Sample Question Paper, 2021-22

(Issued by CBSE Board on 14th January, 2022)

TERM-II

PHYSICS

SOLVED

Time allowed : 2 Hours | **Max. Marks : 35**

General Instructions :

(i) There are 12 questions in all. All questions are compulsory.

(ii) This question paper has three sections: Section A, Section B and Section C.

(iii) Section A contains three questions of two marks each, Section B contains eight questions of three marks each, Section C contains one case study-based question of five marks.

(iv) There is no overall choice. However, an internal choice has been provided in one question of two marks and two questions of three marks. You have to attempt only one of the choices in such questions.

(v) You may use log tables if necessary but use of calculator is not allowed.

Section - A (2 Marks Each)

1. In a pure semiconductor crystal of Si, if antimony is added then what type of extrinsic semiconductor is obtained. Draw the energy band diagram of this extrinsic semiconductor so formed.

2. Consider two different hydrogen atoms. The electron in each atom is in an excited state. Is it possible for the electrons to have different energies but same orbital angular momentum according to the Bohr model? Justify your answer.

OR

Explain how does (i) photoelectric current and (ii) kinetic energy of the photoelectrons emitted in a photocell vary if the frequency of incident radiation is doubled, but keeping the intensity same?

Show the graphical variation in the above two cases.

3. Name the device which converts the change in intensity of illumination to change in electric current flowing through it. Plot I-V characteristics of this device for different intensities. State any two applications of this device.

Section - B (3 Marks Each)

4. Derive an expression for the frequency of radiation emitted when a hydrogen atom de-excites from level n to level $(n-1)$. Also show that for large values of n, this frequency equals to classical frequency of revolution of an electron.

5. Explain with a proper diagram how an ac signal can be converted into dc (pulsating) signal with output frequency as double than the input frequency using p-n junction diode. Give its input and output waveforms.

6. How long can an electric lamp of 100 W be kept glowing by fusion of 2 kg of deuterium?

Take the fusion reaction as

$$^{2}_{1}\text{H} + ^{2}_{1}\text{H} \rightarrow ^{3}_{2}\text{He} + n + 3.27 \text{ MeV}$$

7. Define wavefront. Draw the shape of refracted wavefront when the plane incident wave undergoes refraction from optically denser medium to rarer medium. Hence prove Snell's law of refraction.

8. (a) Draw a ray diagram of compound microscope for the final image formed at least distance of distinct vision?

(b) An angular magnification of 30X is desired using an objective of focal length 1.25 cm and an eye piece of focal length 5 cm. How will you set up the compound microscope for the final image formed at least distance of distinct vision?

OR

(a) Draw a ray diagram of Astronomical Telescope for the final image formed at infinity.

(b) A small telescope has an objective lens of focal length 140 cm and an eyepiece of focal length 5.0 cm. Find the magnifying power of the telescope for viewing distant objects when

(i) the telescope is in normal adjustment,

(ii) the final image is formed at the least distance of distinct vision.

9. Light of wavelength 2000 Å falls on a metal surface of work function 4.2 eV.

(a) What is the kinetic energy (in eV) of the fastest electrons emitted from the surface?

(b) What will be the change in the energy of the emitted electrons if the intensity of light with same wavelength is doubled?

(c) If the same light falls on another surface of work function 6.5 eV, what will be the energy of emitted electrons?

10. The focal length of a convex lens made of glass of refractive index (1.5) is 20 cm.

What will be its new focal length when placed in a medium of refractive index 1.25 ? Is focal length positive or negative? What does it signify?

11. (a) Name the e.m. waves which are suitable for radar systems used in aircraft navigation. Write the range of frequency of these waves.

(b) If the Earth did not have atmosphere, would its average surface temperature be higher or lower than what it is now? Explain.

(c) An e.m. wave exerts pressure on the surface on which it is incident. Justify.

OR

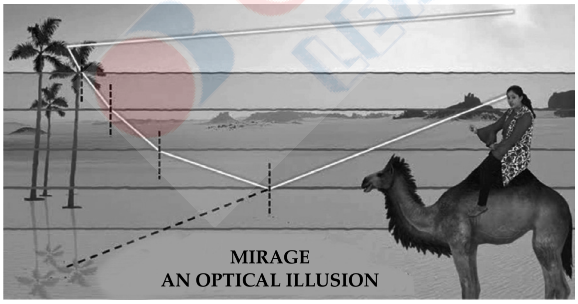
(a) "If the slits in Young's double slit experiment are identical, then intensity at any point on the screen may vary between zero and four times to the intensity due to single slit".

Justify the above statement through a relevant mathematical expression.

(b) Draw the intensity distribution as function of phase angle when diffraction of light takes place through coherently illuminated single slit.

Section - C (5 Marks Each)

12. Case Study : Mirage In Deserts



To a distant observer, the light appears to be coming from somewhere below the ground. The observer naturally assumes that light is being reflected from the ground, say, by a pool of water near the tall object.

Such inverted images of distant tall objects cause an optical illusion to the observer. This phenomenon is called mirage. This type of mirage is especially common in hot deserts.

Based on the above facts, answer the following questions:

(a) Which of the following phenomena is prominently involved in the formation of mirage in deserts? **[1]**

(i) Refraction and Total Internal Reflection

(ii) Dispersion and Refraction

(iii) Dispersion and scattering of light

(iv) Total internal Reflection and diffraction

(b) A diver at a depth 12 m inside water $\left({}^{a}\mu_{w} = \frac{4}{3}\right)$ sees the sky in a cone of semi-vertical angle **[1]**

(i) $\sin^{-1}\frac{4}{3}$ **(ii)** $\tan^{-1}\frac{4}{3}$

(iii) $\sin^{-1}\frac{3}{4}$ **(iv)** 90°

(c) In an optical fibre, if n_1 and n_2 are the refractive indices of the core and cladding, then which among the following, would be a correct equation? **[1]**

(i) $n_1 < n_2$ **(ii)** $n_1 = n_2$

(iii) $n_1 << n_2$ **(iv)** $n_1 > n_2$

(d) A diamond is immersed in such a liquid which has its refractive index with respect to air as greater than the refractive index of water with respect to air. Then the critical angle of diamond-liquid interface as compared to critical angle of diamond -water interface will **[1]**

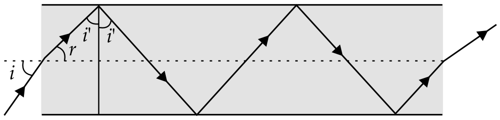
(i) depend on the nature of the liquid only

(ii) decrease

(iii) remain the same

(iv) increase

(e) The following figure shows a cross-section of a 'light pipe' made of a glass fiber of refractive index 1.68. The outer covering of the pipe is made of a material of refractive index 1.44. What is the range of the angles of the incident rays with the axis of the pipe for the following phenomena to occur. **[1]**



(i) $0 < i < 90°$

(ii) $0 < i < 60°$

(iii) $0 < i < 45°$

(iv) $0 < i < 30°$

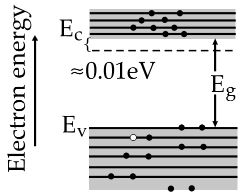
❑❑❑

SOLUTIONS

Section - A

1. As given in the statement antimony is added to pure Si crystal, then an n-type extrinsic semiconductor would be so obtained, since antimony(Sb) is a pentavalent impurity. **1**

Energy level diagram of n-type semiconductor:



T>OK **1**

2. No ½

Because according to Bohr's model,

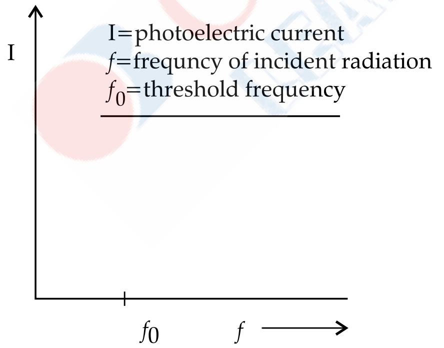
$E_n = \frac{-13.6}{n^2}$ and electrons having different energies belong to different levels having different values of n. ½

So, similarly their angular momenta will be different, as

$L = mvr = \frac{nh}{2\pi}$ **1**

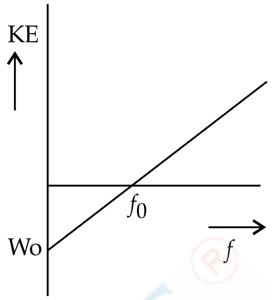
OR

(i) The increase in the frequency of incident radiation has no effect on photoelectric current. This is because of incident photon of increased energy can not eject more than one electron from the metal surface. ½



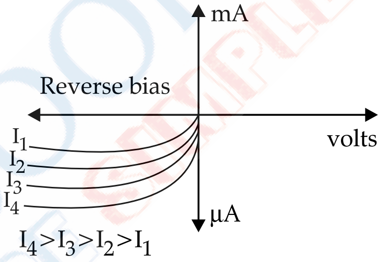
½

(ii) The kinetic energy of the photoelectron becomes more than the double of its original energy. As the work function of the metal is fixed, so incident photon of higher frequency and hence higher energy will impart more energy to the photoelectrons. ½



½

3. Photodiodes are used to detect optical signals of different intensities by changing current flowing through them. ½



½

I-V characteristics of a photodiode

Applications of photodiodes:

1. In detection of optical signals
2. In demodulation of optical signals
3. In light operated switches
4. In speed reading of computer punched cards
5. In electronic counters

(any two out of these or any other relevant application) **½×2=1**

Section - B

4. From Bohr's theory, the frequency f of the radiation emitted when an electron de – excites from level n_2 to level n_1 is given as

$$f = \frac{2\pi^2 mk^2z^2e^4}{h^3}\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

Given $n_1 = n - 1$, $n_2 = n$, derivation of it

$$f = \frac{2\pi^2 mk^2z^2e^4}{h^3}\left[\frac{(2n-1)}{(n-1)^2 n^2}\right]$$ **2**

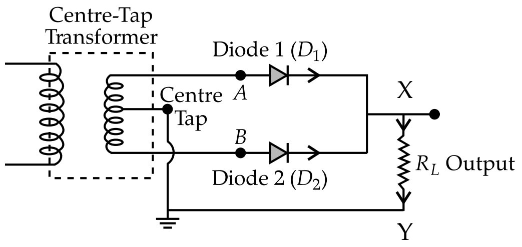
For large n, $2n - 1 = 2n$, $n - 1 = n$ and $z = 1$

Thus, $f = \frac{4\pi^2 mk^2e^4}{n^3h^3}$

which is same as orbital frequency of electron in n^{th} orbit.

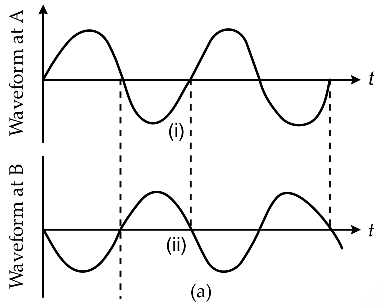
$$f = \frac{v}{2\pi r} = \frac{4\pi^2 mk^2 e^4}{n^3 h^3}$$ **1**

5. A junction diode allows current to pass only when it is forward biased. So, if an alternating voltage is applied across a diode the current flows only in that part of the cycle when the diode is forward biased. This property is used to rectify alternating voltages and the circuit used for this purpose is called a rectifier. **1**

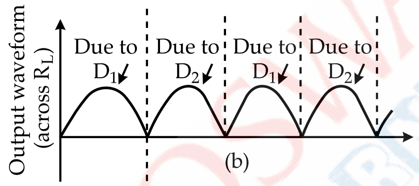


1

Circuit Diagram



Waveform in figure (a) in the input.



Output waveform shown in figure (b). **1**

6. Number of atoms present in 2 g of deuterium = 6 × 10^{23}

Number of atoms present in 2.0 kg of deuterium = 6 × 10^{26}

Energy released in fusion of 2 deuterium atoms = 3.27 MeV **1**

Energy released in fusion of 2.0 kg of deuterium atoms

$$= \frac{3.27}{2} \times 6 \times 10^{26} \text{ MeV}$$

= 9.81 × 10^{26} MeV

= 15.696 × 10^{13} J [$\because$ 1 MeV = 1.6 × 10^{-13} J] **1**

Energy consumed by bulb per sec = 100 J

Time for which bulb will glow $= \frac{15.696 \times 10^{13}}{100}$ s

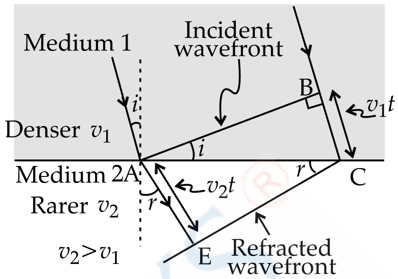
= 4.97 × 10^4 years

[$\because$ 1S = 3.169 × 10^{-8} years] **1**

7. A locus of points, which oscillate in phase is called a wavefront.

OR

A wavefront is defined as a surface of constant phase. **1**



1

Derivation: AC is the surface separating the denser and rarer medium.

v_1 = speed of light wave in denser medium.

v_2 = speed of light wave in rarer medium.

A plane wavefront AB is incident at an angle i with the normal to the interface.

Let t be the time taken by the wavefront to travel distance BC in the denser medium.

$\therefore BC = v_1 t$

To determine the shape of the wavefront, a sphere of radius $v_2 t$ is drawn in rarer medium with centre A. CE is the tangent drawn from point C on the sphere. CE represents the refracted wavefront.

AE makes an angle r with the normal to the interface.

$AE = v_2 t$

Considering the ΔABC and Δ AEC,

$$\sin i = \frac{BC}{AC} = \frac{v_1 t}{AC}$$

$$\sin r = \frac{AE}{AC} = \frac{v_2 t}{AC}$$

$$\therefore \quad \frac{\sin i}{\sin r} = \frac{v_1}{v_2} \quad \dots \text{(i)}$$

(i = Angle of incidence and r = Angle of refraction.)

If c be the speed of light in vacuum, then

$$\mu_1 = \frac{c}{v_1} \text{ and}$$

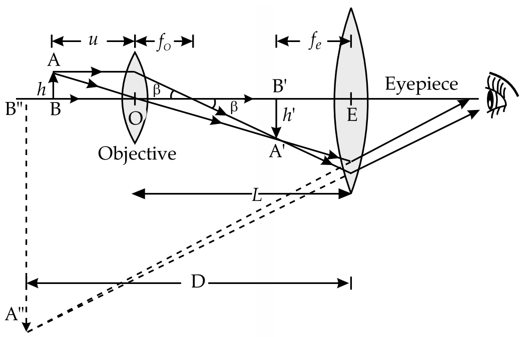
$$\mu_2 = \frac{c}{v_2}$$

Putting in equation (i)

$\mu_1 \sin i = \mu_2 \sin r$

This is Snell's law of refraction. **1**

8. (a) Diagram of Compound Microscope for the final image formed at D:



1½

(b) $m_o = 30, f_o = 1.25$ cm, $f_e = 5$ cm

when image is formed at least distance of distinct vision, then $D = 25$ cm

Angular magnification of eyepiece

$$m_e = \left(1 + \frac{}{}\right) = 1 + \frac{25}{} = 6 \qquad ½$$

Total Angular magnification, $m = m_o\, m_e$

$$\Rightarrow m_o = \frac{m}{m_e} = \frac{30}{6} = 5$$

As the objective lens forms the real image

$$m_o = \frac{v_o}{u_o} = -5 \Rightarrow v_o = -5u_o$$

using lens equation, $u_o = -1.5$ cm,

$v_o = -5 \times (-1.5)$ cm $= +7.5$ cm ½

Given $v_e = -D = -25$ cm, $f_e = +5$ cm, $u_e = ?$

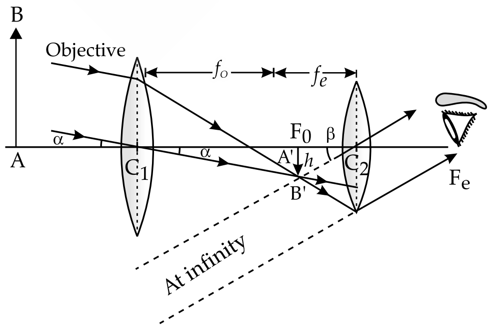
using again lens equation $u_e = \frac{25}{6}$

Thus, object is to be placed at 1.5 cm from the objective and separation between the two lenses should be

$L = |v_0| + |u_e| = 11.67$ cm ½

OR

(a) Ray diagram of astronomical telescope when image is formed at infinity.



1½

(b) (i) In normal adjustment : Magnifying power.

$$m = \frac{f_o}{f_e} = \left(\frac{140}{5}\right) = 28 \qquad ½$$

(ii) When the final image is formed at the least distance of distinct vision (25 cm) :

$$m = \frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right) = 28 \times 1.2 \qquad 1$$

$m = 33.6$

9. $\lambda = 2000$ Å $= (2000 \times 10^{-10})$ m

$W_o = 4.2$eV

$h = 6.63 \times 10^{-34}$ (Js)

(a) Using Einstein's photoelectric equation

K.E. $= h\nu - h\nu_0$

$$\text{K.E.} = \frac{hc}{\lambda} - W_0$$

$$\frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{2000 \times 10^{-10} \times 1.6 \times 10^{-19}} \text{(eV)}$$

$= 6.2$ eV

K.E. $= (6.2 - 4.2)$ eV $= 2.0$ eV **1**

(b) The energy of the emitted electrons does not depend upon intensity of incident light; hence the energy remains unchanged. **1**

(c) For this surface, electrons will not be emitted as the energy of incident light (6.2 eV) is less than the work function (6.5 eV) of the surface. **1**

10. Given ${}^a\mu_g = 1.5$

Focal length of the given convex lens when it is placed in air is $f = +20$ cm

Refractive index of the given medium with respect to air is ${}^a\mu_m = 1.25$

New focal length of the given convex lens when placed in a medium is f'.

$$\frac{1}{f} = \left({}^a\mu_g - 1\right)\left[\left(\frac{1}{R_1}\right) - \left(\frac{1}{R_2}\right)\right] \qquad ½$$

$$\frac{1}{f'} = \left({}^m\mu_g - 1\right)\left[\left(\frac{1}{R_1}\right) - \left(\frac{1}{R_2}\right)\right] \qquad ½$$

Dividing (A) by (B), we get

$$\frac{f'}{f} = \frac{({}^a\mu_g - 1)}{({}^m\mu_g - 1)} = \frac{(1.5 - 1)}{(1.2 - 1)} = \frac{0.5}{0.2} = \frac{5}{2} = 2.5$$

Here, ${}^m\mu_g = \frac{\mu_g}{\mu_m} = \frac{1.5}{1.25}$

$f' = 2.5 f = (2.5 \times 20)$ cm $= +50$ cm

New focal length is positive. ½

The significance of the positive sign of the focal length is that given convex lens is still converging in the given medium. ½

11. (a) Microwaves are suitable for the radar system used in aircraft navigation.

Range of frequency of microwaves is 10^8 Hz to 10^{11} Hz.

(b) If the Earth did not have atmosphere, then there would be absence of greenhouse effect of the atmosphere. Due to this reason, the temperature of the earth would be lower than what it is now, **1**

(c) An e.m. wave carries momentum with itself and given by

$$p = \frac{\text{Energy of wave (U)}}{\text{Speed of the wave (c)}} = \frac{U}{c}$$

when it is incident upon a surface, it exerts pressure on it. **1**

OR

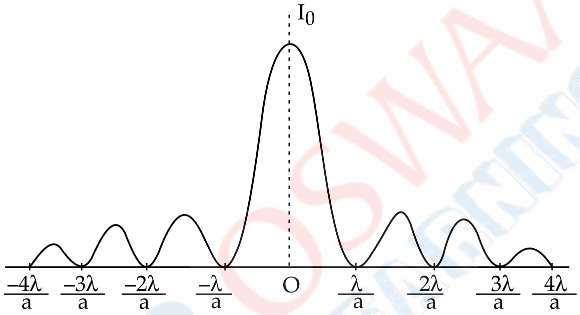
(a) The total intensity at a point where the phase difference is ϕ, is given by $I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$. Here I_1 and I_2 are the intensities of two individual sources which are equal.

When ϕ is 0, $I = 4I_1$.

When ϕ is 180°, $I = 0$

Thus intensity on the screen varies between $4I_1$ and 0. **2**

(b) Intensity distribution as function of phase angle, when diffraction of light takes place through coherently illuminated single slit.



Width of central maximum $= \frac{2D\lambda}{a}$ **1**

Section - C

Case-Study

12. (a) Option (i) in correct. **1**

Explanation: Mirage in desert is observed due to phenomenon of refraction and Total Internal Reflection.

(b) Option (iii) is correct. **1**

Explanation: ${}^{a}\mu_w = \frac{1}{\sin C}$

$$\Rightarrow \sin C = \frac{1}{{}_a\mu_w} \Rightarrow C = \sin^{-1}\left(\frac{1}{{}_a\mu_w}\right)$$

(c) Option (iv) is correct. **1**

Explanation: The refractive index of the core should be greater than the refractive index of the cladding.

(d) Option (iv) is correct. **1**

Explanation:

$${}^{L}\mu_D = \frac{1}{\sin C} = \frac{\mu_D}{\mu_L}, \quad {}^{w}\mu_D = \frac{1}{\sin C'} = \frac{\mu_D}{\mu_W}$$

$\mu_L > \mu_W$

Thus C > C'

(e) Option (ii) is correct. **1**

Explanation:

$${}^{1}\mu_2 = \frac{1}{\sin C'}$$

$$\text{Sin } C' = \frac{1.44}{1.68} = 0.8571$$

$\Rightarrow c' = 59°$

Total internal reflection will occur if the angle i' $> i_c'$,

i.e., if $i' > 59°$ or when $r < r_{max'}$

where $r_{max} = 90° - 59° = 31°$.

Using Snell's law,

$$\frac{\sin i_{max}}{\sin r_{max}} = 1.68$$

or $\sin i_{max} = 1.68 \times \sin r_{max}$

$= 1.68 \times \sin 31°$

$= 1.68 \times 0.5150 = 0.8662$

$\therefore \quad i_{max} = 60°$

Thus, all incident rays which make angles in the range $0° < \boldsymbol{i} < 60°$ with the axis of the pipe will suffer total internal reflection in the pipe.

❑❑❑

Solved Paper, 2021-22

PHYSICS

Term-I, Set-4

Series : SSJ/2

Question Paper Code No. 055/2/4

Time allowed : 90 Minutes **Max. Marks : 35**

General Instructions :

(i) *This question paper contains **55** questions out of which **45** questions are to be attempted. **All** questions carry equal marks.*

(ii) *The question paper consists of three Sections – Section A, B and C.*

(iii) ***Section – A** contains **25** questions. Attempt any **20** questions from Q. No. **01** to **25**.*

(iv) ***Section – B** contains **24** questions. Attempt any **20** questions from Q. No. **26** to **49**.*

(v) ***Section – C** contains **6** questions. Attempt any **5** questions from Q. No. **50** to **55**.*

(vi) *The first **20** Questions attempted in **Section – A** & **Section – B** and first **5** questions attempted in **Section – C** by a candidate will be evaluated.*

(vii) *There is only one correct option for every multiple choice question (MCQ) Marks will not be awarded for answering more than one option*

(viii) *There is no negative marking.*

SECTION-A

This Section consists of 25 multiple choice questions with overall choice to attempt any 20 questions. In case more than desirable number of questions are attempted, only first 20 questions will be considered for evaluation.

1. A negatively charged object X is repelled by another charged object Y. However an object Z is attracted to object Y. Which of the following is the most possibility for the object Z?

(a) positively charged only
(b) negatively charged only
(c) neutral or positively charged
(d) neutral or negatively charged

2. In an experiment three microscopic latex spheres are spread into a chamber and became charged with charges +3e,+5e and –3e respectively. All the three spheres came in contact simultaneously for a moment and got separated. Which one of the following are possible values for the final charge on the spheres?

(a) +5e, –4e, +5e **(b)** +6e, +6e, –7e
(c) –4e, +3.5e, +5.5e **(d)** +5e, –8e, +7e

3. An object has charge of 1 C and gains 5.0×10^{18} electrons. The net charge on the object becomes:

(a) –0.80 C **(b)** +0.80 C **(c)** +1.80 C **(d)** +0.20 C

4. Kirchoff's first rule $\Sigma I = 0$ and second rule $\Sigma IR = \Sigma E$ (where the symbols have their usual meanings) are respectively based on:

(a) conservation of momentum and conservation of charge
(b) conservation of energy, conservation of charge
(c) conservation of charge, conservation of momentum
(d) conservation of charge, conservation of energy

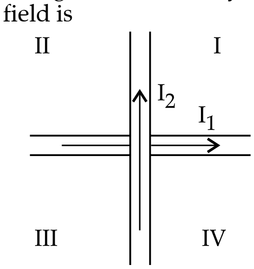
5. The electric power consumed by a 220 V – 100 W bulb when operated at 110 V is

(a) 25 W **(b)** 30 W **(c)** 35 W **(d)** 45 W

6. Which of the following has negative temperature coefficient of resistivity?

(a) metal
(b) metal and semiconductor
(c) semiconductor
(d) metal and alloy

7. Two wires carrying currents I_1 and I_2 lie, one slightly above the other, in a horizontal plane as shown in figure. The region of vertically upward strongest magnetic field is



(a) I **(b)** II **(c)** III **(d)** IV

8. Two parallel conductors carrying current of 4.0 A and 10.0 A are placed 2.5 cm apart in vacuum. The force per unit length between them is:

(a) 6.4×10^{-5} N/m **(b)** 6.4×10^{-2} N/m
(c) 4.6×10^{-4} N/m **(d)** 3.2×10^{-4} N/m

9. If an ammeter is to be used in place of a voltmeter, then we must connect with the ammeter a:

(a) low resistance in parallel
(b) low resistance in series
(c) high resistance in parallel
(d) high resistance in series

10. The magnetic field at the centre of a current carrying circular loop of radius R, is B_1. The magnetic field at a point on its axis at a distance R from the center of the loop is B_2. Then the ratio (B_1/B_2) is

(a) $2\sqrt{2}$ **(b)** $\frac{1}{\sqrt{2}}$ **(c)** $\sqrt{2}$ **(d)** 2

11. The self-inductance of a solenoid of 600 turns is 108 mH. The self-inductance of a coil having 500 turns with the same length, the same radius and the same medium will be

(a) 95 mH **(b)** 90 mH **(c)** 85 mH **(d)** 75 mH

12. The rms current in a circuit connected to 50 Hz ac source is 15 A. The value of the current in the circuit $\left(\frac{1}{600}\right)$s after the instant the current is zero, is:

(a) $\frac{15}{\sqrt{2}}$A **(b)** $15\sqrt{2}$ A **(c)** $\frac{\sqrt{2}}{15}$A **(d)** 8 A

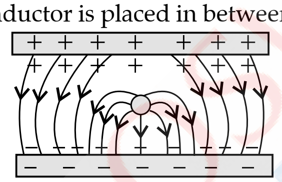
13. In a circuit the phase difference between the alternating current and the source voltage is $\frac{\pi}{2}$. Which of the following cannot be the element(s) of the circuit?

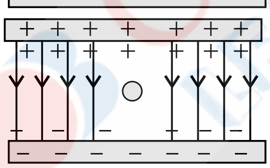
(a) only C **(b)** only L **(c)** L and R **(d)** L or C

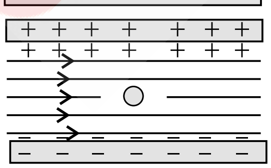
14. The electric potential V at any point (x, y, z) is given by $V = 3x^2$ where x is in metres and V in volts. The electric field at the point (1 m, 0, 2 m) is:

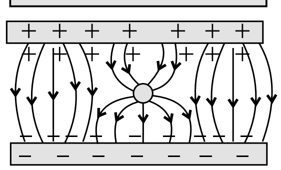
(a) 6 V/m along $-x$-axis
(b) 6 V/m along $+x$-axis
(c) 1.5 V/m along $-x$-axis
(d) 1.5 V/m along $+x$-axis

15. Which of the diagrams correctly represents the electric field between two charged plates if a neutral conductor is placed in between the plates?

(a)


(b)


(c)


(d)


16. A variable capacitor is connected to a 200 V battery. If its capacitance is changed from 2 μF to X μF, the decrease in energy of the capacitor is

(a) 1 μF **(b)** 2 μF **(c)** 3 μF **(d)** 4 μF

17. A potential difference of 200 V is maintained across a conductor of resistance 100 Ω. The number of electrons passing through it in 1 s is

(a) 1.25×10^{19} **(b)** 2.5×10^{18}
(c) 1.25×10^{18} **(d)** 2.5×10^{16}

18. The impedance of a series LCR circuit is:

(a) $R + X_L + X_C$ **(b)** $\sqrt{\frac{1}{X_C^2} + \frac{1}{X_L^2} + R^2}$
(c) $\sqrt{X_L^3 - X_C^2 + R^2}$ **(d)** $\sqrt{R^2 + (X_L - X_C)^2}$

19. When an alternating voltage $E = E_0 \sin \omega t$ is applied to a circuit, a current $I = I_0 \sin\left(\omega t + \frac{\pi}{2}\right)$ flows through it. The average power dissipated in the circuit is

(a) $E_{rms} \cdot I_{rms}$ **(b)** $E_0 I_0$ **(c)** $\frac{E_0 I_0}{\sqrt{2}}$ **(d)** Zero

20. A current carrying wire kept in a uniform magnetic field, will experience a maximum force when it is

(a) perpendicular to the magnetic field
(b) parallel to the magnetic field
(c) at an angle of 45° to the magnetic field
(d) at an angle of 60° to the magnetic field

21. The voltage across a resistor, an inductor, and a capacitor connected in series to an ac source are 20 V, 15 V and 30 V respectively. The resultant voltage in the circuit is

(a) 5 V **(b)** 20 V **(c)** 25 V **(d)** 65 V

22. In a dc circuit the direction of current inside the battery and outside the battery respectively are:

(a) positive to negative terminal and negative to positive terminal
(b) positive to negative terminal and positive to negative terminal
(c) negative to positive terminal and positive to negative terminal
(d) negative to positive terminal and negative to positive terminal

23. The magnitude of electric field due to a point charge $2q$, at distance r is E. Then the magnitude of electric field due to a uniformly charged thin spherical shell of radius R with total charge q at a distance $\frac{r}{2}$ $(r >> R)$ will be

(a) $\frac{E}{4}$ **(b)** 0 **(c)** 2E **(d)** 4E

24. The horizontal component of earth's magnetic field at a place is 0.2 G whereas it's total magnetic field is 0.4 G. The angle of dip at the place is

(a) 30° **(b)** 45° **(c)** 60° **(d)** 90°

25. The current in the primary coil of a pair of coils changes from 7 A to 3 A in 0.4 s. The mutual inductance between the two coils is 0.5 H. The induced emf in the secondary coil is:

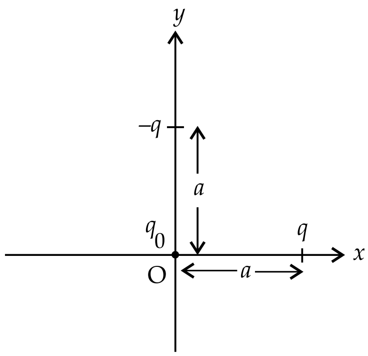
(a) 50 V **(b)** 75 V **(c)** 100 V **(d)** 220 V

SECTION-B

26. A square sheet of side 'a' is lying parallel to XY plane at $z = a$. The electric field in the region is $\vec{E} = cz^2\hat{k}$. The electric flux through the sheet is

(a) a^4c **(b)** $\frac{1}{3}a^3c$ **(c)** $\frac{1}{3}a^4c$ **(d)** 0

27. Three charges q, $-q$ and q_0 are placed as shown in figure. The magnitude of the net force on the charge q_0 at point O is $\left[k = \frac{1}{(4\pi\varepsilon_0)}\right]$



(a) 0 **(b)** $\frac{2kqq_0}{a^2}$ **(c)** $\frac{\sqrt{2}kqq_0}{a^2}$ **(d)** $\frac{1}{\sqrt{2}}\frac{kqq_0}{a^2}$

28. A + 3.0 nC charge Q is initially at rest at a distance of r_1 = 10 cm from a + 5.0 nC charge q fixed at the origin. The charge Q is moved away from q to a new position at r_2 = 15 cm. In this process work done by the field is

(a) 1.29×10^{-5} J **(b)** 3.6×10^{5} J

(c) -4.5×10^{-7} J **(d)** 4.5×10^{-7} J

29. A car battery is charged by a 12 V supply, and energy stored in it is 7.20×10^5 J. The charge passed through the battery is:

(a) 6.0×10^4 C **(b)** 5.8×10^3 J

(c) 8.64×10^6 J **(d)** 1.6×10^5 C

30. A straight conducting rod of length l and mass m is suspended in a horizontal plane by a pair of flexible strings in a magnetic field of magnitude B. To remove the tension in the supporting strings, the magnitude of the current in the wire is

(a) $\frac{mgB}{l}$ **(b)** $\frac{mgl}{B}$ **(c)** $\frac{mg}{lB}$ **(d)** $\frac{lB}{mg}$

31. A constant current is flowing through a solenoid. An iron rod is inserted in the solenoid along its axis. Which of the following quantities will not increase?

(a) The magnetic field at the centre

(b) The magnetic flux linked with the solenoid

(c) The rate of heating

(d) The self-inductance of the solenoid

32. A circuit is connected to an ac source of variable frequency. As the frequency of the source is increased, the current first increases and then decreases. Which of the following combinations of elements is likely to comprise the circuit?

(a) L, C and R **(b)** L and C

(c) L and R **(d)** R and C

33. If n, e, τ and m have their usual meanings, then the resistance of a wire of length l and cross-sectional area A is given by:

(a) $\frac{ne^2A}{2m\tau l}$ **(b)** $\frac{ml}{ne^2\tau A}$ **(c)** $\frac{m\tau A}{ne^2 l}$ **(d)** $\frac{ne^2\tau A}{2ml}$

34. A proton and an alpha particle move in circular orbits in a uniform magnetic field. Their speeds are in the ratio of 9 : 4. The ratio of radii of their circular orbits $\left(\frac{r_p}{r_\alpha}\right)$ is

(a) $\frac{3}{4}$ **(b)** $\frac{4}{3}$ **(c)** $\frac{8}{9}$ **(d)** $\frac{9}{8}$

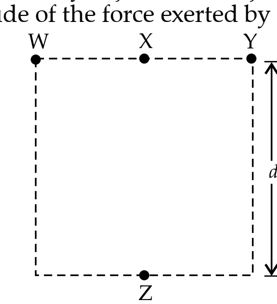
35. A coil of area 100 cm^2 is kept at an angle of 30° with a magnetic field of 10^{-1} T. The magnetic field is reduced to zero in 10^{-4} s. The induced emf in the coal is:

(a) $5\sqrt{3}$ V **(b)** $50\sqrt{3}$ V **(c)** 5.0 V **(d)** 50.0 V

36. A 15 Ω resistor, an 80 mH inductor and a capacitor of capacitance C are connected in series with a 50 Hz ac source. If the source voltage and current in the circuit are in phase, then the value of capacitance is

(a) 100 μF **(b)** 127 μF **(c)** 142 μF **(d)** 160 μF

37. Four objects W, X, Y and Z, each with charge +q are held fixed at four points of a square of side d as shown in the figure. Objects X and Z are on the midpoints of the sides of the square. The electrostatic force exerted by object W on object X is F. Then the magnitude of the force exerted by object W on Z is



(a) $\frac{F}{7}$ **(b)** $\frac{F}{5}$ **(c)** $\frac{F}{3}$ **(d)** $\frac{F}{2}$

38. Two sources of equal emf are connected in series. This combination is, in turn connected to an external resistance R. The internal resistance of two sources are r_1 and r_2 ($r_2 > r_1$). If the potential difference across the source of internal resistance r_2 is zero, then R equals to:

(a) $\frac{r_1 + r_2}{r_2 - r_1}$ **(b)** $r_2 - r_1$ **(c)** $\frac{r_1 r_2}{r_2 - r_1}$ **(d)** $\frac{r_1 + r_2}{r_1 r_2}$

39. Which of the following statements is correct?

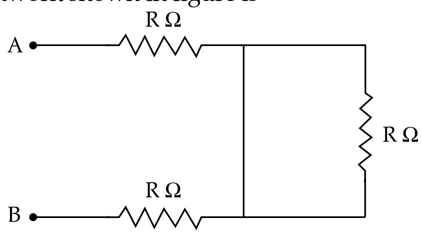
(a) Magnetic field lines do not form closed loops.

(b) Magnetic field lines start from north pole and end at south pole of a magnet.

(c) The tangent at a point on a magnetic field line represents the direction of the magnetic field at that point.

(d) Two magnetic field lines may intersect each other.

40. The equivalent resistance between A and B of the network shown in figure is



(a) 3R Ω **(b)** $\left(\frac{3}{2}\right)$R Ω **(c)** 2R Ω **(d)** $\left(\frac{2}{3}\right)$R Ω

41. A bar magnet has magnetic dipole moment $\vec{M}$. Its initial position is parallel to the direction of uniform magnetic field $\vec{B}$. In this position, the magnitudes of torque and force acting on it respectively are:

(a) 0 and MB **(b)** MB and MB

(c) 0 and 0 **(d)** $|\vec{M} \times \vec{B}|$ and 0

42. Two charges 14 µC and –4 µC are placed at (–12cm, 0, 0) and (12 cm, 0, 0) in an external electric field E $= \left(\frac{B}{r^2}\right)$, where B = 1.2 × 10^6 N/(cm^2) and r is in metres. The electrostatic potential energy of the configuration is

(a) 97.9 J **(b)** 102.1 J **(c)** 2.1 J **(d)** –97.9 J

43. A 300 Ω resistor and a capacitor of $\left(\frac{25}{\pi}\right)$ µF are connected in series to a 200 V – 50 Hz ac source. The current in the circuit is:

(a) 0.1 A **(b)** 0.4 A **(c)** 0.6 A **(d)** 0.8 A

44. The core of a transformer is laminated to reduce the effect of

(a) flux leakage **(b)** copper loss

(c) hysteresis loss **(d)** eddy current

Question No. 45 to 49 are Assertion (a) and Reason (R) type questions. Given below are the two statements labelled as Assertion (a) and Reason (R). Select the most appropriate answer from the options given below as:

(a) Both (a) & are true and (R) is correct explanation of (a).

(b) Both (a) & (R) are true, and (R) is not correct explanation of (a).

(c) (a) is true, but (R) is false.

(d) (a) is false and (R) is also false.

45. Assertion (A): A negative charge in an electric field moves along the direction of the electric field.

Reason (R): On a negative charge a force acts in the direction of the electric field.

46. Assertion (a): The poles of a bar magnet cannot be separated.

Reason (R): Magnetic monopoles do not exist.

47. Assertion (A): When radius of a current carrying loop is doubled, its magnetic moment becomes four times.

Reason (R): The magnetic moment of a current carrying loop is directly proportional to the area of the loop.

48. Assertion (A): Higher the range, lower is the resistance of an ammeter.

Reason (R): To increase the range of an ammeter additional shunt is added in series to it.

49. Assertion (A): A step-up transformer cannot be used as a step-down transformer.

Reason (R): A transformer works only in one direction.

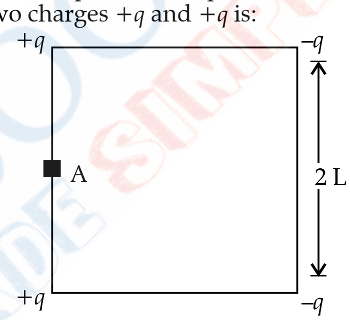
SECTION-C

50. Equipotentials at a large distance from a collection of charges whose total sum is not zero are:

(a) spheres **(b)** planes

(c) ellipsoids **(d)** paraboloids

51. Four charges $-q$, $-q$, $+q$ and $+q$ are placed at the corners of a square of side 2 L is shown in figure. The electric potential at point A midway between the two charges $+q$ and $+q$ is:



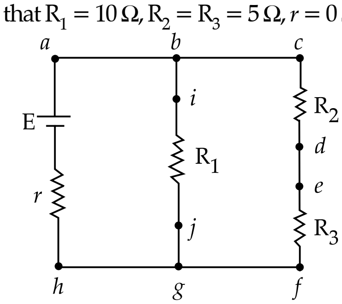
(a) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1-\frac{1}{\sqrt{5}}\right)$ **(b)** $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1+\frac{1}{\sqrt{5}}\right)$

(c) $\frac{1}{4\pi\varepsilon_0}\frac{q}{2L}\left(1-\frac{1}{\sqrt{5}}\right)$ **(d)** zero

CASE STUDY

An experiment was set up with the circuit diagram shown in figure.

Given that R_1 = 10 Ω, R_2 = R_3 = 5 Ω, r = 0 Ω and E = 5 V.



52. The points with the same potential are:

(a) *b, c, d* **(b)** *f, h, j* **(c)** *d, e, f* **(d)** *a, b, j*

53. The current through branch bg is:

(a) 1 A **(b)** $\frac{1}{3}$A **(c)** $\frac{1}{2}$A **(d)** $\frac{2}{3}$A

54. The power dissipated in R_1 is:

(a) 2 W **(b)** 2.5 W **(c)** 3 W **(d)** 4.5 W

55. The potential difference across R_3 is:

(a) 1.5 V **(b)** 2 V **(c)** 2.5 V **(d)** 3 V

❑❑❑

SOLUTIONS

SECTION-A

1. **(c)** neutral or positively charged

Explanation: X is negatively charged. Since it is repelled by Y, Y is also negatively charged. Now, if Z is neutral or positively charged then it will be attracted by Y.

2. **(b)** +6e, +6e, –7e

Explanation: When three spheres are brought in contact the net charge will be –3e + 3e + 5e = 5e
When separated this 5e charge will be distributed.
In option (A), Total charge is 6e. So, this option is not correct.
In option (B), total charge is 5e. So, this option is correct.
In option (C), Total charge is 5e. But this violates quantization of charge principle. Hence this option is not correct.
In option (D), total charge is -10e, Hence this option is not correct.
So, (B) is the correct option.

3. **(d)** +0.20 C

Explanation: Charge of 1 electron $= -1.6 \times 10^{-19}$C
So, Charge of 5×10^{18} electrons
$= -5 \times 1018 \times 1,6 \times 10^{-19}$ C $= -0.8$C
Already existing charge = 1C
So, net charge at present = 1 – 0.8 = 0.2 C

4. **(d)** conservation of charge, conservation of energy

5. **(a)** 25 W

Explanation: Resistance of the bulb = R

$$= \frac{V^2}{P}$$

$$= \frac{220^2}{100}$$

$$= 484\ \Omega$$

Power consumed by the bulb when connected to 110 V is $\frac{V^2}{R} = \frac{110^2}{484} = 25$W

6. **(c)** semiconductor

Explanation: Resistance of semiconductor decreases with rise in temperature due to rupture of covalent bonds.

7. **(b)** II

Explanation: Applying right hand thumb rule, the strongest magnetic field will be in region II.

8. **(d)** 3.2×10^{-4} N/m

Explanation: $F = \frac{\mu_0 i_1 i_2}{2\pi r}$

$$= \frac{4\pi \times 10^{-7} \times 4 \times 10}{2\pi \times 2.5 \times 10^{-2}}$$

$= 3.2 \times 10^{-4}$ N/m

9. **(a)** low resistance in parallel

Explanation: Ammeter and voltmeter are basically galvanometer.
When a high resistance is connected in series with the galvanometer it works as a voltmeter and when a low resistance is connected in parallel with the galvanometer it works as a ammeter.

10. **(a)** $2\sqrt{2}$

Explanation: Magnetic field at the centre

$$B_1 = \frac{\mu_0 i}{2R}$$

Magnetic field on the axis

$$B_2 = \frac{\mu_0 i R^2}{2(R_2 + R^2)^{3/2}}$$

$$= \frac{\mu_0 i}{2^{5/2} R}$$

$$\therefore \quad \frac{B_1}{B_2} = 2^{3/2} = 2\sqrt{2}$$

11. **(d)** 75 mH

Explanation: $L = \frac{\mu_0 N^2 A}{l}$

So, $L \propto N^2$

$\therefore$ $\frac{L_1}{L_2} = \frac{N_1^2}{N_2^2}$

Or, $\frac{108}{L_2} = \frac{600^2}{500^2}$

$\therefore$ $L_2 = 108 \times \frac{25}{36} = 75$ mH

12. **(a)** $\frac{15}{\sqrt{2}}$

Explanation: $I = I_0 \sin \omega t$

or, $I = I_{rms} \times \sqrt{2} \times \sin (2\pi f t)$

or, $I = 15 \times \sqrt{2} \times \sin\left(\frac{2 \times \pi \times 50}{600}\right)$

or, $I = 15 \times \sqrt{2} \times \sin\left(\frac{\pi}{6}\right)$

∴ $I = \frac{15}{\sqrt{2}}$

13. **(a)** only C

Explanation: Only pure C and L can provide the $\pi/2$ phase difference. But if R is also present there then the phase difference deviates from $\pi/2$.

14. **(a)** 6 V/m along $-x$-axis

Explanation: $E = \frac{-dV}{dx}$

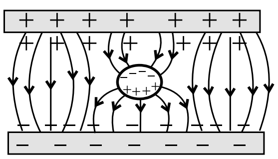
or, $E = -\frac{d}{dx}(3x^2)$

∴ $E = -6x$

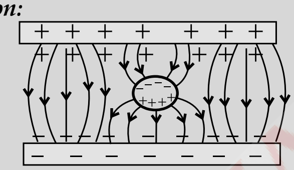
Putting $x = 1$,

$E = 6$ V/m along $-x$ direction.

15. **(d)**



Explanation:



Upper side of the neutral conductor will be negatively charged. Lower side of the neutral conductor will be positively charged. Then the field lines will be from negative to positive as shown in the diagram.

16. **(a)** 1 μF

Explanation: Energy $= \frac{1}{2} CV^2$

In 1st case: $E_1 = \frac{1}{2} \times 2 \times 10^{-6} \times 200^2$

$= 4 \times 10^{-2}$ J

In 2nd case: $E_2 = \frac{1}{2} \times (X) \times 10^{-6} \times 200^2$ J

Decrease in energy $= E_1 - E_2$

or, $2 \times 10^{-2} = 4 \times 10^{-2} - 2 \times (X) \times 10^{-2}$

or, $2 = 4 - 2X$

∴ $X = 1$ μF

17. **(a)** 1.25×10^{19}

Explanation: $I = \frac{V}{R} = \frac{200}{100} = 2$ A

Again, $I = \frac{ne}{t}$

or, $2 = ne$ (since $t = 1$ s)

or, $n = 2/e = 2/(1.6 \times 10^{-19})$

∴ $n = 1.25 \times 10^{19}$

18. **(d)** $\sqrt{R^2 + (X_L - X_C)^2}$

19. **(d)** Zero

Explanation: Power $= V_{RMS} \times I_{rms} \times \cos\phi$

Here $\phi = \frac{\pi}{2}$

So, Power $= 0$

20. **(a)** perpendicular to the magnetic field

Explanation: $F = Bil \sin\theta$

θ is the angle between the direction of current and the direction of magnetic field.

So, when $\theta = 90°$, the force is maximum.

21. **(d)** 65 V

Explanation: Resultant voltage in the circuit is the algebraic sum of all the voltages *i.e.*

20 V + 15 VB + 30 V = 65 V

22. **(c)** negative to positive terminal and positive to negative terminal

Explanation: The direction of an electric current is by convention the direction in which a positive charge would move. Thus, the current in the external circuit is directed is from positive terminal and to negative terminal of the battery.

When the battery is giving power it discharges, then the current inside the cell flows from negative terminal to positive terminal.

23. **(c)** 2E

Explanation: Electric field due to the point charge

$= E = \frac{K \times 2q}{r^2}$

Electric field due to the spherical shell

$= E' = \frac{K \times q}{(r/2)^2} = 2E$

24. **(c)** 60°

Explanation: $\cos\phi = B_H/B = 0.2/0.4 = 1/2$

∴ Angle of dip $= \phi = 60^0$

25. **(a)** 50 V

Explanation: Induced emf $= |\varepsilon| = M\frac{di}{dt}$

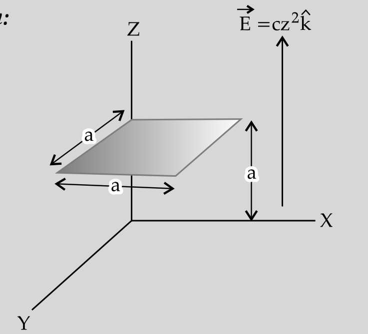
$= 0.5 \times (4/0.04)$

$= 50$V

SECTION-B

26. **(a)** a^4c

Explanation:



Flux = $\vec{E}.\vec{A}$

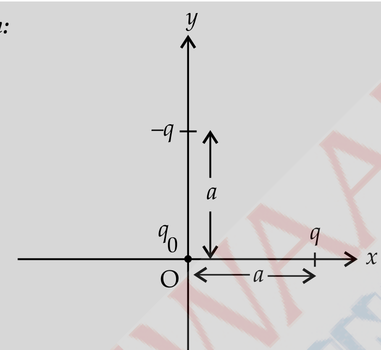
$= cz^2\hat{k}.a^2\hat{k} = cz^2a^2$

It given, $z = a$

So, putting $z^2 = a^2$

27. **(c)** $\frac{\sqrt{2}kqq_0}{a^2}$

Explanation:



Positions of q_0, $-q$ and q are shown.

Both $-q$ and q charges are equidistant from q_0.

So, the magnitude of both the forces on q_0 will be equal. The angle between the forces will be 90° as shown in the diagram.

Hence the resultant force

$= \sqrt{F^2 + F^2 + 2F \times F \times \cos 90°}$

$= \sqrt{2}F = \sqrt{2} \times \frac{kqq_0}{a^2} = \sqrt{2} \times \left(\frac{1}{4\pi\varepsilon_0}\right) \times \left(\frac{qq_0}{a^2}\right)$

28. **(d)** 4.5×10^{-7} J

Explanation: Work done $= \int_{r_1}^{r_2} \vec{F}\vec{dr} = \int_{r_1}^{r_2} \frac{kqQ}{r^2}$

$= kqQ\,[1/r_1 - 1/r_2]$

$= (8.99 \times 10^9) \times (5 \times 10^{-9}) \times (3 \times 10^{-9})\,[1/0.1 - 1/0.15]$

$= 4.5 \times 10^{-7}$ J

29. **(a)** 6.0×10^4 C

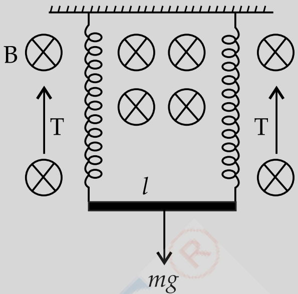
Explanation: $Q = W/V$

$= 7.2 \times 10^5/12$

$= 6 \times 10^4$ C

30. **(c)** $\frac{mg}{LB}$

Explanation:



$F = mg = T$

Magnetic force $= F_{mag} = ilB$

To remove the tension,

$T = F_{mag}$

or, $mg = ilB$

$\therefore$ $i = \frac{mg}{lB}$

To remove the tension,

$T = F_{mag}$

or, $mg = iLB$

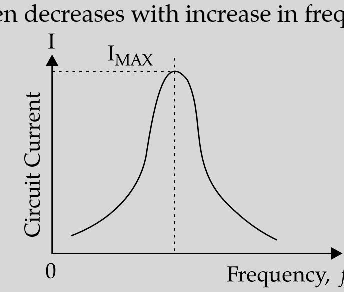
$\therefore$ $i = \frac{mg}{LB}$

31. **(c)** The rate of heating

Explanation: Since the current remains constant, the rate of heating will not increase.

32. **(a)** L, C and R

Explanation: The frequency vs. circuit current graph in a series LCR circuit is as follows, where current initially increases, reaches a maximum and then decreases with increase in frequency.



Hence, the circuit contains a combination of L, R and C.

33. **(b)** is correct.

Explanation: Drift velocity $= v_d = \frac{eV\tau}{ml}$ ...(i)

Current $= I = enAv_d$ ...(ii)

Using equations (i) and (ii)

$\frac{V}{I} = \frac{ml}{ne^2\tau A}$

When m, l, n, e, τ A are constant then

$\frac{V}{I} = R = \frac{ml}{ne^2\tau A}$

34. (d) $\frac{9}{8}$

Explanation: $r = \frac{mV}{qB}$

For proton, $rP = \frac{mV_P}{qB}$

For alpha article,

$$r_\alpha = \frac{4mV_\alpha}{2qB} = \frac{2mV_\alpha}{qB}$$

$$\therefore \quad \frac{r_P}{r_\alpha} = \frac{V_P}{2V_\alpha} = \frac{1}{2} \times \left(\frac{9}{4}\right) = \frac{9}{8}$$

35. (a) $5\sqrt{3}$ V

Explanation: Flux through the coil $\phi = BA\cos\theta$

or, $\phi = 10^{-1} \times (100 \times 10^{-4}) \times \cos 30°$

$$\therefore \quad \phi = 10^{-3} \times \sqrt{3/2} \text{ Wb}$$

Induced emf $= \varepsilon = \frac{-d\phi}{dt} = \frac{-(\phi_f - \phi_i)}{\Delta t}$

$$= \frac{-\left(0 - 10^{-3} \times \frac{\sqrt{3}}{2}\right)}{10^{-4}}$$

$$= 5\sqrt{3} \text{ V}$$

36. (b) 127 µF

Explanation: Voltage and current will be in phase when $X_C = X_L$

Or, $1/\omega C = \omega L$

Or, $1/2\pi f C = 2\pi f L$

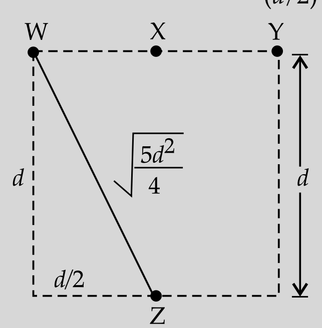
Or, $C = 1/4\pi^2 f^2 L$

Or, $C = \frac{1}{4 \times (3.14)^2 \times (50)^2 \times 80 \times 10^{-3}}$

$\therefore$ $C = 127$ µF

37. (b) $\frac{F}{5}$

Explanation: Force on X by W is $F = \frac{kq^2}{(d/2)^2} = \frac{4kq^2}{d^2}$



$$WZ = \sqrt{d^2 + (d/2)^2}$$

$$= \sqrt{\frac{5d^2}{4}}$$

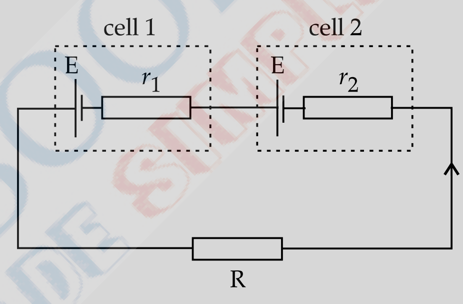
Force on Z by W is $F' = \frac{kq^2}{\frac{5d^2}{4}}$

$$= \frac{4kq^2}{5d^2}$$

$$= \frac{F}{5}$$

38. (b) $r_2 - r_1$

Explanation:



Net emf $= E_{net} = E + E = 2E$

Net resistance $= R_{net} = R + r_1 + r_2$

Current in circuit $= I = \frac{E_{net}}{R_{net}}$

$$= \frac{2E}{(R + r_1 + r_2)}$$

Since the potential difference of the cell of internal resistance r_2 is 0,

$$E - ir_2 = 0$$

or, $\frac{E - 2ER_2}{(R + R_1 + r_2)} = 0$

or, $E = \frac{2Er_2}{(R + r_1 + r_2)}$

or, $1 = \frac{2r_2}{(R + r_1 + r_2)}$

$\therefore$ $R = r_2 - r_1$

39. (c) The tangent at a point on a magnetic field line represents the direction of the magnetic field at that point.

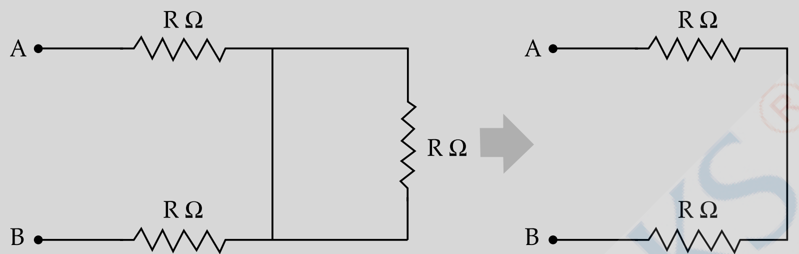
Explanation: Option (A) is wrong since magnetic field lines do form closed loop.

Option (B) is wrong since magnetic field lines do exist also from south pole to north pole inside the magnet.

Option (D) is wrong since two magnetic field lines never intersect each other.

40. **(c)** 2R Ω

Explanation: The given circuit may be further reduced as:



So, the equivalent resistance is $R + R = 2R\ \Omega$

41. **(c)** 0 and 0

Explanation: Torque $= \tau = MB\sin\theta$

Since M and B are parallel, then $\theta = 0$ and hence

$$\tau = 0.$$

Torque is 0. So, in this case force is also zero since the distance is not equal to zero.

42. **(a)** 97.9 J

Explanation: Energy $= q_1V + q_2V + kq_1q_2/r$

$$E = B/r_2$$

$$\therefore \quad V = -\int \frac{B}{r^2}dr$$

$$= B/r = 1.2 \times 10^6/r$$

Now, energy $= 14 \times 10^{-6} \times 1.2 \times 10^6/(12 \times 10^{-2}) - 4 \times 10^{-6} \times 1.2 \times 10^6/(12 \times 10^{-2}) - 9 \times 10^9 \times 14 \times 10^{-6} \times 4 \times 10^{-6}/(24 \times 10^{-2})$

$= (14 - 4) \times 1.2/(12 \times 10^{-2}) - 9 \times 56/240$

$= 100 - 2.1$

$= 97.9$ J

43. **(b)** 0.4 A

Explanation: $X_c = 1/2\pi fC$

Or, $$X_c = \frac{1}{2\pi \times 50 \times \frac{25}{\pi} \times 10^{-6}}$$

$$\therefore \quad X_c = 400\ \Omega$$

$$R = 300\ \Omega$$

$$\therefore \quad Z = \sqrt{R^2 + X_c^2}$$

$$= \sqrt{300^2 + 400^2}$$

$$= 500\ \Omega$$

$$\therefore \quad \text{Current} = V/Z = 200/500$$

$$= 0.4\ \text{A}$$

44. **(d)** eddy current

Explanation: Transformer has 4 types of losses:

(a) **Flux Leakage:** This loss is minimized by using a shell type core

(b) **Copper loss:** Thick wires with considerably low resistance are used to minimize this loss.

(c) **Hysteresis Loss:** This loss can be minimized by using a core with a material having the least hysteresis loss.

(d) **Eddy current loss:** This loss is minimized by using a laminated core. Hence this is the correct option.

45. **(d)** (A) is false and (R) is also false.

Explanation: Assertion is wrong since electron moves in opposite direction of the electric field.

Reason is also false since on negative charge force acts in the opposite direction of the electric field.

46. **(a)** Both (A) & are true and (R) is correct explanation of (A).

Explanation: Assertion is true since poles of bar magnet cannot be separated.

The reason is also true since the magnetic monopoles do not exist. The reason explains the assertions properly.

47. **(a)** Both (A) & are true and (R) is correct explanation of (A).

Explanation: Relation between current and magnetic moment of a current carrying loop is M = IA

$$A = \pi R^2$$

So, $$M \propto R^2$$

So, If the radius is doubled, the moment becomes four times. The assertion is true.

Since $M = IA$, $\therefore M \propto A$. The reason is true. Also reason is the proper explanation of the assertion.

48. **(c)** (A) is true, but (R) is false.

Explanation: $R_{sh} = \dfrac{I_m R_m}{(I - I_m)}$. So as range increases, the value of ammeter resistance decreases. Assertion is true.

To increase the range, resistance is to be lowered and to lower the resistance shunt is to be connected on parallel. Reason is false.

49. **(b)** Both (A) & (R) are true, and (R) is not correct explanation of (A).

Explanation: Step-up transformer cannot be used as a step down transformer or vice versa. The assertion is true.

So, the transformer is a uni-directional device. The reason is also true. The reson is true. But the reason does not explain the assertion.

SECTION-C

50. **(a)** spheres

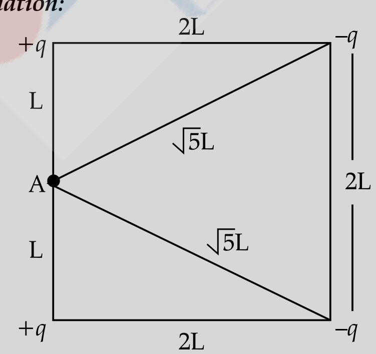
Explanation: The collection of charges, whose total sum is not zero, at great distance may be considered as a point charge.

So, potential is inversely proportional to the distance from the charge.

So, electric potentials due to point charge are the same for all equidistant points. The locus of these equidistant points, which are at same potential, is a sphere.

51. **(a)** $\dfrac{1}{4\pi\varepsilon_0} \times \dfrac{2q}{L}\left(1 - \dfrac{1}{\sqrt{5}}\right)$

Explanation:



Electric potential due to two $+q$ charges

$$= \frac{1}{4\pi\varepsilon_0} \times \frac{2q}{L}$$

Electric potential due to two - q charges

$$= \frac{1}{4\pi\varepsilon_0} \times \frac{-2q}{\sqrt{5}L}$$

Total potential at A $= \dfrac{1}{4\pi\varepsilon_0} \times \dfrac{2q}{L}\left(1 - \dfrac{1}{\sqrt{5}}\right)$

CASE STUDY

52. **(b)** *f, h, j*

Explanation: Points *h, g, f, j* are at same potential. Say V_1.

a, b , c, i are at same potential. Say V_2.

d, e are at same potential. Say V_3.

In option (A): *b, c* are at V_2 but *d* at V_3. So, this option is not correct.

In option (B): *f, h, j* are at V_1. So, this option is correct.

In option (C): *d, e* are at V_3 but *f* is at V_1. So, this option is not correct.

In option (D): *a, b* are at V_2 but *j* is at V_1. So, this option is not correct.

53. **(c)** $\dfrac{1}{2}A$

Explanation: Current through bg branch $= \dfrac{E}{R_1}$

$$= \frac{5}{10} = \frac{1}{2}A$$

54. **(b)** 2.5 W

Explanation: Power $= I^2R_1 = (1/2)^2 \times 10 = 2.5$ W

55. **(c)** 2.5 V

Explanation: Current through cf arm $= E/(R_2 + R_3)$

$= 5/10 = 0.5$ A

So, the potential difference across R_3 is IR_3

$= 0.5 \times 5 = 2.5$ V

❍❍❍

Term – I

OMR SHEET

Booklet Series

A

Use English Numbers / Letters only. Use Blue / Black Ball Point Pen to write in box.

Booklet Series

Ⓐ Ⓑ Ⓒ Ⓓ

Subject

Roll Number

0 1 2 3 4 5 6 7 8 9

Name

Test Date

Student's Signature

Invigilator's Signature

Certified that all the entries In this section have been properly filled by the student

Proper Marking

The OMR Sheet will be computer checked Fill the circles completely and dark enough for proper detection, Use ballpen (black or blue) for marking.

Avoid Improper Marking

Partially Filled

Lightly Filled

Test Center Code

0 1 2 3 4 5 6 7 8 9

IMPORTANT

The candidate should check that the Test Book Series printed on the OMR Sheet is the same as printed on the Test Booklet. In case of discrepancy, the candidate should immediately report the matter to the invigilator for replacement of both the Test Booklet and the Answer Sheet.

Darken the circle for each question.

Q.No.	Response	Q.No.	Response	Q.No.	Response	Q.No.	Response
01	Ⓐ Ⓑ Ⓒ Ⓓ	16	Ⓐ Ⓑ Ⓒ Ⓓ	31	Ⓐ Ⓑ Ⓒ Ⓓ	46	Ⓐ Ⓑ Ⓒ Ⓓ
02	Ⓐ Ⓑ Ⓒ Ⓓ	17	Ⓐ Ⓑ Ⓒ Ⓓ	32	Ⓐ Ⓑ Ⓒ Ⓓ	47	Ⓐ Ⓑ Ⓒ Ⓓ
03	Ⓐ Ⓑ Ⓒ Ⓓ	18	Ⓐ Ⓑ Ⓒ Ⓓ	33	Ⓐ Ⓑ Ⓒ Ⓓ	48	Ⓐ Ⓑ Ⓒ Ⓓ
04	Ⓐ Ⓑ Ⓒ Ⓓ	19	Ⓐ Ⓑ Ⓒ Ⓓ	34	Ⓐ Ⓑ Ⓒ Ⓓ	49	Ⓐ Ⓑ Ⓒ Ⓓ
05	Ⓐ Ⓑ Ⓒ Ⓓ	20	Ⓐ Ⓑ Ⓒ Ⓓ	35	Ⓐ Ⓑ Ⓒ Ⓓ	50	Ⓐ Ⓑ Ⓒ Ⓓ
06	Ⓐ Ⓑ Ⓒ Ⓓ	21	Ⓐ Ⓑ Ⓒ Ⓓ	36	Ⓐ Ⓑ Ⓒ Ⓓ	51	Ⓐ Ⓑ Ⓒ Ⓓ
07	Ⓐ Ⓑ Ⓒ Ⓓ	22	Ⓐ Ⓑ Ⓒ Ⓓ	37	Ⓐ Ⓑ Ⓒ Ⓓ	52	Ⓐ Ⓑ Ⓒ Ⓓ
08	Ⓐ Ⓑ Ⓒ Ⓓ	23	Ⓐ Ⓑ Ⓒ Ⓓ	38	Ⓐ Ⓑ Ⓒ Ⓓ	53	Ⓐ Ⓑ Ⓒ Ⓓ
09	Ⓐ Ⓑ Ⓒ Ⓓ	24	Ⓐ Ⓑ Ⓒ Ⓓ	39	Ⓐ Ⓑ Ⓒ Ⓓ	54	Ⓐ Ⓑ Ⓒ Ⓓ
10	Ⓐ Ⓑ Ⓒ Ⓓ	25	Ⓐ Ⓑ Ⓒ Ⓓ	40	Ⓐ Ⓑ Ⓒ Ⓓ	55	Ⓐ Ⓑ Ⓒ Ⓓ
11	Ⓐ Ⓑ Ⓒ Ⓓ	26	Ⓐ Ⓑ Ⓒ Ⓓ	41	Ⓐ Ⓑ Ⓒ Ⓓ	56	Ⓐ Ⓑ Ⓒ Ⓓ
12	Ⓐ Ⓑ Ⓒ Ⓓ	27	Ⓐ Ⓑ Ⓒ Ⓓ	42	Ⓐ Ⓑ Ⓒ Ⓓ	57	Ⓐ Ⓑ Ⓒ Ⓓ
13	Ⓐ Ⓑ Ⓒ Ⓓ	28	Ⓐ Ⓑ Ⓒ Ⓓ	43	Ⓐ Ⓑ Ⓒ Ⓓ	58	Ⓐ Ⓑ Ⓒ Ⓓ
14	Ⓐ Ⓑ Ⓒ Ⓓ	29	Ⓐ Ⓑ Ⓒ Ⓓ	44	Ⓐ Ⓑ Ⓒ Ⓓ	59	Ⓐ Ⓑ Ⓒ Ⓓ
15	Ⓐ Ⓑ Ⓒ Ⓓ	30	Ⓐ Ⓑ Ⓒ Ⓓ	45	Ⓐ Ⓑ Ⓒ Ⓓ	60	Ⓐ Ⓑ Ⓒ Ⓓ