PHYSICS

BOOKS - KVPY PREVIOUS YEAR

QUESTION PAPER 2013

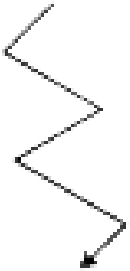
Part I Physics

1. A man inside a freely falling box throws a heavy ball towards a side wall. The ball keeps on bouncing between the opposite walls of

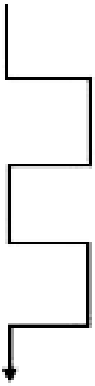
the box. We neglect air resistance and friciton. Which of the following figures depicts the motion of the centre of mass of the entire system (man, the ball and the box)?

A.

B.



C.



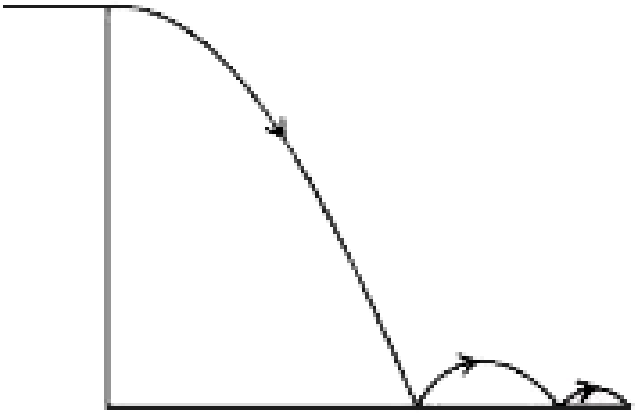
D.

Answer: A

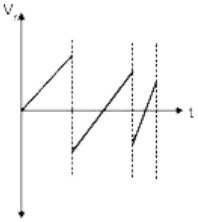
Watch Video Solution

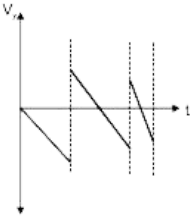
2. A ball is thrown horizontally from a height with a certain initial velocity at time t = 0. The

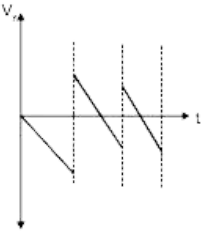
ball bounces repeatedly from the ground with the coefficient of restitution less than 1 as shown.

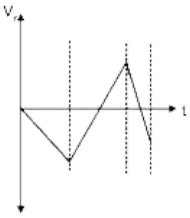


Neglect air resistance and taking the upward direction as positive, which figure qualitatively depicts the vertical component of the balls velocity $\left(V_y\right)$ as a function of time (t)?

A. 

B. 

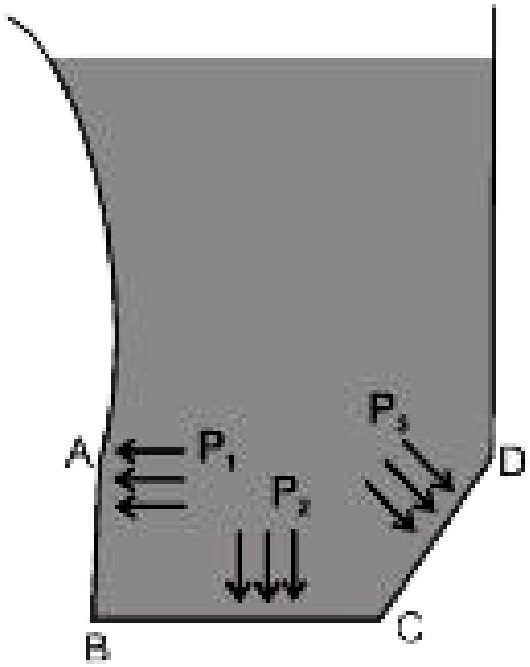
C. 

D. 

Answer: B

Watch Video Solution

3. A tall tank filled with water has an irregular shape as shown. The wall CD makes an angle of 45 with the horizontal, the wall AB is normal to the base BC. The lengths AB and CD are much smaller than the height h of water (figure not to scale).



Let P_1, P_2 and P_3 be the pressures exerted by the water on the wall AB, base BC and the wall CD respectively. Density of water is ρ and g is acceleration due to gravity. Then, approximately

A. $P_1 = P_2 = P_3$

B. $P_1 = 0, P_3 = \frac{1}{\sqrt{2}} P_2$

C. $P_1 = P_3 = \frac{1}{\sqrt{2}} P_2$

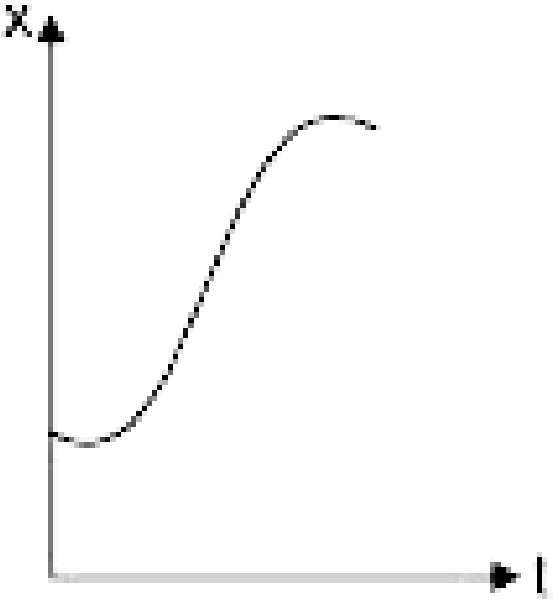
D. $P_1 = P_3 = 0, P_2 = h\rho g$

Answer: A

Watch Video Solution

4. The accompanying graph of position x versus time t represents the motion of a particle. If p and q are both positive constants,

the expression that best describes the acceleration α of the particle is



A. a = p qt

B. a = p + qt

C. a = p + qt

D. a = p qt

Answer: D

Watch Video Solution

5. Two stones of mass m_1 and m_2 (such that $m_1 > m_2$) are dropped Δt time apart from the same height towards the ground. At a later time t the difference in their speed is ΔV and their mutual separation is ΔS. While both stones are in flight

A. ΔV decreases with time and ΔS increases with time

B. Both ΔV and ΔS increase with time

C. ΔV remains constant with time and ΔS decreases with time

D. ΔV remains constant with time and ΔS increases with time

Answer: D

Watch Video Solution

6. The refractive index of a prism measured using three lines of a mercury vapour lamp. If μ_1, μ_2 and μ_3 are the measured refractive indices for these green, blue and yellow lines respectively, then

A. $\mu_2 > \mu_3 > \mu_1$

B. $\mu_2 > \mu_1 > \mu_3$

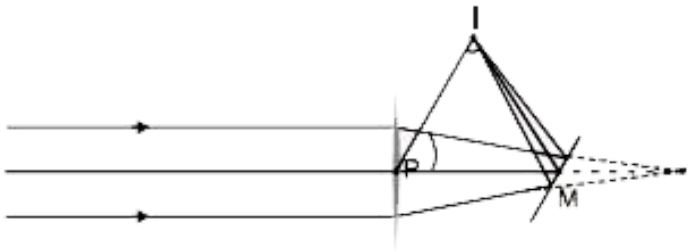
C. $\mu_3 > \mu_2 > \mu_1$

D. $\mu_1 > \mu_2 > \mu_3$

Answer: B

Watch Video Solution

7. A horizontal parallel beam of light passes through a vertical convex lens of focal length 20 cm and is then reflected by a tilted plane mirror so that it converges to a point I. The distance PI is 10 cm.



M is a point at which the axis of the lens intersects the mirror. The distance PM is 10 cm.

The angle which the mirror makes with the horizontal is

A. 15°

B. 30°

C. 45°

D. 60°

Answer: D

Watch Video Solution

8. In a car a rear view mirror having a radius of curvature 1.50 m forms a virtual image of a bus located 10.0 m from the mirror. The factor by which the mirror magnifies the size of the bus is close to

A. 0.06

B. 0.07

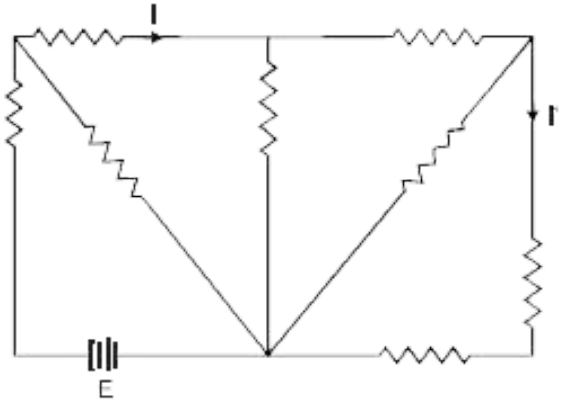
C. 0.08

D. 0.09

Answer: B

Watch Video Solution

9. Consider the circuit shown in the figure below :



All the resistors are identical. The ratio I/I' is

A. 8

B. 6

C. 5

D. 4

Answer: A

Watch Video Solution

10. The figure shows a bar magnet and a metallic coil. Consider four situations.

(I) Moving the magnet away from the coil. (II) Moving the coil towards the magnet. (III) Rotating the coil about the vertical diameter.

(IV) Rotating the coil about its axis.

An emf in the coil will be generated for the following situations.

A. (I) and (II) only

B. (I), (II) and (IV) only

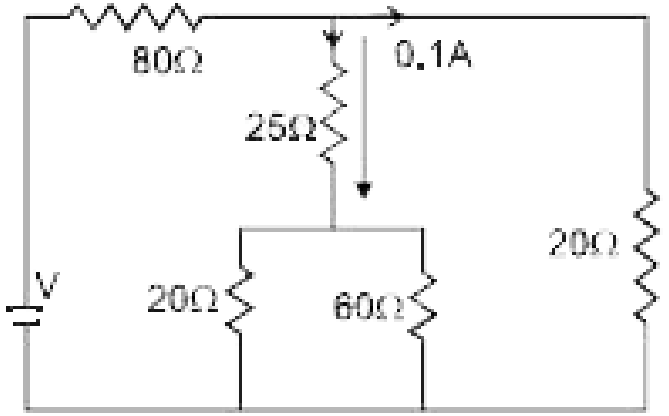
C. (I), (II), and (III) only

D. (I), (II), (III), and (IV)

Answer: C

Watch Video Solution

11. A current of 0.1 A flows through a 25 Ω resistor represented by the circuit diagram. The current in the 80 Ω resistor is



A. 0.1 A

B. 0.2 A

C. 0.3 A

D. 0.4 A

Answer: C

Watch Video Solution

12. Solar energy is incident normally on the earths surface at the rate of about 1.4 kW m^{-2}. The distance between the earth and the sun is 1.510^{11} m. Energy (E) and mass (m) are related by Einstein equation $E = mc^2$ where c

$\left(3 \times 10^8 ms^1\right)$ is the speed of light in free space. The decrease in the mass of the sun is

A. $10^9 kgs^{-1}$

B. $10^{30} kgs^{-1}$

C. $10^{28} kgs^{-1}$

D. $10^{11} kgs^{-1}$

Answer: A

 Watch Video Solution

13. If the current through a resistor in a circuit increases by 3%, the power dissipated by the resistor

A. increases approximately by 3%

B. increases approximately by 6%

C. increases approximately by 9%

D. decreases approximately by 3%

Answer: B

 Watch Video Solution

14. An ideal gas filled in a cylinder occupies volume V. The gas is compressed isothermally to the volume V/3. Now the cylinder valve is opened and the gas is allowed to leak keeping temperature same. What percentage of the number of molecules escape to bring the pressure in the cylinder back to its original value.

A. $66\ \%$

B. $33\ \%$

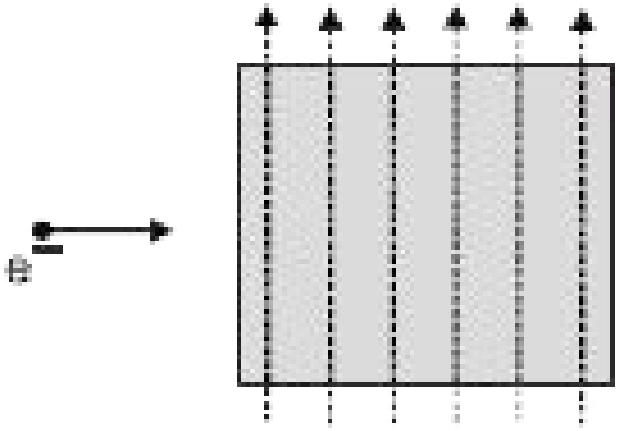
C. $0.33\ \%$

D. $0.66\ \%$

Answer: A

Watch Video Solution

15. An electron enters a chamber in which a uniform magnetic field is present as shown



An electric field of appropriate magnitude is also applied so that the electron travels undeviated without any change in its speed thorugh the chamber. We are ignoring gravity. Then, the direction of the electric field is

A. opposite to the direction of the magnetic field

B. opposite to the direction of the electrons motion

C. normal to the plane of the paper and coming out of the plane of the paper

D. normal to the plane of the paper and into the plane of the paper

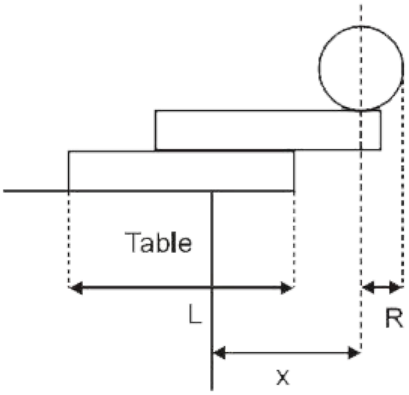
Answer: D

 Watch Video Solution

Part Ii Physics

1. Two identical uniform rectangular blocks (with longest side L) and a solid sphere of radius R are to be balanced at the edge of a

heavy table such that the centre of the sphere remains at the maximum possible horizontal distance from the vertical edge of the table without toppling as indicated in the figure.



If the mass of each block is M and of the sphere is M/2, then the maximum distance x that can be achieved is

A. 8L/15

B. 5L/6

C. (3L/4 + R)

D. (7L/15 + R)

Answer: A

Watch Video Solution

2. Two skaters P and Q are skating towards each other. Skater P throws a ball towards W every 5 s such that it always leaves her hand with speed 2 ms^{-1} with respect to the

ground. Consider two cases:

(I) P runs with speed 1 ms^{-1} towards Q while Q remains stationary

(II) Q runs with speed 1 ms^{-1} towards P while P remains stationary.

Note that irrespective of speed of P, ball always leaves P's hand with speed $2ms^{-1}$ with respect to the ground. Ignore gravity. Balls will be received by Q .

A. one every 2.5 s in case (I) and one every 3.3 s in case (II)

B. one every 2 s in case (I) and one every 4 s in case (II)

C. one every 3.3 s in case (I) and one every 2.5 s in case (II)

D. one every 2.5 s in case (I) and one every 2.5 s in case (II)

Answer: A

Watch Video Solution

3. A 10.0 W electrical heater is used to heat a container filled with 0.5 kg of water. It is found that the temperature of the water and the container rise by 3 K in 15 minutes. The container is then emptied, dried, and filled with 2 kg of an oil. It is now observed that the same heater raises the temperature of the container-oil system by 2 K in 20 minutes. Assuming no other heat losses in any of the processes, the specific heat capacity of the oil is

A. $2.5 \times 10^3 JK^{-1}kg^{-1}$

B. $5.1 \times 10^3 JK^{-1}Kg^{-1}$

C. $3.0 \times 10^3 JK^{-1}Kg^{-1}$

D. $1.5 \times 10^3 JK^{-1}kg^{-1}$

Answer: A

Watch Video Solution

4. A ray of light incident on a transparent sphere at an angle $\pi/4$ and refracted at an angle r, emerges from the sphere after

suffering one internal reflection. The total angle of deviation of the ray is

A. $\frac{3\pi}{2} - 4r$

B. $\frac{\pi}{2} - 4r$

C. $\frac{\pi}{4} - r$

D. $\frac{5\pi}{2} - 4r$

Answer: A

Watch Video Solution

5. An electron with an initial speed of $4.0 \times 10^{6} ms^{-1}$ is brought to rest by an electric field. The mass and charge of an electron are 9×10^{-31} kg and $1.6 \times 10^{-19} C$, respectively. Identify the correct statement

A. The electron moves from a region of lower potential to higher potential through a potential difference of 11.4 μV.

B. The electron moves from a region of higher potential to lower potential through a potential difference of 11.4 μV.

C. The electron moves from a region of lower potential to higher potential through a potential difference of 45 V.

D. The electron moves from a region of higher potential to lower potential through a potential difference of 45 V

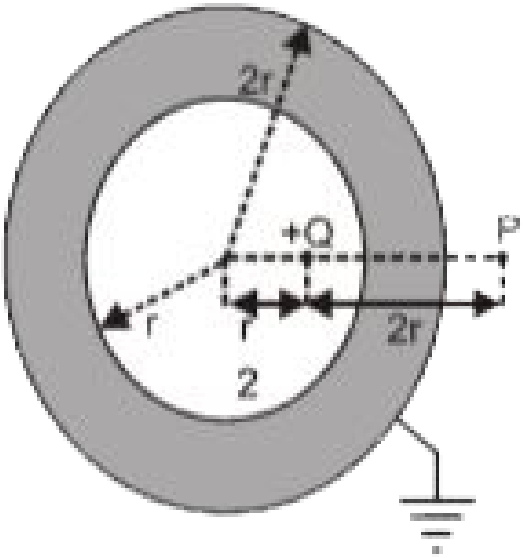
Answer: D

Watch Video Solution

Part I Physics

1. Consider an initially neutral hollow conducting spherical shell with inner radius r and outer radius 2r. A point charge +Q is now placed inside the shell at a distance r/2 from the centre. The shell is then grounded by connecting the outer surface to the earth. P is

an external point at a distance 2r from the point charge +Q on the line passing through the centre and the point charge +Q as shown in the figure.



The magnitude of the force on a test charge +q placed at P will be

A. $\frac{1}{4\pi\varepsilon_0}\frac{qQ}{4r^2}$

B. $\frac{1}{4\pi\varepsilon_0}\frac{9qQ}{100r^2}$

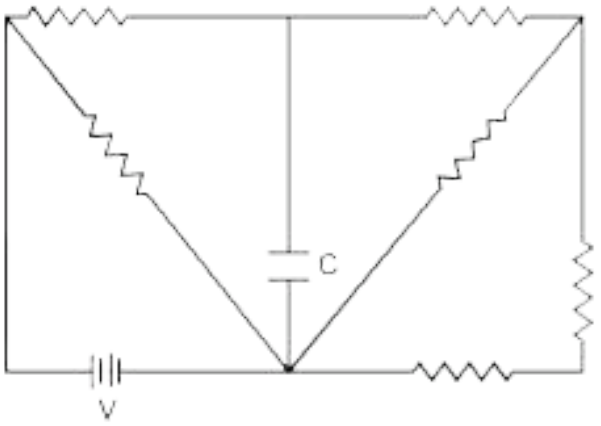
C. $\frac{1}{4\pi\varepsilon_0}\frac{4qQ}{25r^2}$

D. 0

Answer: D

Watch Video Solution

2. Consider the circuit shown in the figure below :



All the resistors are identical. The charge stored in the capacitor, once it is fully charged, is

A. 0

B. $\frac{5}{13}CV$

C. $\frac{2}{3}CV$

D. $\frac{5}{8}CV$

Answer: D

Watch Video Solution

3. A nuclear decay is possible if the mass of the parent nucleus exceeds the total mass of the decay particles. If M(A, Z) denotes the mass of a single neutral atom of an element with mass number A and atomic number Z, then the minimal condition that the β decay

$$X_Z^A \rightarrow Y_{Z+1}^A + \beta^- + \bar{v}_e$$

will occur is (m_e denotes the mass of the β

particle and the neutrino mass m_v can be neglected)

A. $M(A, Z) > M(A, Z+1) + m_e$

B. $M(A, Z) > M(A, Z+1)$

C. $M(A, Z) > M(A, Z+1) + Zm_e$

D. $M(A, Z) > M(A, Z+1) - m_e$

Answer: A

View Text Solution

4. The equation of state of n moles of a non-ideal gas can be approximated by the equation $\left(P + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$ where a and b are constants characteristic of the gas. Which of the following can represent the equation of a quasistatic adiabat for this gas (Assume that C_V, the molar heat capacity at constant volume, is independent of temperature)?

A. $T(V - nb)^{R/C_V}$ = constant

B. $T(V - nb)^{C_V/R}$ = contant

C. $\left(T+\frac{ab}{V^2R}\right)(V-nb)^{R/C_V}$ = constant

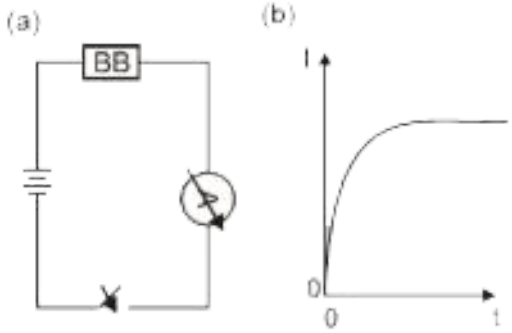
D. $\left(T+\frac{n^2ab}{V^2R}\right)(V-nb)^{C_V/R}$ = constant

Answer: A

Watch Video Solution

5. A blackbox (BB) which may contain a combination of electrical circuit elements (resistor, capacitor or inductor) is connected with other external circuit elements as shown below in the figure (a). After the switch (S) is

closed at time t = 0, the current (I) as a function of time (t) is shown in the figure (b).



From this we can infer that the blackbox contains

A. A resistor and a capacitor in series

B. A resistor and a capacitor in parallel

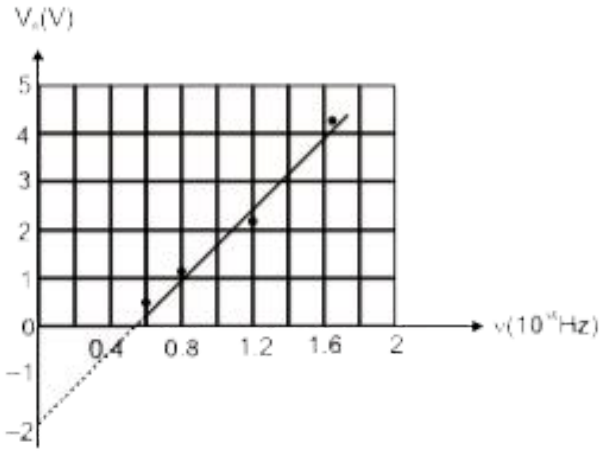
C. A resistor and an inductor in series

D. A resistor and an inductor in parallel

Answer: C

Watch Video Solution

6. In a photocell circuit the stopping potential, V_0, is a measure of the maximum kinetic energy of the photoelectrons. The following graph shows experimentally measured values of stopping potential versus frequency v of incident light.



The values of Planks constant and the work function as determined from the graph are (taking the magnitude of electronic charge to be $e = 1.6 \times 10^{-19}C$)

A. $6.4 \times 10^{-34}Js, 2.0eV$

B. $6.0 \times 10^{-34}Js, 2.0eV$

C. $6.4 \times 10^{-34}Js, 3.2eV$

D. $6.0 \times 10^{-34} Js, 3.2eV$

Answer: B

 Watch Video Solution

7. An engine moving away from a vertical cliff blows a born at a frequency f. Its speed is 0.5% of the speed of sound in air. The frequency of the reflected sound received at the engine is

A. 0.990 f

B. 0.995 f

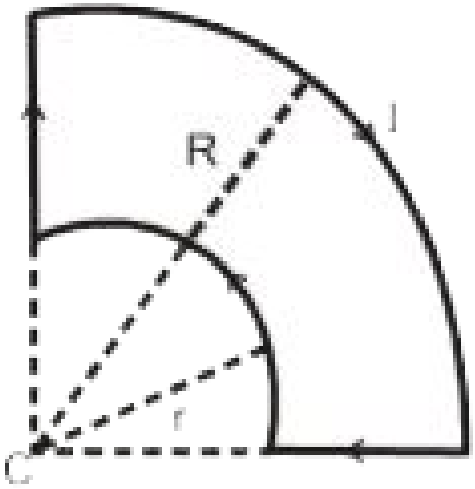
C. 1.005

D. 1.010 f

Answer: A

Watch Video Solution

8. An arangement with a pair of quarter circular coils of radii r and R with a common centre C and carrying a current I is shown.



The permeability of free space is μ_0. The magnetic field at C is

A. $\mu_0 I(1/r - 1/R)/8$ into the page

B. $\mu_0 I(1/r - 1/R)/8$ out of the page

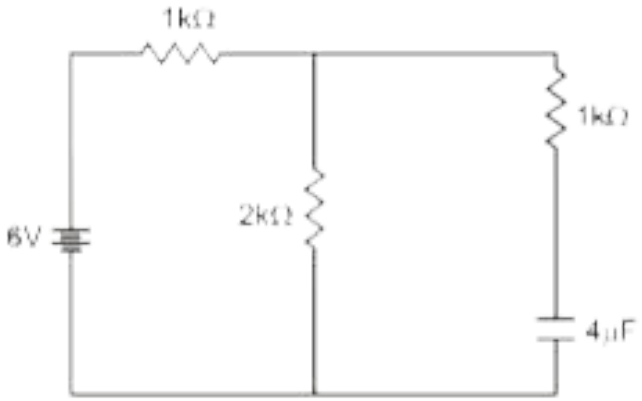
C. $\mu_0 I(1/r + 1/R)/8$ out of the page

D. $\mu_0 I(1/r + 1/R)/8$ into the page

Answer: B

Watch Video Solution

9. The circuit shown has been connected for a long time. The voltage across the capacitor is



A. 1.2V

B. 2.0 V

C. 2.4V

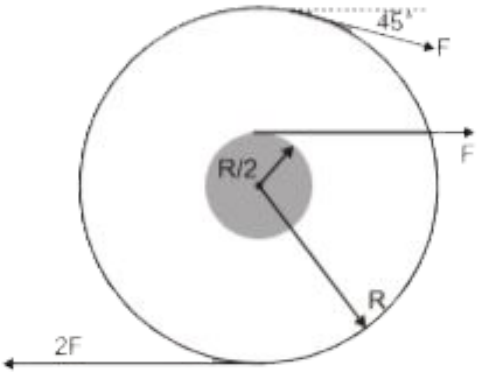
D. 4.0 V

Answer: D

Watch Video Solution

10. A wheel of radius R with an axle of radius R/2 is shown in the figure and is free to rotate about a frictionless axis through its centre and perpendicular to the page. Three forces (F,

F, 2F) are exerted tangentially to the repective rims as shown in the figure.



The magnitude of the net torque acting on the system is nearly

A. 3.5 FR

B. 3.2 FR

C. 2.5 FR

D. 1.5 FR

Answer: A

Watch Video Solution

11. Two species of radioactive atoms are mixed in equal number. The disintegration of the first species is λ and of the second is $\lambda/3$. After a long time the mixture will behave as a species with mean life of approximately

A. $0.70/\lambda$

B. $2.10/\lambda$

C. $1.00/\lambda$

D. $0.52/\lambda$

Answer: B

Watch Video Solution

12. The bulk modulus of a gas is defined as B = -VdP/dV. For an adiabatic process the variation of B is proportional to P^n. For an idea gas, n is

A. 0

B. 1

C. $\frac{5}{2}$

D. 2

Answer: B

Watch Video Solution

13. Photons of energy 7 eV are incident on two metals A and B with work functions 6 eV and 3 eV respectively. The minimum de Broglie

wavelengths of the emitted photoelectrons with maximum energies are λ_A and λ_B, respectively where λ_A / λ_B is nearly

A. 0.5

B. 14

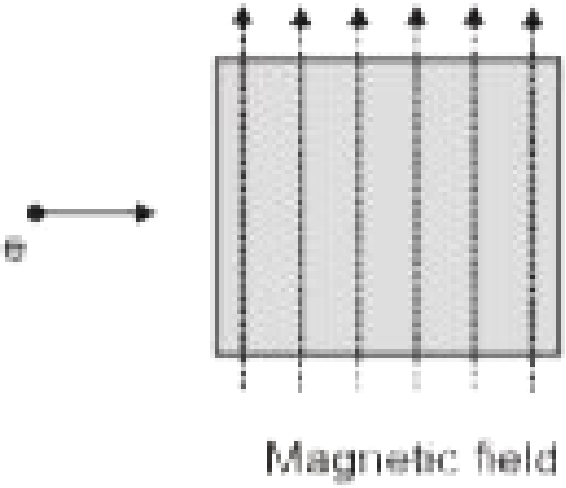
C. 4.0

D. 2.0

Answer: D

Watch Video Solution

14. An electron enters a chamber in which a uniform magnetic field is present as shown. Ignore gravity



During its motion inside the chamber

A. the force on the electron remains constant

B. the kinetic energy of the electron remains constant

C. the momentum of the electron remains constant

D. the speed of the electron increases at a uniform rate

Answer: B

Watch Video Solution

15. A ray of light incident on a glass sphere (refractive index $\sqrt{3}$) suffers total internal reflection before emerging out exactly parallel to the incident ray. The angle of incidence was

A. 75°

B. 30°

C. 45°

D. 60°

Answer: D

Watch Video Solution

Watch Video Solution

16. Young-Laplace law states that the excess pressure inside a soap bubble of radius R is given by $\Delta P = 4\sigma / R$ where σ is the coefficient of surface tension of the soap. The $E\ddot{o}tv\ddot{o}s$ number E_0 is a dimensionless number that is used to describe the shape of bubbles rising through a surrounding fluid. It is a combination of g, the acceleration due to gravity, ρ, the density of the surrounding fluid, σ and a characterstic length scale L which

could be the radius of the bubble. A possible expression for E_0 is

A. $\frac{\rho g}{\sigma L^3}$

B. $\frac{\rho L^2}{\sigma g}$

C. $\frac{\rho g L^2}{\sigma}$

D. $\frac{g L^2}{\sigma \rho}$

Answer: C

Watch Video Solution

17. A plank is resting on a horizontal ground in the northern hemisphere of the Earth at a 45° latitude. Let the angular speed of the Earth be ω and its radius r_e. The magnitude of the frictional force on the plank will be

A. $mr_e\omega^2$

B. $\frac{mr_e\omega^2}{\sqrt{2}}$

C. $\frac{mr_e\omega^2}{2}$

D. Zero

Answer: C

Watch Video Solution

18. The average distance between molecules of an ideal gas at STP is approximately of the order of

A. 1nm

B. 100 nm

C. 100 cm

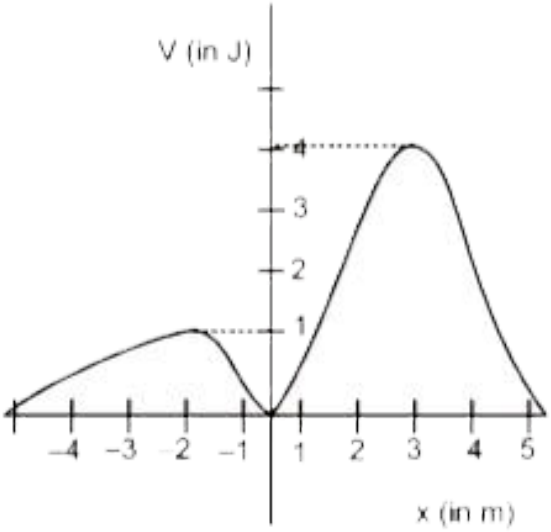
D. $1\mu m$

Answer: A

Watch Video Solution

19. A point particle of mass 0.5 kg is moving along the x-axis under a force described by the potential energy V shown below. It is projected towards the right from the origin with a speed v. What is the minimum value of v for which the particle will escape infinitely fasr away

from the origin ?



A. $2\sqrt{2}ms^{-1}$

B. $2ms^{-1}$

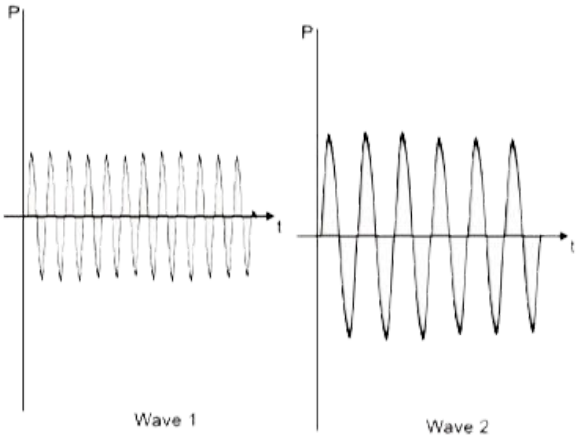
C. $4ms^{-1}$

D. The particle will never escape

Answer: B

Watch Video Solution

20. The figure below shows pressure variation in two different sound waves in air with time at a given position. Both the figures are drawn to the same scale.



Which of the following statement is true ?

A. Wave 1 has lower frequency and smaller amplitude compared to wave

B. Wave 1 has higher frequency and greater amplitude compared to wave 2

C. Wave 1 has shroter wavelength and greater amplitude compared to wave 2

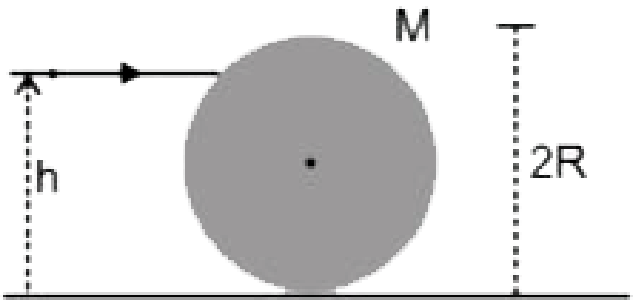
D. Wave 1 has shorter wavelength and smaller amplitude compared to wave 2

Answer: D

Watch Video Solution

Part Ii Physics

1. A bullet of mass m is fired horizontally into a large sphere of mass M and radius R resting on a smooth horizontal table.



The bullet hits the sphere at a height h from the table and sticks to its surface. If the sphere

starts rolling without slippng immediately on impact, then

A. $\frac{h}{R} = \frac{4m + 3M}{2(m + M)}$

B. $\frac{h}{R} = \frac{m + 3M}{m + 2M}$

C. $\frac{h}{R} = \frac{10m + 7M}{5(m + M)}$

D. $\frac{h}{R} = \frac{4m + 3M}{m + M}$

Answer: C

Watch Video Solution

2. A small boy is throwing a ball towards a wall 6 in front of him. He releases the ball at a height of 1.4 m from the ground. The ball bounces from the wall at a height of 3 m, rebounds from the ground and reaches the boys hand exactly at the point of release. Assuming the two bounces (one from the wall and the other from the ground) to be perfectly elastic, how far ahead of the boy did the ball bounce from the ground?

A. $1.5m$

B. $2.5m$

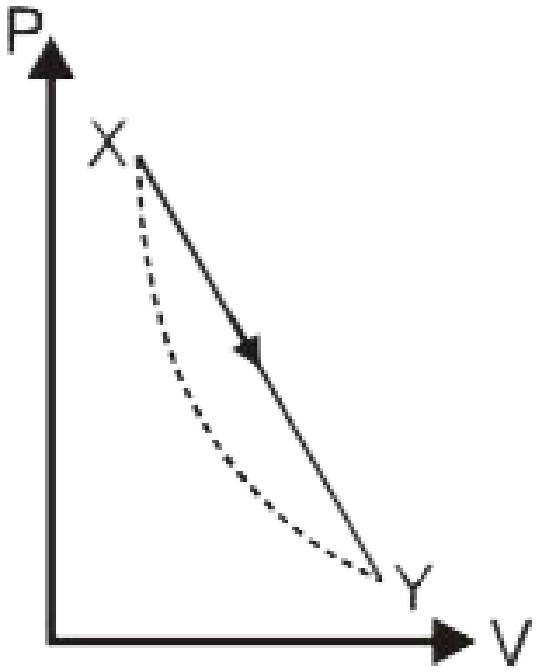
C. $3.5m$

D. $4.5m$

Answer: A

View Text Solution

3. In the P-V diagram below the dashed curved line is an adiabat.



For a process that is described by a straight line joining two points X and Y on the adiabat (solid line in the diagram) heat is : (hint : Consider the variations in temperature from X to Y along the straitght line)

A. absorbed throughtout from X to Y

B. released throughout from X to Y

C. absorbed from X up to an intermediate point Z (not shown in the figure) and then released from Z to Y

D. released from X up to an intermediate point Z (not shown in the figure) and then absorbed from Z to Y

Answer: C

View Text Solution

4. A singly ionized helium atom in an excited state (n = 4) emits a photon of energy 2.6 eV. Given that the ground state energy of hydrogen atom is 13.6 eV, the energy (E_t) and quantum number (n) of the resulting state are respectively,

A. $E_t = -13.6eV, n = 1$

B. $E_t = -6.0eV, n = 3$

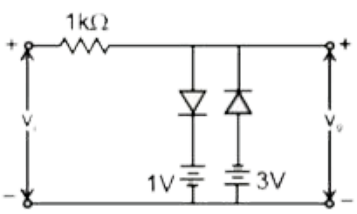
C. $E_t = -6.0eV, n = 2$

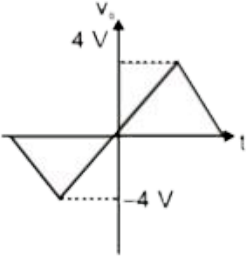
D. $E_t = -13.6eV, n = 2$

Answer: B

Watch Video Solution

5. The figure below shows a circuit and its input voltage v_i as function of time t.

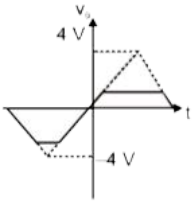




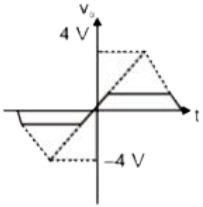
Assuming the diodes to be ideal, which of the

following graphs depicts the output voltage v_0 as function of time t ?

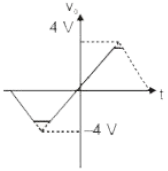
A.



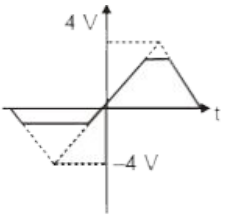
B.



C.



D.



Answer: A

View Text Solution

6. A ball is rolling without slipping in a spherical shallow bowl (radius R) as shown in the figure and is executing simple harmonic motion. If the radius of the ball is doubled, the period of oscillation

A. increases slightly

B. is reduced by a factor of 1/2

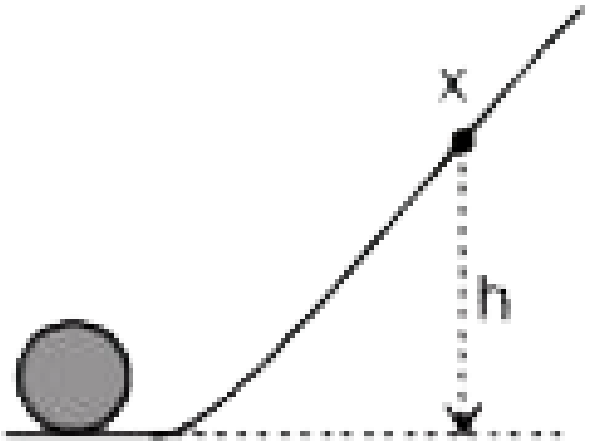
C. is increased by a factor of 2

D. decreases slightly

Answer: D

Watch Video Solution

7. A solid sphere rolls without slipping, first horizontal and then up to a point X at height h on an inclined plane before rolling down, as shown.



The initial horizontal speed of the sphere is

A. $\sqrt{10gh/7}$

B. $\sqrt{7gh/5}$

C. $\sqrt{5gh/7}$

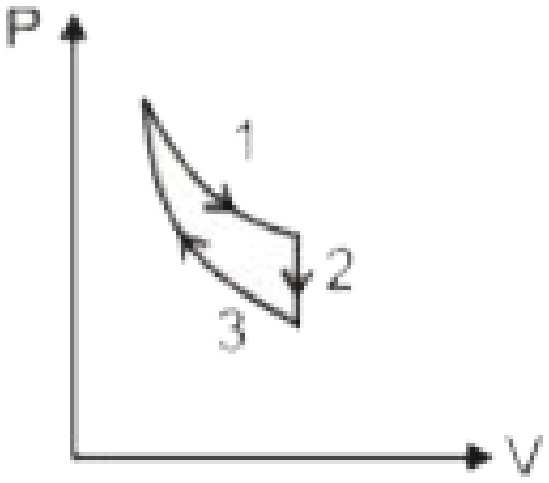
D. $\sqrt{2gh}$

Answer: A

Watch Video Solution

8. The three processes in a thermodynamic cycle shown in the figure are : Process 1 $\rightarrow$ 2 is isothermal, Process 2 $\rightarrow$ 3 is isochoric (volume remains constant), Process 3 $\rightarrow$ 1 is adiabatic. The total work done by the ideal gas in this cycle is 10 J. The internal energy decreases by 20 J in the isochoric process. The work done by the gas in the adiabatic process is -20 J. The heat added to the system in the

isothermal process is



A. 0J

B. 10J

C. 20J

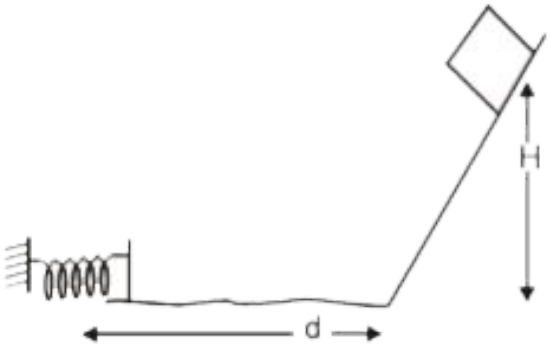
D. 30J

Answer: D

Watch Video Solution

9. A block of mass m slides from rest at a height H on a frictionless inclined plane as shown in the figure. It travels a distance d across a rough horizontal surface with coefficient of kinetic friction μ , and compresses a spring of spring k by a distance x before coming to rest momentarily. Then the spring extends and the block travels back

attaining a final height of h. Then



A. $h = H - 2\mu(d + x)$

B. $h = H + 2\mu(d + x)$

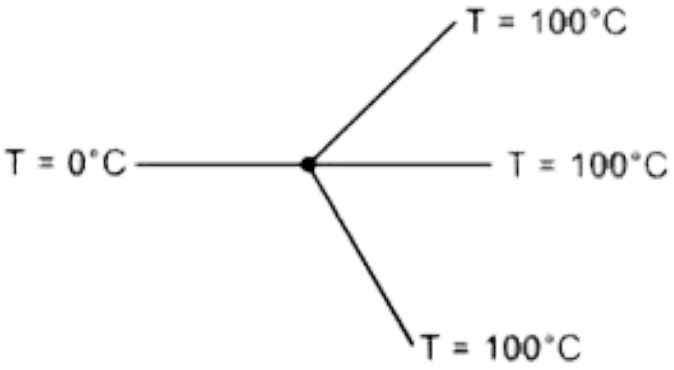
C. $h = H - 2\mu d + kx^2 / mg$

D. $h = H - 2\mu(d + x) + kx^2 / 2mg$

Answer: A

Watch Video Solution

10. A metallic prong consists of 4 rods made of the same material, cross-section and same lengths as shown. The three forked ends are kept at $100^\circ C$ and the handle end is at $0^\circ C$. The temperature of the junction is



A. $25^\circ C$

B. $50^\circ C$

C. $60^\circ C$

D. $75^\circ C$

Answer: D

Watch Video Solution