SAMPLE PAPER-05 (solved)
PHYSICS (Theory)
Class – XII

Time allowed: 3 hours Maximum Marks: 70

General Instructions:

a) All the questions are compulsory.
b) There are **26** questions in total.
c) Questions **1** to **5** are very short answer type questions and carry **one** mark each.
d) Questions **6** to **10** carry **two** marks each.
e) Questions **11** to **22** carry **three** marks each.
f) Questions **23** to **26** carry **five** marks each.
g) There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all three questions in five marks each. You have to attempt only one of the choices in such questions.
h) Use of calculators is **not** permitted. However, you may use log tables if necessary.
i) You may use the following values of physical constants wherever necessary:

$c = 3x10^{8} m/s$

$h = 6.63x10^{-34} Js$

$e = 1.6x10^{-19} C$

$\mu_o = 4\pi x10^{-7} TmA^{-1}$

$\frac{1}{4\pi\varepsilon_0} = 9x10^{9} Nm^2C^{-2}$

$m_e = 9.1x10^{-31} kg$

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1. A man inside an insulated metallic cage does not receive a shock when the cage is highly charged. Why?
2. Write the names of three ferromagnetic substances.
3. How X-rays are produced?
4. When light is incident on a rarer medium from a denser medium, write the relation between the critical angle and refractive indices of the two media.
5. What are the three basic units of a communication system?
6. Equipotential surfaces are perpendicular to field lies why?
7. A circular coil of 50 turns and radius 20 cm carries a current of 12 A. find the magnetic moment associated with it.
8. Find the wavelength of electromagnetic waves of frequency 5 x 10^{19} Hz in free space. Give its two applications.

9. Determine the speed of electron in the n = 3 orbit of He^+. Is the non-relativistic approximation valid?

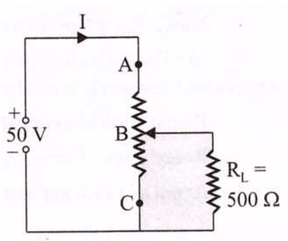
10. Why a common emitter transistor amplifier is preferred over a common base transistor amplifier?

11. A number of identical cells, n each of emf E, internal resistance r connected in series are charged by a. d.c source of emf E', using a resistor R.

   a. Draw circuit arrangement

   b. Deduce the expression for (i) the charging current and (ii) the potential difference across the combination of the cells.

12. As shown in the below figure a variable rheostat of $2k\Omega$ is used to control the potential difference across a 500 ohm load.

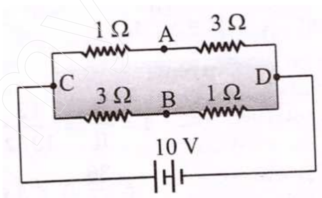


(i) If the resistance AB is $500\,\Omega$. What is the potential difference across the load?

(ii) If the load is removed, what should be the resistance of BC to get 40 volt between B and C?

Or

A battery of emf 10 V is connected to resistance as shown in the below figure. Determine the potential difference between A and B.



13. In Yong's double slit experiment, the two slits 0.15 mm apart are illuminated by monochromatic light of wavelength 450 nm. The screen is 1.0 m away from the slits.

   a. Find the distance of the second (i) bright fringe(ii) dark fringe from the central maximum

   b. How will the fringe pattern change if the screen is moved away from the slits?

14. Write the expression for the force acting on a charged particle of charge q moving with velocity $\vec{v}$ in the presence of magnetic field $\vec{B}$. Show that in the presence of this force:

a. The kinetic energy of the particle does not change.

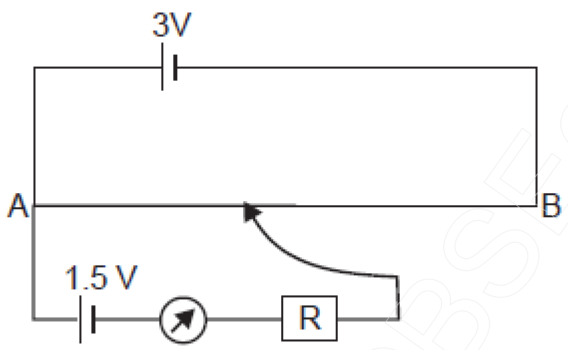
b. Its instantaneous power is zero.

15. The vertical component of the earth's magnetic field at a given place is $\sqrt{3}$ times its horizontal component. If total intensity of Earth's magnetic field at the place is 0.4 G find the value of:

a. Angle of dip.

b. The horizontal component of Earth' magnetic fleld.

16. A potentiometer wire of length 1 m is connected to a driver cell of emf 3 V as shown in the below diagram. When cell of 1.5 V emf is used in the secondary circuit, the balance point is found to be 60 cm. on replacing this cell and using a cell of unknown emf, the balance point shifts to 80 cm



a. Calculate unknown emf of the cell.

b. Explain with reason, whether the circuit works, if the driver cell is replaced with a cell of emf 1 V.

c. Does the high resistance R, used in the secondary circuit affect the balance point? Justify our answer.

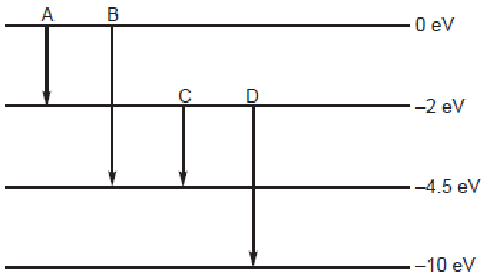
17. Prove that a convex lens produces an n times magnified image when the object distances from the lens have magnitude $\left(f \pm \frac{f}{n}\right)$. Here f is the magnitude of the focal length of the lens.

Hence find the two values of object distance for which a convex lens of power 2.5 D will produce an image that is four times as large as the object.

18. Calculate the de-Broglie wavelength of a beam of electrons, accelerated through a potential difference of 10 kV.

19.

a. The energy levels of a hypothetical hydrogen-like atom are shown below diagram. Find out the transition, from the ones shown in the diagram, which will result in the emission of a photon of wavelength 275 nm.



b. Which of these transitions corresponds to the emission of radiation of (i) maximum and (ii) minimum wavelength?

20. Draw plot of the variation of amplitude versus ω for an amplitude modulated wave. Define modulation index. State its importance for effective amplitude modulation.

21. Distinguish between nuclear fusion and fission

22. In a diode AM demodulation the output circuit consists of R = 1 $k\Omega$ and C= 10pF.a carrier signal of 100 kHz, is to be demodulated. Is the given set-up good for this purpose? If not suggest a value of C that would make the diode circuit good for demodulating this carrier signal.

23. Two students are situated in a room 10 m high, they are separated by 7 m partition wall. The students are unable to see each other even though they can converse easily. But they know that both light and sound waves can bend around the obstacles. So they were interested to know scientific cause of such phenomena. Then they went to their friend Sara who convinced them with basic facts.

a. What are the values shown by Sara

b. How did Sara convenience them such basic facts?

24.

a. Using Gauss law, derive an expression for the electric field intensity at any point outside a uniformly charged thin spherical shell of radius R and charge density

$\sigma C/m^2$. Draw the field lines when the charge density of the sphere is positive and negative.

b. A uniformly charged conducting sphere of 2.5 m in diameter has a surface charge density of $100\mu C/m^2$. Calculate the

i) Charge on the sphere

ii) Total electric flux passing through the sphere.

Or

A spherical capacitor has an inner sphere of radius 12 cm and an outer sphere of radius 13 cm. the outer sphere is earthed and the inner sphere is given a charge of 2.5μC. the space between the concentric spheres is filled with liquid of dielectric constant 32.

a. Determine the capacitance of the capacitor

b. What is the potential of the inner sphere

c. Compare the capacitance of this capacitor with that of an isolated sphere of radius 12 cm. explains why the latter is much smaller.

25. Two charges 5×10^{-8} C and -3×10^{-8} C are located 16 cm apart. At what point(s) on the line joining the two charges is the electric potential zero? Take the potential at infinity to be zero.

Or

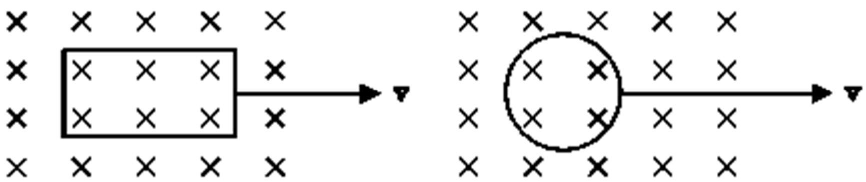
A parallel plate capacitor with air between the plates has a capacitance of 8 pF (1pF = 10^{-12}F). What will be the capacitance if the distance between the plates is reduced by half, and the space between them is filled with a substance of dielectric constant 6?

26.

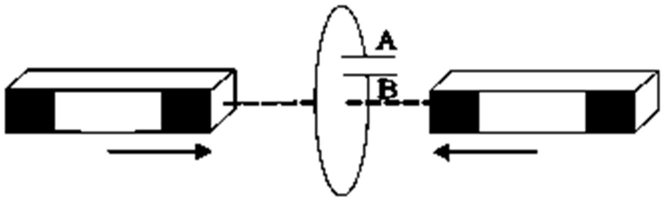
a) A closed loop is held stationary in the magnetic field between the north and south poles of two permanent magnets held fixed. Can we hope to generate current in the loop by using very strong magnets?

b) A closed loop moves normal to the constant electric field between the plates of a large capacitor. Is a current induced in the loop, (i) when it is wholly inside the region between the capacitor plates, (ii) when it is partially outside the plates of the capacitor? The electric field is normal to the plane of the loop.

c) A rectangular loop and a circular loop are moving out of a uniform magnetic field region in the figure given below to a field-free region with a constant velocity v. In which loop do you expect the induced emf to be constant during the passage out of the field region? The field is normal to the loops.

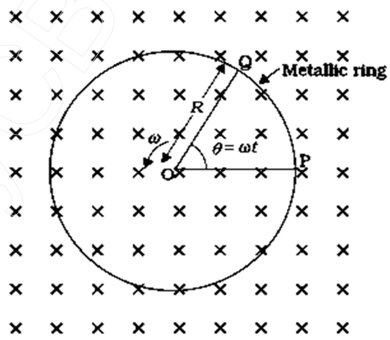


d) Predict the polarity of the capacitor in the situation described in the figure below:



Or

A metallic rod of 1 m length is rotated with a frequency of 50 rev/s, with one end hinged at the centre and the other end at the circumference of a circular metallic ring of radius 1 m, about an axis passing through the centre and perpendicular to the plane of the ring in the figure given below. A constant and uniform magnetic field of 1 T parallel to the axis is present everywhere. What is the emf between the centre and the metallic ring?



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Solutions

1. The potential in all points inside the cage is same as cage itself. Potential difference between man and cage is zero. So man does not receive shock.
2. Iron, cobalt and nickel.
3. When fastly moving electron are stopped on a metal target on higher atomic number, then X-rays are produced. The X-rays will also be produced when an electron jumps from higher orbits to a vacancy on the inner complete orbits in an atom of the element.
4. When the light travels from denser medium to rarer medium the critical angle is given by

$$\sin C = \frac{\mu_{rarer}}{\mu_{denser}} \Rightarrow {}_a\mu_r < 1$$

5. In principle, a communication system consists of the following basic units:
   a. Transmitter
   b. Communication channel
   c. Receiver
6. No work is done in moving a charge from one point on equipotential surface to the other. Therefore component of electric field intensity along the equipotential surface is zero. Hence, the surface is perpendicular to field lines.
7. Given N = 50, r = 20 cm = 0.2 m

   I = 12 A

   M = NIA $= NI\left(\pi r^2\right)$

   $$M = 50 \text{ x } 12\pi(0.2)^2 = 75.4Am^2$$

8.

$$\lambda = \frac{c}{v} = \frac{3 \text{ x } 18^8}{5 \text{ x } 10^{19}} = 6 \text{ x } 10^{-12}m$$

$$\lambda = 0.06\overset{0}{\mathrm{A}}$$

This wavelength corresponds to X-rays which are used in diagnostic tool and treatment for certain forms of cancer.

9.

$$v = \frac{nh}{mr}$$

$$r = \frac{4\pi\varepsilon_0 h^2}{Ze^2 m} n^2$$

$$v = \frac{Ze^2}{4\pi\varepsilon_0 nh}$$

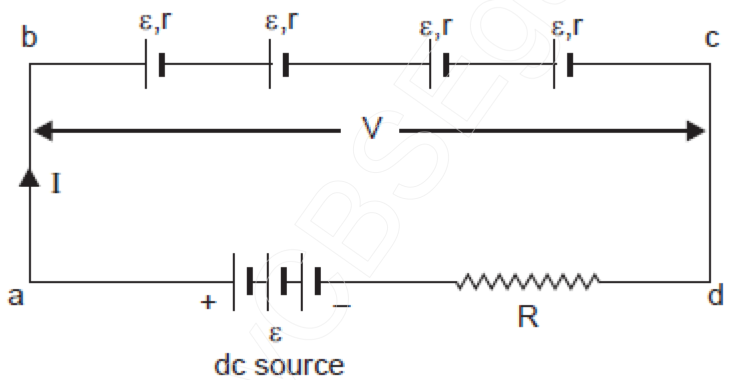
For n =3, Z = 2, $v = 1.46 \times 10^6$ m s^{-1}

$\frac{v}{c} = 0.005$ Non-relativistic approximation is valid because $\frac{v}{c} << 1$.

10. This is because the current gain of common emitter transistor amplifier is much higher as compared with that of common base transistor amplifier.

11.

a. The circuit arrangement as shown below



b. Applying Kirchhoff's second law to the circuit abcda.

$$-n\varepsilon - I(nr) - IR + \varepsilon' = 0$$

$$I = \frac{\varepsilon' - n\varepsilon}{R + nr}$$

(i) Charging current

$$I = \frac{\varepsilon' - n\varepsilon}{R + nr}$$

(ii) Potential difference across the combination V is given by

$$-V - IR + \varepsilon' = 0$$
$$V = \varepsilon' - IR$$
$$V = \varepsilon' - \frac{(\varepsilon' - n\varepsilon)}{R + nr}$$
$$V = \frac{\varepsilon'(R + nr) - \varepsilon' + n\varepsilon}{R + nr}$$
$$V = \frac{\varepsilon'(R + nr - 1) + n\varepsilon}{R + nr}$$

12. $R_{BC} = R_{AC} - R_{AB} = (2000 - 500)\Omega = 1500\Omega$

Equivalent resistance R_p of parallel combination of 1500Ω and 500Ω is

$$\frac{1500 \text{ x } 500}{1500 + 500}\Omega = 375\Omega$$

Total resistance of circuit $= (500 + 375)\Omega = 875\Omega$

Current $I = \frac{50}{875}A = \frac{2}{35}A$

(i) Potential drop across R_L is the same as the potential drop across the parallel combination.

Potential drop across R_L = 50 - V_{AB}

$$= 50 - \frac{2}{35} X 500 = 21.43V$$

(ii) After the load has been removed.

$$I' = \frac{50}{2000}A = \frac{1}{40}A$$
$$R'_{BC} = \frac{40}{1/40}\Omega = 1600\Omega$$

Or

Total resistance = $\frac{4 \text{ x } 4}{4 + 4} = 2\Omega$

Current $I = \frac{10V}{2\Omega} = 5A$

Since the resistance of both the branches is equal therefore the current of 5A shall be equally distributed.

Current through each branch $= \frac{5}{2}A = 2.5A$

$V_C - V_A = 2.5 \text{ x } 1 = 2.5$
$V_C - V_B = 2.5 \text{ x } 3 = 7.5$
$V_A - V_B = (V_C - V_B) - (V_C - V_A) = 7.5V - 2.5V = 5.0V$

13. Given d = 0.15 mm = 0.15 x 10^{-3} m

$\lambda = 450nm = 450 \text{ x } 10^{-9}m, D = 1.0m$

a. Distance of second bright maximum from central maximum (n=2)

$$y_2 = \frac{nD\lambda}{d} = \frac{2 \text{ x } 1.0 \text{ x } 450 \text{ x } 10^{-9}}{0.15 \text{ x } 10^{-3}} m = 6 \text{ x } 10^{-3} m = 6mm$$

Distance of second dark fringe from central maximum(n=2)

$$y'_2 = \left(n - \frac{1}{2}\right)\frac{D\lambda}{2} = \left(2 - \frac{1}{2}\right)\frac{1.0 \text{ x } 450 \text{ x } 10^{-9}}{0.15 \text{ x } 10^{-3}} m$$
$$= 4.5 \text{ x } 10^{-3} m = 4.5mm$$

b. If screen is moved away from the slits, D increases, so fringe width $\beta = \frac{D\lambda}{d}$ increases.

14. $\vec{F} = q(\vec{v} \text{ x } \vec{B})$

a. Force acts in a direction normal to the velocity vector. Thus work done by the force is zero and kinetic energy remains same.

b. We know that $P = \vec{F}.\vec{v}$

$P = Fv\cos\theta$

At any instant of time force and velocity vector are mutually perpendicular (θ=90^0). So the instantaneous power is zero.

15. Given

$V = \sqrt{3}H$

Total intensity of earth's magnetic field = 0.4 G

$B_e = \sqrt{V^2 + H^2}$
$0.4 = \sqrt{(\sqrt{3}H)^2 + H^2}$
$0.4 = \sqrt{3H^2 + H^2}$
$0.4 = 2H$
$H = 0.2G$
$V = \sqrt{3} \text{ x } 0.2\text{G}$

a. Angle of dip

$$\delta = \tan^{-1}\left(\frac{V}{H}\right)$$

$$\delta = \tan^{-1}\left(\frac{\sqrt{3}H}{H}\right) = \tan^{-1}(\sqrt{3})$$

$$\delta = 60^0$$

b. The horizontal component of earth's magnetic field H = 0.2 G

16. As

a. Unknown emf ε_2 is given by

$$\frac{\varepsilon_2}{\varepsilon_1} = \frac{l_2}{l_1} \Rightarrow \varepsilon_2 = \frac{l_2}{l_1}\varepsilon_1$$

Given $\varepsilon_1 = 1.5V, l_1 = 60cm, l_2 = 80cm$

$$\therefore \varepsilon_2 = \frac{80}{60} \text{ x } 1.5\text{V} = 2.0\text{V}$$

b. The circuit will not work if emf of driver cell is 1 V(less than that of cell in secondary circuit), because total voltage across wire AB is 1 V which cannot balance the voltage 1.5 V.

c. No, since at balance point no current flows through galvanometer G cell remains in open circuit.

17.

$$m = \frac{f}{u+f}$$

When image is real, m = – *n*.

$$\therefore \; -n = \frac{f}{u+f} \;\; or \;\; u+f = -\frac{f}{n} \;\; or \;\; u = -\left(f + \frac{f}{n}\right) \;....(i)$$

When image is virtual, *m* = *n*.

$$\therefore \; n = \frac{f}{u+f} \;\; or \;\; u+f = -\frac{f}{n} \;\; or \;\; u = -\left(f - \frac{f}{n}\right) \;....(ii)$$

It follows from (i) and (ii) that the magnitude of the object distance is $\left(f \pm \frac{f}{n}\right)$.

Focal length of lens = $\frac{1}{2.5}m = \frac{1}{2.5} \times 100 \; cm$

Now, $\pm 4 = \frac{40}{u+40}$

u = – 30 cm or – 50 cm

18. The de-Broglie wavelength λ of electron

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mK}}$$

(Since k=eV and K = $\frac{1}{2}mv^2 = \frac{p^2}{2m'}$ $p = \sqrt{2mK} = \sqrt{2meV}$)

$$\lambda = \frac{h}{\sqrt{2meV}}$$

Putting values of h, m and e we get

$$\lambda = \frac{6.626 \text{ x } 10^{-34}}{\sqrt{2 \text{ x } 9.1 \text{ x } 10^{-31} \text{ x } 1.6 \text{ x } 10^{-19} \text{ x V}}}$$

$$\lambda = \frac{1.227}{\sqrt{V}}$$

Given V = 10 kV = 10 x 10^3 V = 10^4 V

$$\lambda = \frac{1.227}{\sqrt{10^4}} = \frac{1.227}{100} = 0.01227nm$$

$\lambda = 0.01227 \text{ x } 10^{-9}$ m = $0.1227 \text{ x } 10^{-10}$ m

19.

a. The energy of photon of wavelength (275 nm) in terms of eV can be given as

$$E = \left(\frac{\lambda c}{e\lambda}\right) eV$$

$$E = \frac{6.6 \text{ x } 10^{-34} \text{ x } 10^8}{1.6 \text{ x } 10^{-19} \text{ x } 275 \text{ x } 10^{-9}}$$

$$E = \frac{19.8}{1.6 \text{ x } 275} \text{ x } 10^2 eV = 435eV$$

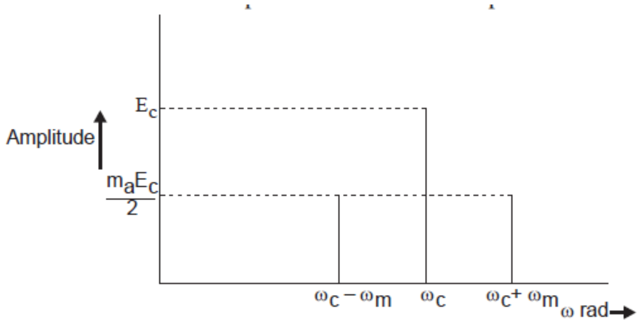
The energy of photon in transition $B \Delta E = [0eV - (-4.5eV)] = 4.5eV$. Hence transition B is possible.

b. The wavelength of the photon in a transition is given by $\lambda = \frac{\lambda c}{\Delta E}$

(i) Maximum wavelength of photon is possible for transition having minimum ΔE, so transition ‘A’ is possible with ΔE = 2eV.

(ii) Minimum wavelength of the photon is possible for transition having maximum energy difference. So transition D is possible with ΔE =10eV.

20. Plot of variation of amplitude versus ω for amplitude modulated wave is shown below.



Modulation Index – the ratio of amplitude of modulating signal to the amplitude of carrier wave is called modulation index.

$$m_a = \frac{E_m}{E_c}$$

For effective amplitude modulation index determines the distortions, so its value is kept < 1 for avoiding distortions.

21.

S.No	Nuclear Fission	Nuclear Fusion
1	It's a process in which a heavy unstable nucleus disintegrates into two or more lighter and relatively stable nuclei.	It's a process in which two small, lighter nuclei combine to form stable heavy nucleus.
2	The product of nuclear fission is radioactive in nature	The product is stable and non-radioactive in nature.
3	It can be controlled and hence can be used for peaceful purposes.	It is yet to be controlled.

22. Given

R = 1 $k\Omega$ = 10^3 Ω

C = 10pF = 10 x 10^{-12} F = 10^{-11} F

RC = 10^3 x 10^{-11} s = 10^{-8} s

We find that $\frac{1}{f_c}$ is not less than RS as is required for demodulation. Therefore, the arrangement is not good.

For satisfactory arrangement, let us try

$C = 1\mu F = 10^{-6} F$

$\therefore RC = 10^3 \text{ x } 10^{-6} s = 10^{-3} s$

Now $\frac{1}{f_c} (= 10^{-5} s) << RC (= 10^{-3} s)$

The condition is satisfied. This is good enough for demodulation.

23.

a. The values shown by Sara are

i) High degree of general awareness.

ii) Ability to convince someone

iii) Thinking skills

iv) Concern for her friends.

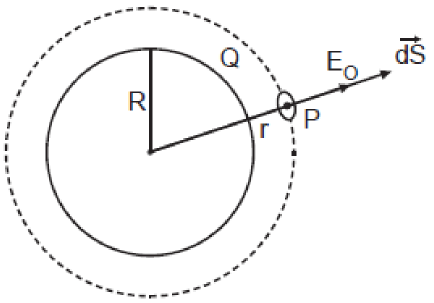
b. The size of the obstacle should be comparable to the wavelength of the light wave in order to obtain an observable diffraction pattern. Size of the wall is 7 m, which is comparable enough with sound wave but not with the light wave. so the two students cannot see each other but can talk to each other.

24.

a. Electric field intensity at a point outside a uniformly charged thin spherical shell- consider a uniformly charged thin spherical shell of radius R carrying charge Q. to find the electric field outside the shell, we consider a spherical Gaussian surface of radius (>R), Concentric with given shell. If $\vec{E}$ is electric field outside the shell, then by symmetry electric field strength has same magnitude E_0 on the Gaussian surface and is directed radially outward. Also the directions of normal at each point is radially outward, so angle between $\vec{E_i}$ *and* d$\vec{S}$ is zero at each point. Hence, electric flux through Gaussian surface will be,

$$\oint S \vec{E}.d\vec{S}$$

$$\oint E_0 dS \cos 0 = E_o.4\pi r^2$$



Now Gaussian surface is outside the given charged shell, so charge enclosed by bGaussian surface Q. hence Gaus theoerm

$$\oint \overrightarrow{E_o}.d\vec{E} = \frac{1}{\varepsilon_o} \text{ x charged enclosed}$$

$$E_0 4\pi r^2 = \frac{1}{\varepsilon_0} \text{ x Q}$$

$$\text{E}_0 = \frac{1}{4\pi\varepsilon_o}\frac{Q}{r^2}$$

Thus electric field outside a charged thin spherical shell is the same as if the whole charge Q is concentrated at the centre.

If σ is the surface charge density of the spherical shell then,

$$\phi = 4\pi R^2 \sigma C$$

$$E_0 = \frac{1}{4\pi\varepsilon_0}\frac{4\pi R^2\sigma}{r^2} = \frac{R^2\sigma}{\varepsilon_0 r^2}$$

b. Given

$\sigma = 100\mu C/m^2 = 100 \text{ x } 10^{-6} C/m^2$

Diameter D = 2 R = 2.5 m

i) Charge on sphere Q = $\sigma.4\pi R^2 = \sigma.\pi(2R)^2$

$$= (100 \text{ x } 10^{-6} C/m^2) \text{ x } 3.14 \text{ x } (2.5 \text{ m})^2$$

$$= 19.625 \text{ x } 10^{-4} C$$

$$= 1.96 mC$$

ii) Electric flux passing through the sphere

$$\phi = \frac{1}{\varepsilon_0}(Q) = \frac{1}{8.86 \text{ x } 10^{-12}} \text{ x } (1.96 \text{ x } 10^{-3})$$

$$= 2.21 \text{ x } 10^{8} Nm^2C^{-1}$$

Or

Radius of the inner sphere r_2 = 12cm = 0.12m

Radius of the outer sphere r_1 – 13 cm = 0.13 m

Charge on the inner sphere q = 2.5μC = 2.5 x 10^{-6}C

Dielectric constant of a liquid ε_r = 32

(a) Capacitance of the capacitor is given by the relation

$$C = \frac{4\pi\varepsilon_0\varepsilon_1 r_1 r_2}{r_1 - r_2}$$

Where ε0 = permittivity of the free space = 8.85 x 10^{-12} C^2 N^{-1} m^{-2}

$$\frac{1}{4\pi\varepsilon_0} = 9x10^9 \, Nm^2C^{-2}$$

$$C = \frac{32 \text{ x } 0.12 \text{ x } 0.13}{9 \text{ x } 10^9 \text{x } (0.13 - 0.12)}$$

$$C = 5.5x10^9 F$$

Hence the capacitance of the capacitor is approximately 5.5 x 10^{-9} F

(b) Potential of the inner sphere is given by

$$r = \frac{q}{C}$$

$$r = \frac{2.5 \text{ x } 10^{-6}}{5.5 \text{ x } 10^{9}} = 4.5 \text{ x } 10^2 \text{V}$$

Hence, the potential of the inner sphere is 4.5 x 10^2V.

(c) Radius of an isolated sphere r = 12 x 10^{-2}m

Capacitance of the sphere is given by the reaction,

$C' = 4\pi\varepsilon_0 r$

$= 4\pi \text{ x } 8.85 \text{ x } 10^{-12} \text{ x } 12 \text{ x} 10^{-12}$

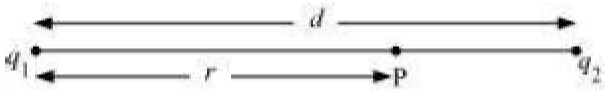
$= 1.33 \text{ x } 10^{-11}$F

The capacitance of the isolated sphere is less in comparison to the concentric spheres. This is because the outer sphere of the concentric spheres is earthed. Hence the potential difference is less and the capacitance is more than the isolated sphere.

25. There are two charges, $q_1 = 5 \times 10^{-8}$ C and $q_2 = -3 \times 10^{-8}$ C

Since between the two charges, d = 16 cm = 0.16 m.

Consider a point P on the line joining the two charges, as shown in the given figure.



Distance of point P from charge q_1 = r

Let the electric potential (V) at point P be zero.

Potential at point P is the sum of potentials caused by charges q_1 and q_2 respectively.

$$V = \frac{q_1}{4\pi\varepsilon_0 r} + \frac{q_2}{4\pi\varepsilon_0 (d-r)} ----------(1)$$

Where ε_0 = permittivity of free space. For V =0 , equation (1) reduces to

$$\frac{q_1}{4\pi\varepsilon_0 r} = -\frac{q_2}{4\pi\varepsilon_0 (d-r)}$$

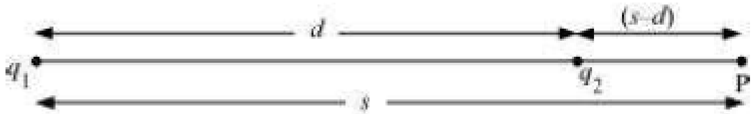
$$\frac{q_1}{r} = -\frac{q_2}{d - r}$$

Substituting the values, we get

R = 0.1 m = 10 cm

Therefore the potential is zero at distance of 10 cm from the positive charge between the charges.

Suppose point P is outside the system of two charges at a distance s from the negative charge, where potential is zero as shown in the figure.



For this arrangement, potential is given by

$$V = \frac{q_1}{4\pi\varepsilon_0 s} + \frac{q_2}{4\pi\varepsilon_0 (s - d)} ----------(2)$$

For V =0, equation (ii) reduce to,

$$\frac{q_1}{s} = -\frac{q_2}{(s - d)}$$

Substituting the values, we get

s = 0.4 m = 40 cm

Therefore, potential is zero at a distance of 40cm from the positive charge outside the system of charges.

Or

Capacitance between the parallel plates of the capacitor C = 8 pF

Initially distance between the parallel plates was d and it was filled with air. Dielectric constant of air k=1,

Capacitance C is given by formula

$$C = \frac{k\varepsilon_0 A}{d} = \frac{\varepsilon_0 A}{d} \text{-------------- (1)}$$

Where A = area of each plate and ε_0 = permittivity of free space.

If the distance between the plates is reduced to half, then new distance d′ = d/2

Dielectric constant of the substance filled in between the plates k′ = 6

$$C = \frac{k'\varepsilon_0 A}{d'} = \frac{6\varepsilon_0 A}{\frac{d}{2}} \text{-------------- (2)}$$

Taking ratios of equation (i) and (ii) we obtain

C′ = 2 x 6C

= 12 C

= 12 x 8 = 96 pF

Therefore, the capacitance between the plates is 96pF.

26.

a. No. However strong the magnet may be, current can be induced only by changing the magnetic flux through the loop.

b. No current is induced in either case. Current cannot be induced by changing the electric flux.

c. The induced emf is expected to be constant only in the case of the rectangular loop. In the case of circular loop, the rate of change of area of the loop during its passage out of the field region is not constant; hence induced emf will vary accordingly.

d. The polarity of plate ‘A’ will be positive with respect to plate ‘B’ in the capacitor.

Or

As the rod is rotated, free electrons in the rod move towards the outer end due to Lorentz force and get distributed over the ring. Thus, the resulting separation of charges produces an emf across the ends of the rod. At a certain value of emf, there is no more flow of electrons and a steady state is reached. We know that, the magnitude of the emf generated across a length d*r* of the rod as it moves at right angles to the magnetic field is given by,

Dε = Bvdr, hence

$$\varepsilon = \int d\varepsilon = \int_0^R Bv\,dr = \int_0^R B\omega r\,dr = \frac{B\omega R^2}{2}$$

Substituting the value, we get 157 V.