 m/s. A plane flys horizontally at an altitude of 10,000 m and a speed of 400 m/s. When an observer on the ground hears the sonic boom the horizontal distance from the point on its path directly above the observer to the plane is:
(A) 5800 m (B) 6200 m (C) 8400 m (D) 12,000 m (E) 16,000 m

(C)80. A concave mirror forms a real image which is twice the size of the object. If the object is 20 cm from the mirror, the radius of curvature of the mirror must be about:
(A) 13 cm (B) 20 cm (C) 27 cm (D) 40 cm (E) 80 cm

(A)81. The object-lens distance for a certain converging lens is 400 mm. The image is three times the size of the object. To make the image five times the size of the object-lens distance must be changed to:
(A) 360 mm (B) 540 mm (C) 600 mm (D) 720 mm (E) 960 mm

(E)82. When a single-lens camera is focused on a distant object, the lens-to-film distance is found to be 40.0 mm. To focus on an object 0.54 m in front of the lens, the film-to-lens distance must be:
(A) not changed (B) decreased by 2.7 mm (C) decreased by 3.2 mm (D) increased by 2.7 mm (E) increased by 3.2 mm

(A)83. A converging lens of focal length 20 cm is placed in contact with a diverging lens of focal length 30 cm. The focal length of this combination is:
(A) +60 cm (B) +25 cm (C) +12 cm (D) –10 cm (E) +10 cm

(B)84. Two thin lenses (focal lengths f_1 and f_2) are in contact. Their equivalent focal length is:
(A) $f_1 + f_2$ (B) $f_1f_2/(f_1 + f_2)$ (C) $1/f_1 + 1/f_2$ (D) $f_1 - f_2$ (E) $f_1(f_1 - f_2)/f_2$

(B)85. A soap film, 4×10^{-5} cm thick, is illuminated by white light normal to its surface. The index of refraction of the film is 1.50. Which wavelengths will be intensified in the reflected beam?
(A) 400 nm and 600 nm (B) 480 nm and 800 nm (C) 360 nm and 533 nm
(D) 400 nm and 800 nm (E) 510 nm and 720 nm

(C)86. An air wedge is formed using two glass plates which are in contact along their left edge. When viewed by highly monochromatic light, there are exactly 4001 dark bands in the reflected light. The air is now evacuated (with the glass plates remaining rigidly fixed) and the number of dark bands decreases to 4000. The index of refraction of the air is:
(A) 0.00025 (B) 0.00050 (C) 1.00025 (D) 1.00050 (E) 1.00000 by definition

(A)87. Two point sources, vibrating in phase, produce an interference pattern in a ripple tank. If the frequency is increased by 20%, the number of nodal lines:
(A) is increased by 20% (B) is increased by 40% (C) remains the same
(D) is decreased by 20% (E) is decreased by 40%

(B)88. At the first minimum adjacent to the central maximum of a single-slit diffraction pattern the Huygens wavelet from the top of the slit is 180° out of phase with the wavelet from:
(A) a point one-fourth of the slit width from the top (B) the midpoint of the slit
(C) a point one-fourth of the slit width from the bottom of the slit (D) the bottom of the slit
(E) none of these

(C) 89. A certain automobile is 6 m long if at rest. If it is measured to be 4/5 as long, its speed is:
(A) $0.1c$ (B) $0.3c$ (C) $0.6c$ (D) $0.8c$ (E) $> 0.95c$

(D) 90. Frame S' moves in the positive x direction at $0.6c$ with respect to frame S. A particle moves in the positive x direction at $0.4c$ as measured by an observer in S'. The speed of the particle as measured by an observer in S is:
(A) $c/5$ (B) $5c/19$ (C) $8c/25$ (D) $25c/31$ (E) c

(A) 91. The intensity of a light beam with a wavelength of 500 nm is 2000 W/m^2. The concentration of photons in the beam is:
(A) 1.7×10^{13} photons/m^3 (B) 5.0×10^{15} photons/m^3 (C) 5.0×10^{21} photons/m^3 (D) 1.7×10^{22} photons/m^3 (E) not determined by the given data

(D) 92. Electromagnetic radiation with a wavelength of 5.7×10^{-12} m is incident on stationary electrons. The radiation that has been scattered through 50° has a wavelength of:
(A) 2.43×10^{-12} m (B) 4.83×10^{-12} m (C) 5.13×10^{-12} m (D) 6.27×10^{-12} m

(B) 93. Consider the following three particles:
1. a free electron with kinetic energy K_0
2. a free proton with kinetic energy K_0
3. a free proton with kinetic energy $2K_0$
Rank them according to the wavelengths of their waves, least to greatest.
(A) 1, 2, 3 (B) 3, 2, 1 (C) 2, 3, 1 (D) 1, 3, 2 (E) 1, then 2 and 3 tied

(C) 94. The uncertainty in position of an electron in a certain state is 5×10^{-10} m. The uncertainty in its momentum (in kg · m/s) must be
(A) less than 10^{-26} (B) less than 10^{-22} (C) greater than 10^{-25} (D) greater than 10^{-23}
(E) greater than 10^{-21}

(D) 95. The ground state energy of a hydrogen atom is –13.6 eV. When the electron is in the first excited state its excitation energy is:
(A) 0 (B) 3.4 eV (C) 6.8 eV (D) 10.2 eV (E) 13.6 eV

(B) 96. Starting with a sample of pure ^{66}Cu, 7/8 of it decays into Zn in 15 minutes. The corresponding half-life is:
(A) 15 minutes (B) 5 minutes (C) 7 minutes (D) 3.75 minutes (E) 10 minutes

(A)97. Visible light, with a frequency of 6.0×10^{14} Hz, is reflected from a spaceship moving directly away at a speed of 0.90*c*. The frequency of the reflected waves observed at the source is:
(A) 3.2×10^{13} Hz (B) 1.4×10^{14} Hz (C) 6.0×10^{14} Hz (D) 2.6×10^{15} Hz (E) 1.1×10^{16} Hz

(B)98. The work function for a certain sample is 2.3 eV. The stopping potential for electrons ejected from the sample by 7.0×10^{14}-Hz electromagnetic radiation is:
(A) 0 (B) 0.60 V (C) 2.3 V (D) 2.9 V (E) 5.2 V

(B)99. A cylindrical region contains a uniform electric field that is parallel to the axis and is changing with time. If r is distance from the cylinder axis the magnitude of the magnetic field outside the region is:
(A) 0 (B) proportional to 1/r (C) proportional to r^2 (D) proportional to $1/r^2$ (E) proportional to r

(C)100. The shimmering or wavy lines that can often be seen near the ground on a hot day are due to:
(A) Brownian movement (B) reflection (C) refraction (D) diffraction (E) dispersion