CBSE – AIPMT – 2010

General Instructions

1. *There are objective type questions with four options having single correct answer.*
2. *For each incorrect response, one fourth (1/4) of the total marks allotted to the question would be deducted.*
3. *No deduction from the total score will, however, be made if no response is indicated for an item in the answer sheet. The candidates are advised not to attempt such item in the answer sheet if they are not sure of the correct response.*
4. *More than one answer indicated against a question will be deemed as incorrect response and will be negatively marked.*

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1. The dimension of $\frac{1}{2}\varepsilon_0 E^2$, where ε_0 is permittivity of free space and E is electric field is

(a) MLT^{-1} (b) ML^2T^{-2}
(c) $ML^{-1}T^{-2}$ (d) ML^2T^{-1}

Solution

(c) The given expression gives the energy density of the electric field.

$$\frac{E}{V} = \frac{1}{2}\varepsilon_0 E^2$$

$$\left[\frac{1}{2}\varepsilon_0 E^2\right] = M^1L^{-1}T^{-2}$$

2. A particle moves a distance x in time t according to equation $x = (t + 5)^{-1}$. The acceleration of particle is proportional to

(a) $(\text{Velocity})^{2/3}$ (b) $(\text{Velocity})^{3/2}$
(c) $(\text{Distance})^2$ (d) $(\text{Distance})^{-2}$

Solution

(b) The displacement $x = (t+5)^{-1}$
Therefore the velocity

$$v = \frac{dx}{dt} = -(t+5)^{-2}$$

and

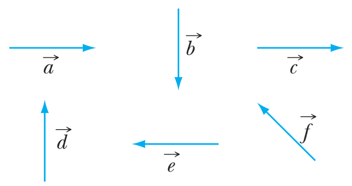
$$a = \frac{dv}{dt} = 2(t+5)^{-3}$$

$$a = 2v^{3/2}$$

Therefore

$$a \propto v^{3/2}$$

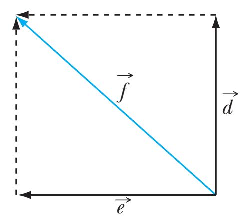
3. Six vectors, $\vec{a}$ through $\vec{f}$ have the magnitudes and directions indicated in the figure. Which of the following statements is true?



(a) $\vec{b}+\vec{e}=\vec{f}$ (b) $\vec{b}+\vec{c}=\vec{f}$
(c) $\vec{d}+\vec{c}=\vec{f}$ (d) $\vec{d}+\vec{e}=\vec{f}$

Solution

(d) According to the parallogram law of vector addition



Therefore $\vec{e}+\vec{d}=\vec{f}$.

4. A particle has initial velocity $(3\hat{i}+4\hat{j})$ and has acceleration $(0.4\hat{i}+0.3\hat{j})$. Its speed after 10 s is

(a) 10 units (b) 7 units
(c) $7\sqrt{2}$ units (d) 8.5 units

Solution

(c) For linear motion the velocity of

$$\vec{v} = \vec{u} + \vec{a}t$$

$$\vec{u} = 3\hat{i} + 4\hat{j} \text{ and } \vec{a} = 0.4\hat{i} + 0.3\hat{j}$$

Therefore the velocity of the particle after 10 seconds is

$$\vec{v} => \vec{\mu} + \vec{a}t$$

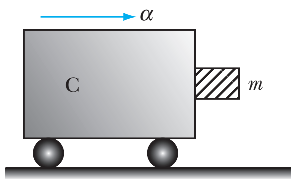
$$= 7(\hat{i}+\hat{j})$$

Therefore the speed $= \sqrt{7^2+7^2}$

$$= 7\sqrt{2}$$

$$|v| = 7\sqrt{2} \text{ units}$$

5. A block of mass m is in contact with the cart C as shown in the figure.



The coefficient of static friction between the block and the cart is μ. The acceleration α of the cart that will prevent the block from falling satisfies

(a) $\alpha < \frac{g}{\mu}$ (b) $\alpha > \frac{mg}{\mu}$
(c) $\alpha > \frac{g}{\mu m}$ (d) $\alpha \geq \frac{g}{\mu}$

Solution

(d) Normal reaction

$$N = ma$$

Therefore the frictional force which can support the block is

$$\mu N = \mu ma = mg$$

Or the acceleration

$$a \geq \frac{g}{\mu}$$

6. A man of 50 kg mass is standing in a gravity free space at a height of 10 m above the floor. He throws a stone of 0.5 kg mass downwards with a speed 2 m/s. When the stone reaches the floor, the distance of the man above the floor will be

(a) 20 m (b) 9.9 m
(c) 10.1 m (d) 10 m

Solution

(c) Change in momentum of the stone = change in momentum of the man

$$\Delta P_{\text{man}} = MV = mv$$

Where $M = 50$ kg, $m = 0.5$ kg, $v = 2$ m/s.

$$\text{Therefore } V = \frac{mv}{M} = \frac{1}{50}\text{m/s}$$

The time taken by the stone to reach ground

$$t = \frac{10\text{ m}}{v} = 5\text{ s}$$

The distance travelled by man in 5 s is 1/10 meter. Therefore the man will be at height

$$H = 10\text{ m} + \frac{1}{10}\text{ m} = 10.1\text{ m}$$

7. An engine pumps water through a hose pipe. Water passes through the pipe and leaves it with a velocity of 2 m/s. The mass per unit length of water in the pipe is 100 kg/m. What is the power of the engine?

(a) 800 W (b) 400 W
(c) 200 W (d) 100 W

Solution

(b) Mass of water flowing out in one second = mass per unit length × velocity.

$$m = 100 \times 2 = 200\text{ kg.}$$

Power = K. E of water flowing out in one second

$$P = \frac{1}{2}mv^2 = \frac{1}{2}200 \times 2^2 = 400\text{ W}$$

8. A ball moving with velocity 2 m/s collides head on with another stationary ball of double the mass. If the coefficient of restitution is 0.5 then their velocities (in m/s) after collision will be

(a) 0, 2 (b) 0, 1
(c) 1, 1 (d) 1, 0.5

Solution

(b) From law of conservation of momentum.

$$m \times 2\,ms^{-1} + 0 = mv_1 + 2mv_2$$

$$v_1 + 2v_2 = 2\,m/s$$

But we have

$$0.5 \times 2 = v_1 - v_2$$

adding

$$v_2 = 1,\ v_1 = 0$$

9. A gramophone record is revolving with an angular velocity ω. A coin is placed at a distance r from the centre of the record. The static coefficient of friction is μ. The coin will revolve with the record if

(a) $r \geq \frac{\mu g}{\omega^2}$ (b) $r = \mu g \omega^2$
(c) $r < \frac{\omega^2}{\mu g}$ (d) $r \leq \frac{\mu g}{\omega^2}$

Solution

(d) The coin skid from the record when the centrifugal force need to keep the coin exceeds the frictional force.

$$\mu mg \geq mr\omega^2$$

$$r \leq \frac{\mu g}{\omega^2}$$

10. A circular disk of moment of inertia I_t is rotating in a horizontal plane, about its symmetry axis, with a constant angular speed ω_i. Another disk of moment of inertia I_b is dropped coaxially onto the rotating disk. Initially the second disk has zero angular speed. Eventually both the disks rotate with a constant angular speed ω_f. The energy lost by the initially rotating disc to friction is

(a) $\frac{1}{2}\frac{I_b I_t}{(I_t + I_b)}\omega_i^2$ (b) $\frac{1}{2}\frac{I_b^2}{(I_t + I_b)}\omega_i^2$
(c) $\frac{1}{2}\frac{I_t^2}{(I_t + I_b)}\omega_i^2$ (d) $\frac{I_b - I_t}{(I_t + I_b)}\omega_i^2$

Solution

(a) The initial rotational kinetic energy

$$K.E_i = \frac{1}{2} I_t \omega_i^2$$

The K. E. after droping the second disc is

$$K.E_f = \frac{1}{2} \times \frac{I_t}{I_t + I_b} \times \omega_i^2$$

Therefore

$$\Delta E = \frac{1}{2} I_t \omega_i^2 - \frac{1}{2} \times \frac{I_t}{I_t + I_b} \times \omega_f^2$$

$$= \frac{I_b I_t \omega_i^2}{2(I_b + I_t)}$$

11. Two particles which are initially at rest, move towards each other under the action of their internal attraction. If their speeds are v and $2v$ at any instant, then the speed of centre of mass of the system will be

(a) v (b) $2v$ (c) Zero (d) $1.5v$

Solution

(c) The position of the centre of mass does not change due to the internal forces. Therefore the velocity of the center of mass is zero.

12. The radii of circular orbits of two satellites A and B of the earth, are $4R$ and R, respectively. If the speed of satellite A is $3V$, then the speed of satellite B will be

(a) $\frac{3V}{2}$ (b) $\frac{3V}{4}$ (c) $6V$ (d) $12V$

Solution

(c) The velocity of the satellite in the orbit inversely proportional to the square of the radius of orbit.

$$V \propto \frac{1}{\sqrt{r}}$$

$$\frac{V_A}{V_B} = \sqrt{\frac{r_B}{r_A}}$$

It is given that

$$V_A = 3V, r_A = 4R \quad \text{and} \quad r_B = R$$

Then

$$V_B = 6\text{ V}$$

13. A particle of mass M is situated at the centre of a spherical shell of same mass and radius a. The gravitational potential at a point situated at $\frac{a}{2}$ distance from the centre, will be

(a) $-\frac{4GM}{a}$ (b) $-\frac{3GM}{a}$

(c) $-\frac{2GM}{a}$ (d) $-\frac{GM}{a}$

Solution

(b) The gravitational potential at distance r inside body is

$$V = V_{surface} - \frac{GM}{r}$$

Therefore the gravitational potential at a distance $a/2$ is

$$V_{a/2} = -\frac{GM}{a} - \frac{GM}{\frac{a}{2}} = -\frac{3GM}{a}$$

14. A ball is dropped from a high rise platform at $t = 0$ starting from rest. After 6 seconds another ball is thrown downwards from the same platform with a speed v. The two balls meet at $t = 18$ s. What is the value of v? (Take $g = 10\text{ m/s}^2$)

(a) 60 m/s (b) 75 m/s

(c) 55 m/s (d) 40 m/s

Solution

(b) The distance travelled by the first ball in 18 seconds = distance travelled by the second ball in 12 seconds

$$\frac{1}{2} g t^2 = v t' + \frac{1}{2} g t'^2$$

$$\frac{1}{2} 10 \times (18)^2 = v \times 12 + \frac{1}{2} \times 10 \times 12^2$$

$$v = \frac{5(18^2 - 12^2)}{12} = 75\text{ m/s}$$

15. A cylindrical metallic rod in thermal contact with two reservoirs of heat at its two ends conducts an amount of heat Q in time t. The metallic rod is melted and the material is formed into a rod of half the radius of the original rod. What is the amount of heat conducted by the new rod, when placed in thermal contact with the two reservoirs in time t?

(a) $\frac{Q}{2}$ (b) $\frac{Q}{4}$

(c) $\frac{Q}{16}$ (d) $2Q$

Solution

(c) The total volume of the rod is constant

$$Al = A'l'$$

Therefore the new length of the rod $l' = \frac{A}{A'} l = 4l$

The heat transferred is directly proportional to the area of the rod and inversely proportional to the length.

$$\frac{Q'}{Q} = \frac{lA'}{Al'} = \frac{1}{16}$$

or $$Q' = \frac{Q}{16}$$

16. The total radiant energy per unit area, normal to the direction of incidence, received at a distance R from the centre of a star of radius r, whose outer surface radiates as a black body at a temperature T K is given by

(a) $\frac{4\pi\sigma r^2 T^4}{R^2}$ (b) $\frac{\sigma r^2 T^4}{R^2}$

(c) $\frac{\sigma r^2 T^4}{4\pi r^2}$ (d) $\frac{\sigma r^4 T^4}{r^4}$

Solution

(b) The energy radiation by the black body

$$E = 4\pi r^2 \sigma T^4$$

Therefore the energy received per unit area at distance R

$$\frac{E}{A} = \frac{4\pi r^2 \sigma T^4}{4\pi R^2} = \frac{r^2 \sigma T^4}{R^2}$$

17. If ΔU and ΔW represent the increase in internal energy and work done by the system respectively in a thermodynamical process, which of the following is true?

(a) $\Delta U = -\Delta W$, in a isothermal process
(b) $\Delta U = -\Delta W$, in a adiabatic process
(c) $\Delta U = \Delta W$, in a isothermal process
(d) $\Delta U = \Delta W$, in a adiabatic process

Solution

(b) In an adiabatic process the internal energy change is positive when the work done on the system or

$$\Delta U = -\Delta W$$

18. The displacement of a particle along the x-axis is given by $x = a\sin^2 \omega t$. The motion of the particle corresponds to

(a) Simple harmonic motion of frequency $\frac{\omega}{2\pi}$
(b) Simple harmonic motion of frequency $\frac{\omega}{\pi}$
(c) Simple harmonic motion of frequency $\frac{3\omega}{2\pi}$
(d) Non-simple harmonic motion

Solution

(b)
$$x = a\left[\frac{1 - \cos 2\omega t}{2}\right]$$
$$x = \frac{a}{2} - \frac{a}{2}\cos 2\omega t$$
$$x - \frac{a}{2} = -\frac{a}{2}\cos 2\omega t$$

or
$$x = -\frac{a}{2}\cos 2\omega t$$

The period of oscillation of a mass M suspended from a spring of negligible mass is T. If along with it another mass M is also suspended, the period of oscillation will now be

(a) $\sqrt{2}T$ (b) T (c) $\frac{T}{\sqrt{2}}$ (d) $2T$

Solution

(a) The time period of the spring proportional to the square root of the mass.

$$T \propto \sqrt{M}$$

Therefore

$$\frac{T_2}{T_1} = \sqrt{\frac{M_2}{M_1}} = \sqrt{\frac{2M}{M}}$$

or
$$T_2 = \sqrt{2}T$$

19. A transverse wave is represented by $y = A\sin(\omega t - kx)$. For what value of the wavelength is the wave velocity equal to the maximum particle velocity?

(a) A (b) $\frac{\pi A}{2}$ (c) πA (d) $2\pi A$

Solution

(d) We have the particle velocity $= A\omega$
Therefore

$$\text{wave velocity} = \frac{\omega}{k} = A\omega$$

or
$$\lambda = 2\pi A.$$

20. A tuning fork of frequency 512 Hz makes 4 beats per second with the vibrating string of a piano. The beat frequency decreases to 2 beats per sec when the tension in the piano string is slightly increased. The frequency of the piano string before increasing the tension was

(a) 508 Hz (b) 510 Hz
(c) 514 Hz (d) 516 Hz

Solution

(a) Number of beats $= f_1 - f_2$
since the beat frequency decrease because of the increase in the tension, the frequency of the piano is less than the frequency of the tuning fork.

$$f_1 - f_2 = 4$$
$$f_2 = 512 - 4 = 508 \text{ Hz.}$$

21. Which of the following statement is false for the properties of electromagnetic waves?

(a) These waves do not require any material medium for propagation
(b) Both electric and magnetic field vectors attains the maxima and minima at the same place and same time
(c) The energy in electromagnetic wave is divided equally between electric and magnetic vectors
(d) Both electric and magnetic field are parallel to each other and perpendicular to the direction of propagation of wave

Solution

(d) Electric and magnetic fields of an electromagnetic wave are perpendicular to each other and perpendicular to the direction of propagation of the wave.

22. A lens having focal length f and aperture of diameter d forms an intensity I. Aperture of diameter $\frac{d}{2}$ in central region of lens is covered by a black paper. Focal length of lens and intensity of image now will be respectively

(a) $\frac{f}{2}$ and $\frac{I}{2}$ (b) f and $\frac{I}{4}$
(c) $\frac{3f}{4}$ and $\frac{I}{2}$ (d) f and $\frac{3I}{4}$

Solution

(d) The focal length is independent of the aperture size.
The intensity $I \propto$ *area of aperture*

$$I = \pi d^2$$

and $$I' = \pi d^2 - \pi\left(\frac{d}{2}\right)^2$$

$$I' = \frac{3}{4} I$$

23. A ray of light travelling in a transparent medium of refractive index μ, falls on a surface separating the medium from air at an angle of incidence of 45°. For which of the following value of μ the ray can undergo total internal reflection?

(a) $\mu = 1.25$ (b) $\mu = 1.33$
(c) $\mu = 1.40$ (d) $\mu = 1.50$

Solution

(d) For total internal reflection

$$\mu \sin 45 \geq 1$$

or $$\mu \geq \sqrt{2} = 1.41$$

24. Two positive ions, each carrying a charge q, are separated by a distance d. If F is the force of repulsion between the ions, the number of electrons missing from each ion will be (e being the charge on an electron)

(a) $\dfrac{4\pi\varepsilon_0 Fd^2}{q^2}$ (b) $\dfrac{4\pi\varepsilon_0 Fd^2}{e^2}$

(c) $\sqrt{\dfrac{4\pi\varepsilon_0 Fe^2}{d^2}}$ (d) $\sqrt{\dfrac{4\pi\varepsilon_0 Fd^2}{e^2}}$

Solution

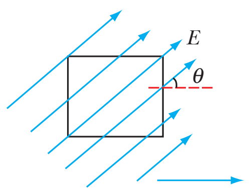
(d) The force

$$F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q^2}{d^2} = \frac{n^2}{4\pi\varepsilon_0} \cdot \frac{e^2}{d^2}$$

Therefore

$$n = \sqrt{\frac{4\pi\varepsilon_0 Fd^2}{e^2}}$$

25. A square surface of side L meter in the plane of the paper is placed in a uniform electric field E (volt/m) acting along the same plane at an angle θ with the horizontal side of the square as shown in figure. The electric flux linked to the surface, in units of volt-m, is



(a) Zero (b) EL^2
(c) $EL^2 \cos\theta$ (d) $EL^2 \operatorname{Sin}\theta$

Solution

(a) The flux

$$\Phi = \vec{E} \cdot d\vec{a}$$

But the angle between the $\vec{E}$ and $d\vec{a}$ is 90. Therefore the net flux passing through the plane is zero.

26. A series combination of n_1 capacitors, each of value C_1, is charged by a source of potential difference 4 V. When another parallel combination of n_2 capacitors, each of value C_2, is charged by a source of potential difference V, it has the same (total) energy stored in it, as the first combination has. The value of C_2, in terms of C_1, is then

(a) $\dfrac{16C_1}{n_1 n_2}$ (b) $\dfrac{2C_1}{n_1 n_2}$

(c) $16\dfrac{n_2}{n_1}C_1$ (d) $2\dfrac{n_2}{n_1}C_1$

Solution

(a) The effective capacitance of the first combination is

$$C = \frac{c_1}{n_1}$$

Therefore the energy stored in the first combination is

$$E = \frac{1}{2}C(4V)^2 = \frac{1}{2}\left(\frac{c_1}{n_1}\right)16V^2 = \frac{8c_1}{n_1}V^2$$

The effective capacitance of the second combination

$$C' = n_2 c_2$$

Therefore the energy stored

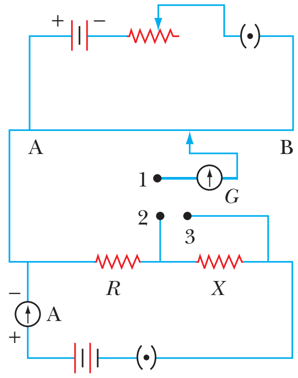
$$E = \frac{1}{2}C'V^2 = \frac{n_2 c_2}{2}V^2$$

But both the energies are equal

$$\frac{n_2 c_2}{2}V^2 = \frac{8c_1}{n_1}V^2$$

$$c_2 = \frac{16c_1}{n_1 n_2}$$

27. A potentiometer circuit is set up as shown. The potential gradient, across the potentiometer wire, is k volt/cm and the ammeter, present in the circuit, reads 1.0 A when two way key is switched off. The balance points, when the key between the terminals (i) 1 and 2 (ii) 1 and 3, is plugged in, are found to be at lengths l_1 cm and l_2 cm respectively. The magnitudes, of the resistors R and X, in ohms, are then, equal, respectively, to



(a) kl_1 and kl_2 (b) $k(l_2 - l_1)$ and kl_2
(c) kl_1 and $k(l_2 - l_1)$ (d) $k(l_2 - l_1)$ and kl_1

Solution

(c) The voltage drop across R

$$R = kl_1$$

also $R + X = kl_2$

or $X = k(l_2 - l_1)$

28. A galvanometer has a coil of resistance 100 Ω and gives a full scale deflection for 30 mA current. If it is to work as a voltmeter of 30 V range, the resistance required to be added will be

(a) 1000 Ω (b) 900 Ω
(c) 1800 Ω (d) 500 Ω

Solution

(b) The value of the high resistance

$$R = \frac{V}{I_g} - G$$

where V is the maximum voltage to be measured, I_g is the galvanometer current for maximum deflection and G is the galvanometer resistance.

$$R = \frac{30\,\text{V}}{30\times10^{-3}\,\text{A}} - 100\,\Omega$$

$$R = 900\,\Omega$$

29. Consider the following two statements

(A) Kirchhoff's junction law follows from the conservation of charge.
(B) Kirchhoff's loop law follows from the conservation of energy.

Which of the following is correct?

(a) Both (A) and (B) are correct?
(b) Both (A) and (B) are wrong
(c) (A) is correct and (B) is wrong
(d) (A) is wrong and (B) is correct

Solution

(a) Kirchhoff's first law states that the net charge entering a junction is constant and Kirchhoff's second law states that the total potential drop in loop is zero. Therefore both statement A and B are correct.

30. In producing chlorine by electrolysis 100 kW power at 125 V is being consumed. How much chlorine per minute is liberated (E.C.E. of chlorine is 0.367×10^{-6} kg/C)

(a) 3.67×10^{-3} kg (b) 1.76×10^{-3} kg
(c) 9.67×10^{-3} kg (d) 17.61×10^{-3} kg

Solution

(d) The current passing through the circuit is

$$I = \frac{P}{V} = \frac{10^5}{125}$$

The amount of chlorine deposited in time t is

$$m = ZIt$$

It is given that

$$Z = 0.376\times10^{-6}\,\text{KgC}^{-1}, I = \frac{10^5}{125} t = 60\,\text{s}$$

Therefore

$$m = 0.376\times10^{-6}\times\frac{10^5}{125}\times60 \approx 17.61\times10^{-3}\,\text{kg}$$

31. A square current carrying loop is suspended in a uniform magnetic field acting in the plane of the loop. If the force on one arm of the loop is $\vec{F}$, the net force on the remaining three arms of the loop is

(a) $\vec{F}$ (b) $3\vec{F}$
(c) $-\vec{F}$ (d) $-3\vec{F}$

Solution

(c) The net magnetic force acting on a current carrying loop is zero(net torque is not zero)
Therefore the net force acting on the remaining three arms of the loop is equal and opposite to $\vec{F}$. i.e $-\vec{F}$.

32. A thin ring of radius R meter has charge q coulomb uniformly spread on it. The ring rotates about its axis with a constant frequency of f revolutions/s. The value of magnetic induction in Wb/m^2 at the centre of the ring is

(a) $\frac{\mu_0 qf}{2R}$ (b) $\frac{\mu_0 qf}{2\pi R}$
(c) $\frac{\mu_0 q}{2\pi fR}$ (d) $\frac{\mu_0 q}{2fR}$

Solution

(a) The net current flow in the loop is

$$I = qf$$

The net magnetic field inside a current carrying loop is

$$B = \frac{\mu_0 I}{2R} = \frac{\mu_0 qf}{2R}$$

33. Electromagnets are made of soft iron because soft iron has

(a) High retentivity and low coercive force
(b) Low retentivity and high coercive force
(c) High retentivity and high coercive force
(d) Low retentivity and low coercive force

Solution

(d) The material used for the electromagnetic core should be low retentivity and coercivity so that the net force need to change the magnetism is less and also the energy dissipated in the core is less.

34. A vibration magnetometer placed in magnetic meridian has a small bar magnet. The magnet executes oscillations with a time period of 2 sec in earth's horizontal magnetic field of 24 microtesla. When a horizontal field of 18 microtesla is produced opposite to the earth's field by placing a current carrying wire, the new time period of magnet will be

(a) 4 s (b) 1 s (c) 2 s (d) 3 s

Solution

(a) The time period of oscillation

$$T \propto \frac{1}{\sqrt{B}}$$

Therefore the ratio of time periods

$$\frac{T_1}{T_2} = \sqrt{\frac{B_2}{B_1}}$$

$$\text{Therefore } T_2 = 2 \times \sqrt{\frac{24}{6}} = 4 \text{ s}$$

35. A conducting circular loop is placed in a uniform magnetic field, $B = 0.025$ T with its plane perpendicular to the loop. The radius of the loop is made to shrink at a constant rate of 1 mms^{-1}. The induced emf when the radius is 2 cm is

(a) 2 μV (b) 2 $\pi\mu$V

(c) $\pi\mu$V (d) $\frac{\pi}{2}\mu$V

Solution

(c) The magnetic flux rate through the loop

$$\phi = B\pi r^2$$

The induced electromagnetic field

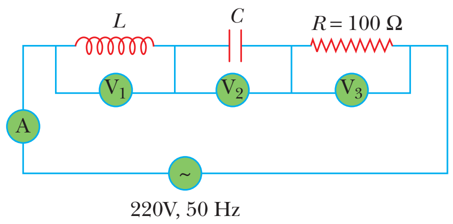
$$|\varepsilon| = \frac{d\phi}{dt}$$

$$= 2B\pi r\left(\frac{dr}{dt}\right)$$

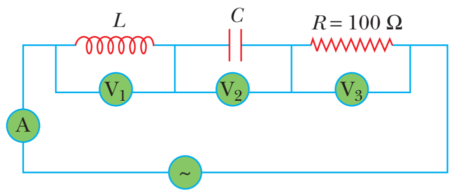
$$= 2 \times 0.025 \times \pi \times 2 \times 10^{-2} \times 10^{-3}$$

$$|\varepsilon| = \pi\mu V.$$

36. In the given circuit the reading of voltmeter V_1 and V_2 are 300 V each. The reading of the voltmeter V_3 and ammeter A are respectively



(a) 100 V, 2.0 A (b) 150 V, 2.2 A
(c) 220 V, 2.2 A (d) 220 V, 2.0 A



Solution

(c) The net voltage drop across the inductor and capacitor are zero.
Therefore the net voltage drop in the circuit is across the resistor and its value is 220 V.
The current in the circuit

$$I = \frac{V}{R} = \frac{220}{100} = 2.2 \text{ A}$$

37. A 220 V input is supplied to a transformer. The output circuit draws a current of 2.0 A at 440 V. If the efficiency of the transformer is 80%, the current drawn by the primary windings of the transformer is

(a) 5.0 A (b) 3.6 A
(c) 2.8 A (d) 2.5 A

Solution

(a) The net power transferred to the secondary

$$E_f I_f = \eta E_i I_i$$

Therefore the input current is

$$I_i = \frac{E_f I_f}{\eta E_i} = \frac{440 \times 2.0}{0.8 \times 220} = 5 \text{ A}$$

38. A source S_1 is producing 10^{15} photons per second of wavelength 5000 Å. Another source S_2 is producing 1.02×10^{15} photons per second of wavelength 5100 Å
Then (power of S_2)/(power of S_1) is equal to

(a) 0.98 (b) 1.00
(c) 1.02 (d) 1.04

Solution

(b) The power emitted by the source

$$P = \frac{nhc}{\lambda}$$

Then

$$\frac{P_2}{P_1} = \frac{n_2\lambda_1}{n_1\lambda_2} = \frac{1.02 \times 10^{15} \times 5000\text{ Å}}{10^{15} \times 5100\text{Å}} = 1$$

39. A beam of cathode rays is subjected to crossed Electric (E) and Magnetic field (B). The fields are adjusted such that the beam is not defected. The specific charge of the cathode rays is given by (where V is the potential difference between cathode and anode)

(a) $\frac{E^2}{2VB^2}$ (b) $\frac{B^2}{2VE^2}$

(c) $\frac{2VB^2}{E^2}$ (d) $\frac{2VE^2}{B^2}$

Solution

(a) The net force acting on the cathode ray

$$qvB = qE \qquad (1)$$

The net energy of the particle

$$\frac{1}{2}mv^2 = qV$$

$$\frac{q}{m} = \frac{v^2}{2V}$$

From (1)

$$v = \frac{E}{B}$$

$$\frac{q}{m} = \frac{E^2}{2VB^2}$$

40. The potential difference that must be applied to stop the fastest photo electrons emitted by a nickel surface, having work function 5.01 eV, when ultraviolet light of 200 nm falls on it, must be

(a) 1.2 V (b) 2.4 V
(c) −1.2 V (d) −2.4 V

Solution

(c) The net kinetic energy of the electron

$$K\cdot E = \frac{hc}{\lambda} - \phi$$

$$= \frac{1240}{200}\text{eV} - 5.01\,\text{eV} = 1.19\text{ eV}$$

Therefore the net voltage need to stop the fastest electron is 1.2 V.

41. The activity of a radioactive sample is measured as N_0 counts per minute at $t = 0$ and N_0/e counts per minute at $t = 5$ minutes. The time (in minutes) at which the activity reduces to half its value is

(a) $5\log_e 2$ (b) $\log_e \frac{2}{5}$
(c) $\frac{5}{\log_e 2}$ (d) $5\log_{10} 5$

Solution

(a) The activity reduce to N_0 to N_0/e in $1/\lambda$ time. Therefore the half-life of the given sample is

$$\lambda = \frac{1}{5}\text{min}^{-1}.$$

The activity reduces to the half the original value in

or $$T_{1/2} = \frac{\log_e 2}{\lambda} = 5\log_e 2\text{ min.}$$

42. The energy of a hydrogen atom in the ground state is −13.6 eV. The energy of a He^+ ion in the first excited state will be

(a) −6.8 eV (b) −13.6 eV
(c) −27.2 eV (d) −54.4 eV

Solution

(b) The energy of the helium atom at *n*th excited state is

$$E_n = \frac{Z^2(-13.6\text{ eV})}{n^2}$$

$$= \frac{2^2}{2^2}(-13.6\text{ eV}) = -13.6\text{ eV}$$

43. The mass of a ${}_3^7\text{Li}$ nucleus is 0.042 u less than the sum of the masses of all its nucleons. The binding energy per nucleon of ${}_3^7\text{Li}$ nucleus is nearly

(a) 23 MeV (b) 46 MeV
(c) 5.6 MeV (d) 3.9 MeV

Solution

(c) The binding energy

$$B\cdot E = \Delta Mc^2$$

If mass is in amu, then

$$B\cdot E = \Delta M \times 931\text{ MeV}$$

$$= 0.042 \times 931 = 39.1\text{ MeV.}$$

Therefore the binding energy per nucleon is

$$\frac{B\cdot E}{A} = \frac{39.1}{7} = 5.6\text{ MeV.}$$

44. An alpha nucleus of energy $\frac{1}{2}mv^2$ bombards a heavy nuclear target of charge *Ze*. The distance of closest approach for the alpha nucleus will be proportional to

(a) $\frac{1}{v^4}$ (b) $\frac{1}{Ze}$
(c) v^2 (d) $\frac{1}{m}$

Solution

(d) The distance of closes approach

$$r_0 = \frac{1}{2\pi\varepsilon_0}\cdot\frac{Ze^2}{mv^2}$$

Therefore

$$r_0 \propto \frac{1}{m}.$$

45. A common emitter amplifier has a voltage gain of 50, an input impedance of 100 Ω and an output impedance of 200 Ω. The power gain of the amplifier is

(a) 50 (b) 500
(c) 1000 (d) 1250

Solution

(d) The voltage gain

$$A_v = \frac{\beta R_{out}}{R_{in}}$$

Therefore

$$\beta = \frac{50 \times 100}{200} = 25$$

The power gain of the amplifier

$$= \beta A_v = 25 \times 50 = 1250$$

46. Which one of the following bonds produces a solid that reflects light in the visible region and whose electrical conductivity decreases with temperature and has high melting point?

(a) Covalent bonding (b) Metallic bonding
(c) van der Waal's bonding (d) Ionic bonding

Solution

(b) Metallic bonds

47. The device that can act as a complete electronic circuit is

(a) Zener diode (b) junction diode
(c) Integrated circuit (d) Junction transistor

Solution

(c) An integrated circuit is a complete electronic circuit.

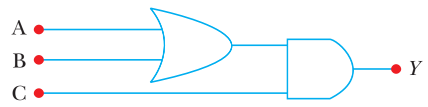
48. Which of the following statement is False?

(a) The resistance of intrinsic semiconductor decreases with increase of temperature
(b) Pure Si doped with trivalent impurities gives a *p*-type semiconductor
(c) Majority carries in a *n*-type semiconductors are holes
(d) Minority carries in a *p*-type semiconductor are electrons

Solution

(c) The majority carriers in the *n*-type semiconductor is electrons.

49. To get an output $Y = 1$ from the circuit shown below, the input must be



	A	B	C
(1)	1	0	0
(2)	0	1	0
(3)	0	0	1
(4)	1	0	1

Solution

(d) The truth table of the given diagram is

A	B	C	Y
1	0	0	0
0	1	0	0
1	0	1	1
0	1	1	1
1	1	0	0
0	0	1	0
1	1	1	1