KSEAB PYQ 2025

Physics

1. A point charge q_1 exerts a force F on another point charge q_2 when placed at a fixed distance. If another point charge q_3 is brought near q_2, the force on q_2 due to q_1 :

(A) increases
(B) decreases
(C) may increase or decrease
(D) does not change

2. Equipotential surfaces for an isolated point charge are _____ in shape.

(A) spherical (B) planar
(C) cylindrical (D) conical

3. Resistivity of a metal wire depends on its :

(A) area of cross-section
(C) material
(B) length
(D) volume

4. The following table lists magnetic fields due to different current configurations. Column - I lists the current configurations and Column - II lists expressions for magnetic fields. Symbols have usual meanings.

	Column – I		**Column - II**
I.	At a distance r from an infinitely long straight wire.	P.	$B=\mu_0 nI$
II.	At the centre of a circular current loop of radius r.	Q.	$B=\frac{\mu_0 I}{2r}$
III.	At the centre of a current carrying solenoid.	R.	$B=\frac{\mu_0 I}{2\pi r}$

Match the current configurations in Column - I with the correct magnetic field expressions in Column - II.

(A) I-P, II-Q, III-R (B) I-R, II-Q, III-P
(C) I-R, II-P, III-Q (D) I-Q, II-R, III-P

5. 'The net magnetic flux through any closed surface is zero'. This law is called

(A) Gauss' law in electrostatics
(B) Gauss' law in magnetism
(C) Ampere's circuital law
(D) Faraday's law of electromagnetic induction

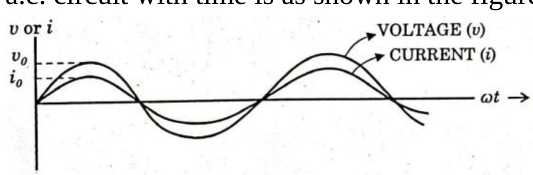
6. Consider the following statements :

Statement-1: A.C. Generator works on the principle of electromagnetic induction
Statement-2: In an A.C. Generator, as the armature is rotated in a uniform magnetic field , the magnetic flux linked with the coil changes which induces an emf in the coil.

Among the above two statements :

(A) Both Statements are true
(B) Both Statements are false
(C) Statement-1 is true and Statement-2 is false
(D) Statement-1 is false and Statement-2 is true

7. The variation of voltage and current through an a.c. circuit with time is as shown in the figure.



Along with the a.c. source, the circuit :

(A) has a series combination of resistance and capacitance
(B) has only inductance
(C) has only capacitance
(D) may have only resistance or may have a suitable series combination of inductance (L), capacitance (C) and resistance (R)

8. Transformer cores are usually laminated. This is to reduce energy loss due to

(A) flux leakage
(B) winding resistance
(C) eddy currents
(D) hysteresis

9. 'Ampere-Maxwell Law' is written as (symbols have usual meanings) :

(A) $\oint \vec{B} \cdot \vec{dl} = \mu_0 i + \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$

(B) $\oint \vec{B} \cdot \vec{dl} = \mu_0 i + \varepsilon_0 \frac{d\phi_E}{dt}$

(C) $\oint \vec{B} \cdot \vec{dl} = \mu_0 i$

(D) $\oint \vec{E} \cdot \vec{dl} = -\frac{d\phi_B}{dt}$

10. Final image of a real object formed by a compound microscope is _______ with respect to the object.

(A) real, inverted and magnified
(B) virtual, erect and magnified
(C) virtual, erect and diminished
(D) virtual, inverted and magnified

11. Which one of the following statements is WRONG about interference of light?

(A) Light waves of same wavelength coming from two independent sources can be coherent and can produce interference
(B) When the path difference between two interfering waves in $n\lambda$, bright fringe is produced (Here $n = 0, 1, 2, \dots$ and λ is the wavelength of light)
(C) When the phase difference between two interfering waves is $(2n+1)\pi$, dark fringe is produced (Here $n = 0, 1, 2, ..$)
(D) In Young's double slit experiment, dark and bright fringes are equally spaced

12. A ball is dropped from a certain height and it falls freely under gravity. During the fall, the de Broglie wavelength associated with it:

(A) keeps increasing
(B) keeps decreasing
(C) is zero
(D) may increase or decrease

13. In Rutherford's α-ray scattering experiment, α-particles of specific energy are projected towards a thin gold foil. If the impact parameter for the α-particles is zero, the angle of scattering is

(A) $\theta = 0^\circ$ (B) $\theta = 90^\circ$
(C) $\theta = 180^\circ$ (D) $\theta = 45^\circ$

14. Binding energy per nucleon of a nucleus is a measure of its

(A) radius (B) mass
(C) volume (D) stability

15. The energy gap for silicon is :

(A) 0.72 eV (B) 1.1 eV
(C) 3 eV (D) 5 eV

16. An electric dipole placed in a uniform electric field experiences a net _______ .

17. Water is an example for ____ material.

18. When a ____ rod is inserted into a coil, its self-inductance increases.

19. Polarization of light shows that light is a ____ wave.

20. Photoelectric effect is a/an ____ effect.

21. Define electric potential energy of a system of charges.
What happens to the potential energy of a system of two unlike charges when the distance between them is increased (assume there is no external electric field)?

22. List any two limitations of Ohm's law.

23. Write the expression for Lorentz force and explain the terms.

24. State Lenz's law. What is its significance?

25. Give any two uses of microwaves.

26. How are focal length (f) and radius of curvature (R) of a spherical mirror related? What is the sign of focal length of a convex mirror?

27. Mention the conditions for total internal reflection.

28. An intrinsic semi conductor crystal is doped with pentavalent atoms has an electron concentration of $5\times10^{22}\ \mathrm{m}^{-3}$. If, at thermal equilibrium, the intrinsic concentration $n_i = 1.5\times10^{16}\ \mathrm{m}^{-3}$, find the hole concentration.

29. Mention three properties of electric field lines.

30. Derive the expression for the equivalent capacitance of two capacitors connected in parallel.

31. Explain with a circuit diagram, how a galvanometer can be converted into voltmeter.

32. Define the terms :
(A) Magnetization
(B) Magnetic permeability and
(C) Magnetic susceptibility.

33. Derive the expression for motional emf induced in a rod moving in a uniform magnetic field.

34. When a light radiation of energy 3 eV falls on a metal surface, photoelectrons with a maximum kinetic energy 1 eV are emitted from the surface. Find the threshold frequency for the metal surface. (Given : Planck's constant, $h = 6.63\times10^{-34}\,\mathrm{Js}$; Charge on the electron $e = 1.6\times10^{-19}\,\mathrm{C}$).

35. State the postulates of Bohr's hydrogen atom model.

36. Write any three properties of nuclear force.

37. Derive the expression for the electric potential at a point due to a point charge.

38. Arrive at the condition for balance of a Wheatstone's network using Kirchhoff's rules.

39. Obtain the expression for the force per unit length between two infinitely long straight parallel current carrying conductors placed in vacuum. Hence define the unit 'ampere'.

40. (A) State Huygen's principle.
(B) Prove Snell's law of refraction using Huygen's principle by considering refraction of a plane wave by a surface.

41. (A) What is a rectifier?
(B) With the help of a circuit diagram, input and output waveforms, explain the working of a full wave rectifier.

42. A uniformly charged spherical shell of radius 10 cm has a surface charge density of $16\mu\ \mathrm{cm}^{-2}$. Find the electric field due to the shell at a distance of
(A) 20 cm from the centre of the shell.
(B) 5 cm from the centre of the shell.

43. Two identical cells each of emf 15 V either connected in series or connected in parallel across an external resistance of 5Ω produce the same current through the resistor.
(A) Calculate the value of internal resistance of the cell.
(B) Find the current through the external resistor in either case.

44. A series LCR circuit with $L = 0.5\mathrm{H}$ and $R = 100\Omega$ is connected to a $200\ \mathrm{V}, 50\ \mathrm{Hz}$ a.c. supply.
(A) Calculate the value of capacitance of the capacitor that drives the circuit into resonance.
(B) Find the value of voltage across the inductor at resonance.

45. An object of height 1 mm is kept perpendicular to the axis of a thin convex lens of power +10 D . The distance between the object and the lens is 15 cm . Find the position and height of the image formed.

PART - E

VII. (For Visually Challenged Students only)

7. When a.c. is passed through an a.c. circuit, it is observed that the voltage and the current are in phase. Along with the a.c. source, the circuit :

(A) has a series combination of resistance and capacitance.

(B) has only inductance.

(C) has only capacitance.

(D) may have only resistance or may have a suitable series combination of inductance (L), capacitance (C) and resistance (R).

Hint & Solution

1. (D)
does not change

2. (A)
spherical

3. (C)
material

4. (B)
(i) - (r), (ii) - (q), (iii) - (p)

5. **(B)**
Gauss' law in magnetism

6. (A)
Both statements are true

7. (D)
may have only resistance or may have a suitable series combination of inductance (L), capacitance (C) and resistance (R)

8. **(C) eddy currents**

9. **(A)**

$$\oint \vec{B} \cdot d\vec{l} = \mu_o I + \mu_o \varepsilon_o \frac{d\phi_E}{dt}$$

10

(d) virtual, inverted and magnified

11. **(A)**
Light waves of same wavelength coming from two independent sources can be coherent and can produce interference.

12. **(B)**
keeps decreasing

13. **(C)**
$\theta = 180^\circ$

14. **(D)**
stability

15. **(B)**
1.1 eV

16. TORQUE.

17. DIAMAGNETIC

18. FERROMAGNETIC

19. TRANSVERSE

20. INSTANTANEOUS

21. Electric potential energy of a system of charges is the amount of work done to assemble the system of charges bringing each charge from infinity to their respective positions. The potential energy increases.

22. **1. Ohms law is not applicable to semiconductors**
2. Ohms law is not applicable at very high and very low temeperature.

23. $\vec{F} = q\left(\vec{E} + \vec{v} \times \vec{B}\right)$

where q is the charge; $\vec{E}$ is the electric field; $\vec{B}$ is the magnetic field and $\vec{v}$ is the velocity of the charge.

24. The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it.
Lenz law gives the polarity of induced emf.

25. (1) They are used in radar systems used in aircraft navigation.
(2) They are used in speed guns.
(3) They are used in microwave ovens.
(Any two) (Any other relevant use should be considered)

26. $f = \dfrac{R}{2}$

The focal length of a convex mirror is positive.

27. (a) The light ray should be travelling from a denser medium to a rarer medium.
(b) The angle on incidence should be greater than the critical angle for the pair of media.

28. Given: $n_e = 5\times10^{22}\ \text{m}^{-3}$ and $n_i = 1.5\times10^{16}\ \text{m}^{-3}$

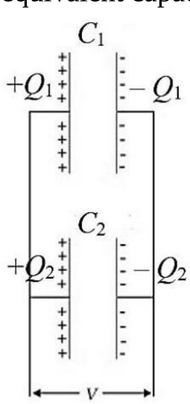
$$n_e n_h = n_i^2$$

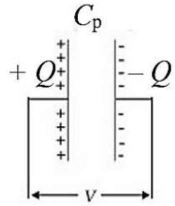
$$\Rightarrow n_h = \frac{n_i^2}{n_e} = \frac{\left(1.5\times10^{16}\right)^2}{5\times10^{22}} = 0.45\times10^{10}\ \text{m}^{-3}$$

OR $n_h = 4.5\times10^{9}\ \text{m}^{-3}$

29. (1) Field lines start from positive charges and end at negative charges.
(2) In a charge-free region, electric field lines can be taken to be continuous curves without any breaks.
(3) Two field lines can never cross each other.
(4) Electrostatic field lines do not form any closed loops.
(5) A tangent drawn to an electric field line at any point gives the direction of electric field at that point.
(6) Density of field lines is a measure of the strength of electric field. (Any three)

30. Consider two capacitors C_1 and C_2 connected in parallel across a voltage V. Let C_p be the equivalent capacitance of the combination.





For the first capacitor: $Q_1 = C_1V_1$ and for the second capacitor $Q_2 = C_2V_2$.

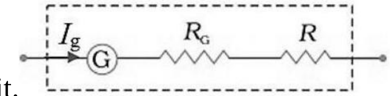
For the equivalent capacitor, $Q = C_pV$.

As the capacitors are in parallel, $Q = Q_1 + Q_2$

$$\Rightarrow C_pV = C_1V_1 + C_2V_2$$

$$\Rightarrow C_p = C_1 + C_2$$

31. A galvanometer can be converted into a voltmeter by connecting a suitable high resistance in series with it.



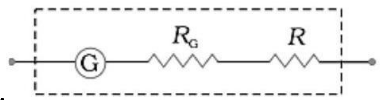
Voltmeter

The value of high resistance is: $R = \frac{V}{I_g} - R_G$

Where, V is the voltage to be measured, R_G is the resistance of the galvanometer and I_g is the maximum galvanometer current.

OR

As a voltmeter is connected in parallel with that section of the circuit it must draw a very small current.

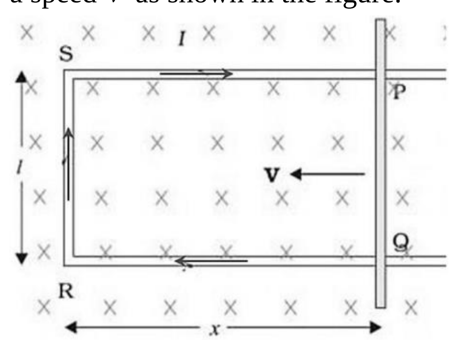


Voltmeter

Therefore, to convert a galvanometer into a voltmeter, a large resistance R is connected in series with it.

32. (a) The net magnetic moment per unit volume is called magnetization.
(b) Magnetic permeability is the ratio between magnetic field and magnetic intensity.
(c) Magnetic susceptibility is the ratio between magnetization and magnetic intensity.

33. Consider a rod PQ of length l moving perpendicular to a uniform magnetic field B with a speed v as shown in the figure.



Magnetic flux for the surface PQRS, $\phi_B = BA\cos\theta = Blx$

Induced emf in the rod: $\varepsilon = -\frac{d\phi_B}{dt}$

$$\varepsilon = -\frac{d\left(Blx\right)}{dt} = Blv$$

34. Given: $h\nu = 3\text{eV}$ and $K_{max} = 1\text{eV}$.

From Einstein's photoelectric equation:

$$\phi_o = h\nu - K_{max} = 3\text{eV} - 1\text{eV} = 2\text{eV}$$

$$\nu_o = \frac{\phi_o}{h}$$

$$= \frac{2\times1.6\times10^{-19}}{6.63\times10^{-34}} = 4.83\times10^{14}\ \text{Hz}$$

35. (1) An electron in an atom could revolve in certain stable orbits without the emission of radiant energy. These are called the stationary states of the atom.

(2) The electron revolves around the nucleus only in those orbits for which the angular momentum is some integral multiple of $h/2\pi$ where h is the Planck's constant.

OR

The angular momentum of the electron in an orbit is quantized in terms of $h/2\pi$ where h is the Planck's constant.

(3) An electron might make a transition from one of its orbits to another of lower energy. When it does so, a photon is emitted having energy equal to the energy difference between the initial and final states.

OR

When an electron makes a transition from a higher energy E_2 to a lower energy E_1, a photon is emitted whose frequency is given by: $\nu = \dfrac{E_2 - E_1}{h}$

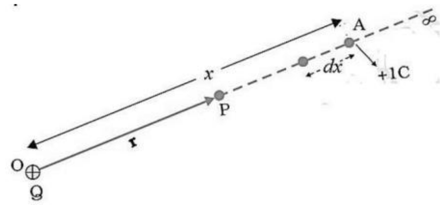
36. Write any three properties of nuclear force.

(1) It is a very strong force.
(2) It is a short-range force.
(3) It is charge independent.
(4) It shows saturation property.
(5) The force is attractive for distances larger than 0.8 fm and repulsive if they are separated by distances less than 0.8 fm .

(Any three) (Any other correct answer should be considered)

37. Let us calculate the potential due to this charge at a point P at a distance r from Q. Suppose a unit positive charge is brought radially from infinity to P.

Consider an intermediate point A at a distance x from the charge. Let the unit positive charge be displaced by a small displacement dx.



The force at this point is given by:

$$F = \frac{1}{4\pi\varepsilon_0}\frac{Q\times1}{x^2}$$

The work done to move the unit positive charge through a distance dx is:

$$dW = Fdx\cos\theta = -\frac{1}{4\pi\varepsilon_0}\frac{Q}{x^2}dx$$

Therefore, the total work done which is equal to the potential at the point is given by:

$$W = \int dW = \int_\infty^r -\frac{1}{4\pi\varepsilon_0}\frac{Q}{x^2}dx = -\frac{Q}{4\pi\varepsilon_0}\int_\infty^r \frac{1}{x^2}dx$$

$$\Rightarrow W = \frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{r} - \frac{1}{\infty}\right] = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$$

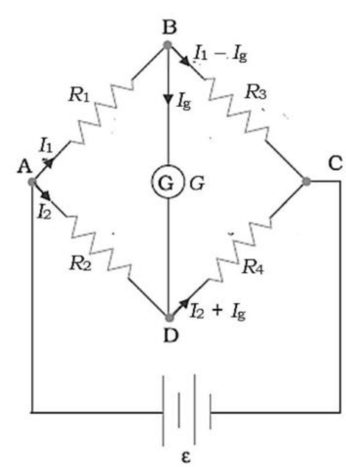
This is the work done to move the unit positive charge from infinity to point P . By definition, it is equal to the electric potential at P .

$$W = V$$

$$\therefore\quad V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$$

38.

The following circuit show a Wheatstone's network



Applying KVL to loop ABDA,

$$-I_1R_1 - I_gG + I_2R_2 = 0$$

Applying KVL to loop BCDB,

$$-\left(I_1 - I_g\right)R_3 + \left(I_2 + I_g\right)R_4 + I_gG = 0$$

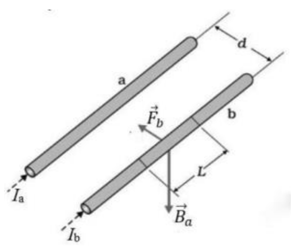
When the network is balanced, the current through the galvanometer is zero (or $I_g = 0$). Then, we have:

$$-I_1R_1 + I_2R_2 = 0 \Rightarrow I_1R_1 = I_2R_2$$
$$-I_1R_3 + I_2R_4 = 0 \Rightarrow I_1R_3 = I_2R_4$$

Dividing one question by another, we get:

$$\frac{R_1}{R_3} = \frac{R_2}{R_4}\left(\text{OR}\,\frac{R_1}{R_2} = \frac{R_3}{R_4}\right)$$

39. Consider two infinitely long straight parallel conductors a and b separated by a distance d . The current through them respectively are I_a and I_b . Let us consider a section L of the wire b .



The magnetic field due to wire a at the position of wire b is: $B_a = \dfrac{\mu_o I_a}{2\pi d}$

The force on the section of wire b due to wire a is:

$$F_b = I_bLB_a\sin\theta = \frac{\mu_o I_a I_b}{2\pi d}L$$

towards wire a.

We can see that a similar section of wire a experiences an equal and opposite force due to wire b. Therefore, $F_a = F_b = F$, the force between the wires.

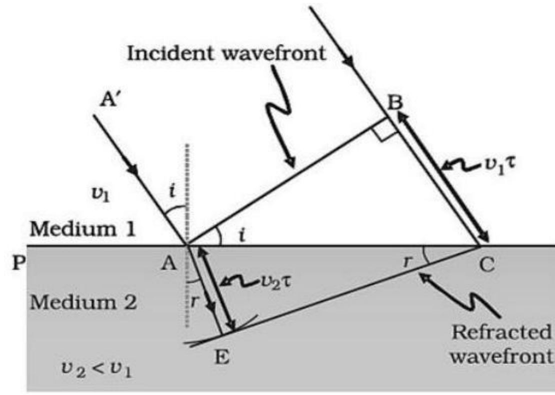
Hence, force per unit length between the wires is:

$$f = \frac{F}{L} = \frac{\mu_o I_a I_b}{2\pi d}$$

The ampere is the value of that steady current which, when maintained in each of the two very long, straight, parallel conductors of negligible cross-section, and placed one metre apart in vacuum, would produce on each of these conductors a force equal to 2×10^{-7} newtons per metre of length.

40. (a) Every point on a primary wavefront act as a source of secondary disturbance and it produces spherical secondary wavelets. A tangent surface drawn to all these secondary wavelets gives the new wavefront.

(b) Consider a plane wavefront incident AB on the interface of two media PP' as shown in the figure. The angle of incidence is i . EC is the refracted wavefront, and r is the angle of refraction.



From the figure:

$$\sin i = \frac{BC}{AC} = \frac{v_1\tau}{AC} \quad \text{and} \quad \sin r = \frac{AE}{AC} = \frac{v_2\tau}{AC}$$

$$\Rightarrow \frac{\sin i}{\sin r} = \frac{v_1}{v_2}$$

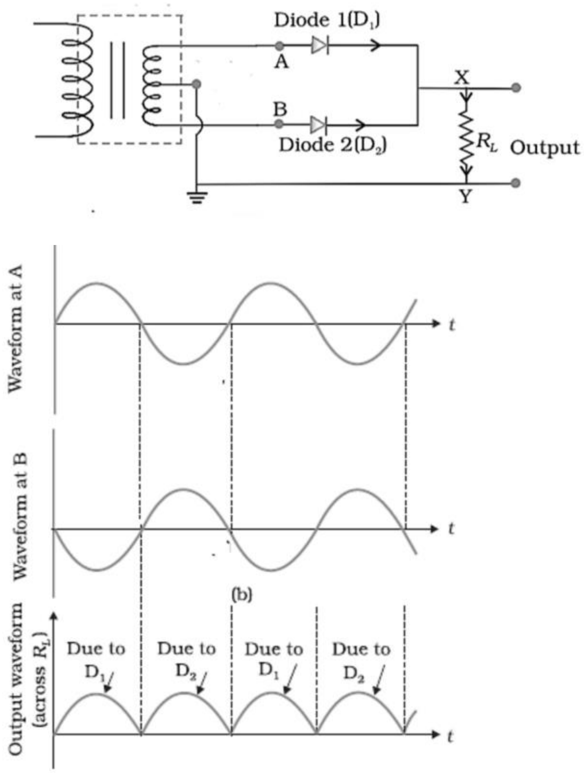
But $\dfrac{v_1}{v_2} = \dfrac{n_2}{n_1} \Rightarrow \dfrac{\sin i}{\sin r} = \dfrac{n_2}{n_1}$

41. (a) A rectifier is a device (or circuit) which converts AC into DC.

(b) The circuit for a full wave rectifier is constructed as shown in the figure.

WORKING: During positive half-cycle of AC, A becomes positive and B becomes negative. Then diode $\mathrm{D_1}$ is forward biased and it conducts; diode $\mathrm{D_2}$ is reverse biased and it does not conduct. The output due to $\mathrm{D_1}$ appears across R_L .

During negative half-cycle of AC, A becomes negative and B becomes positive. Then diode $\mathrm{D_2}$ is forward biased and it conducts; diode $\mathrm{D_1}$ is reverse biased and it does not conduct. The output due to $\mathrm{D_2}$ appears across R_L .



42. Given:

$\sigma = 16\mu\text{Cm}^{-2} = 16\times10^{-6}\text{Cm}^{-2}, R = 10\text{ cm} = 0.1\text{ m}$

Charge on the spherical shell, $Q = \sigma\times4\pi R^2$

$= \left(16\times10^{-6}\right)\times\left(4\times3.14\times(0.1)^2\right) = 2\times10^{-6}\text{C}$

(a) The electric field at a distance of 20 cm is:

$$E = \frac{1}{4\pi\varepsilon_o}\frac{Q}{r^2}$$

$$\Rightarrow E = \left(9\times10^9\right)\times\frac{2\times10^{-6}}{0.2^2}$$

$$= 4.5\times10^5\ \text{NC}^{-1}$$

Alternate Method:

Electric field: $\text{E} = \dfrac{\sigma}{\varepsilon_0}\dfrac{\text{R}^2}{\text{r}^2}$

$$= \frac{16\times10^{-6}}{8.854\times10^{-12}}\left(\frac{10}{20}\right)^2 = 0.452\times10^6\,\text{NC}^{-1}$$

OR

Given:

$\sigma = 16\mu\text{Ccm}^{-2} = 16\times10^{-2}\text{Cm}^{-2}, R = 10\text{ cm} = 0.1\text{ m}$

Charge on the spherical shell, $Q = \sigma\times4\pi R^2$

$= \left(16\times10^{-2}\right)\times\left(4\times3.14\times(0.1)^2\right) = 2\times10^{-2}C$

(a) The electric field at a distance of 20 cm is:

$$E = \frac{1}{4\pi\varepsilon_o}\frac{Q}{r^2}$$

$$\Rightarrow E = \left(9\times10^9\right)\times\frac{2\times10^{-2}}{0.2^2}$$

$$I = I_s = \frac{30}{5+2r} = \frac{30}{5+2\times5} = 2\text{A}$$

Alternate Method:

Electric field:

$$\text{E} = \frac{\sigma}{\varepsilon_0}\frac{\text{R}^2}{\text{r}^2} = \frac{16\times10^{-2}}{8.854\times10^{-12}}\left(\frac{10}{20}\right)^2 = 0.452\times10^{10}\,\text{NC}^{-1}$$

(b) A point 5 cm from the centre lies within the spherical conductor. Hence electric field is zero.

43. Given: $\varepsilon_1 = \varepsilon_2 = 15\text{ V}; R = 5\Omega; r_1 = r_2 = r; I_s = I_p$

(a) $\varepsilon_s = \varepsilon_1 + \varepsilon_2 = 30V; \varepsilon_P = \dfrac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2} = 15\text{ V}$

$$r_s = r_1 + r_2 = 2r; r_p = \frac{r_1 r_2}{r_1 + r_2} = \frac{r}{2}$$

$$I = \frac{\varepsilon}{R+r}$$

$$I_s = I_p \Rightarrow \frac{30}{5+2r} = \frac{15}{5+r/2}$$

(b) $\Rightarrow r = 5\Omega$

$$I = I_s = \frac{30}{5+2r} = \frac{30}{5+2\times5} = 2\text{A}$$

(Any other alternative method should be considered)

44. Given: $L = 0.5\text{H}; R = 100\Omega;$

$V = 200\text{ V};\ f = f_o = 50\text{ Hz}$

(a) $f_o = \dfrac{1}{2\pi\sqrt{LC}} \Rightarrow C = \dfrac{1}{4\pi^2 f_o^2 L}$

$$= \frac{1}{4\times(3.14)^2\times(50)^2\times0.5} = 20.2\times10^{-6}\text{ F}$$

(b) Current through the circuit, $I = \dfrac{V}{R} = \dfrac{200}{100} = 2\text{ A}$

Inductive reactance,

$X_L = 2\pi fL = 2\times3.14\times50\times0.5 = 157\Omega$

Voltage across inductor,

$V_L = IX_L = 2 \times 157 = 314$ V

(Any other alternative method should be considered)

45. Given: $P = +10\text{D}; u = -15$ cm; $h_\text{i} = 1$ mm

Focal length of the lens,

$$f = \frac{1}{P} = \frac{1}{10} = 0.1 \text{ m} = 10 \text{ cm}$$

Thin lens formula: $-\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

$$\Rightarrow v = \frac{uf}{u+f} = \frac{(-15) \times (10)}{(-15) + (10)} = 30 \text{ cm}$$

Height of the image, $h_i = m \times h_o = \frac{v}{u} \times h_o$

$$h_i = \frac{v}{u} \times h_o = \frac{30}{-15} \times 1 = -2 \text{ mm}$$

OR Height of the image is 2 mm.

(Any other alternative method should be considered)

PART – E

46. **(D)**

may have only resistance or may have a suitable series combination of inductance (L), capacitance (C) and resistance (R).