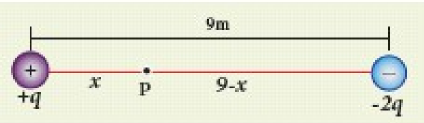
Unit 1 to 5 Five Marks Question With Answer

12th Standard

Physics

1) Consider a point charge +q placed at the origin and another point charge -2q placed at a distance of 9 m from the charge +q. Determine the point between the two charges at which electric potential is zero.
Answer : According to the superposition principle, the total electric potential at a point is equal to the sum of the potentials due to each charge at that point.
Consider the point at which the total potential zero is located at a distance x from the charge +q as shown in the figure.

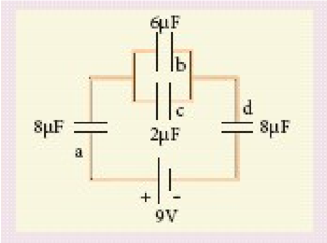


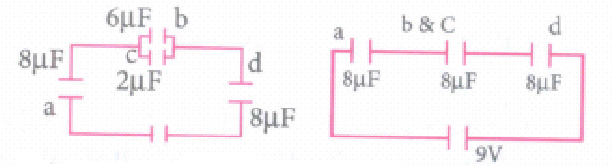
The total electric potential at P is zero.
Vtot = $\frac{1}{4\pi\varepsilon_0}\left(\frac{q}{x}-\frac{2q}{(9-x)}\right)$=0
Which gives $\frac{q}{x}-\frac{2q}{(9-x)}$
or $\frac{1}{x}=\frac{2}{(9-x)}$
Hence, x=3m

2) A parallel plate capacitor has square plates of side 5 cm and separated by a distance of 1 mm.
(a) Calculate the capacitance of this capacitor.
(b) If a 10 V battery is connected to the capacitor, what is the charge stored in any one of the plates? (The value of ε_o = 8.85 x 10^{-12} Nm^2 C^{-2})
Answer : (a) The capacitance of the capacitor is
C= $\frac{\varepsilon_0 A}{d}=\frac{8.85\times10^{-12}\times25\times10^{-4}}{1\times10^{-3}}$
=221.2 x 10^{-13} F
C=22.12 x 10^{-12}F = 22.12pF
(b) The charge stored in any one of the plates is Q = CV, Then
Q=22.12 x 10^{-12} x 10 =221.2 x 10^{-12}C=221.2 pC

3) For the given capacitor configuration
(a) Find the charges on each capacitor
(b) potential difference across them

(c) energy stored in each capacitor



Answer : 

B & C are parallel so C = (6 +2) μF= 8μF Now all a, b & c, d are in series.

Effectivecapacitance $\frac{1}{C_s} = \frac{1}{8} + \frac{1}{8} + \frac{1}{8} = \frac{3}{8} \quad \therefore C_s = \frac{8}{3}$

a. Charges on each capacitor:

Total charges on capacitor = q = C.

V=$\frac{1}{8}$x9x10-6=24μ=C

Charge on capacitor a = q_a = C.V.

q_a = 24μC

In case of capacitor in series the charge flowing through capacitor is same.

q_a=q_d=24μC

But across b & c, the charge is not same total are in parallel.

Charge on b=qb=$\frac{6}{3}$x9x10^{-6}

=18μC

Charge on c= qc=$\frac{2}{3}$x9x10^{-6}

=6μC

b. Potential difference across capacitor a

$V_a = \frac{q_a}{C_a} = \frac{24\times10^{-6}}{8\times10^{-6}} = 3V$

Potential difference across capacitor b

$V_b = \frac{q_b}{C_b} = \frac{18\times10^{-6}}{6\times10^{-6}} = 3V$

Potential difference across capacitor c

$V_c = \frac{q_c}{C_c} = \frac{6\times10^{-6}}{2\times10^{-6}} = 3V$

Potential difference across capacitor d

$V_d = \frac{q_d}{C_d} = \frac{24\times10^{-6}}{8\times10^{-6}} = 3V$

c. Energy stored in a Ua U_a=$\frac{1}{2}$$CV^2$

U_a=$\frac{1}{2}$x8 X 10-6 X 3 X 3 = 36 μJ

Energy stored in b

U_b=$\frac{1}{2}$x6 X 3 X 3 X 10^{-6}= 27 μJ

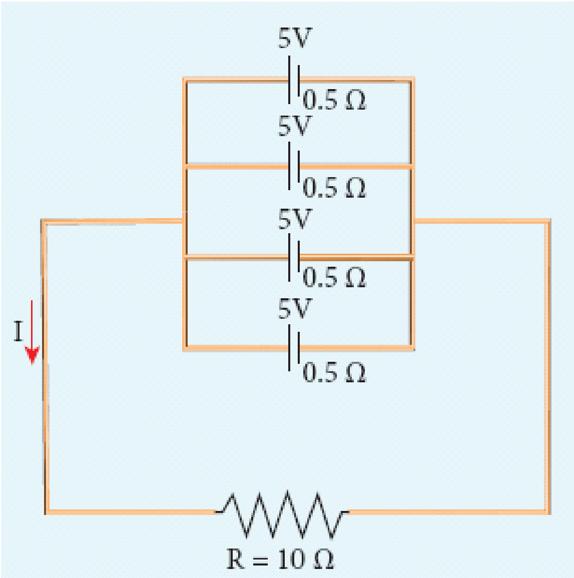
[C_b=6μF]

Energy stored in c

U_c=$\frac{1}{2}$x2 x 3 x 3 X 10-6= 9 μJ

[C_c=2μF]

4) From the given circuit



Find

i) Equivalent emf

ii) Equivalent internal resistance

iii) Total current (I)

iv) Potential difference across each cell

v) Current from each cell

Answer : i) Equivalent emf ξ_{eq} = 5 V

ii) Equivalent internal resistance,

$R_{eq} = \frac{r}{n} = \frac{0.5}{4} = 0.125\Omega$

iii) total current, $I = \frac{\xi}{R_5 + \frac{r}{n}}$

$I = \frac{5}{10+0.125} = \frac{5}{10.125}$

I ≈ 0.5 A

iv) Potential difference across each cell

V = IR = 0.5 × 10 = 5 V

v) Current from each cell, $I' = \frac{I}{n}$

$I' = \frac{0.5}{4} = 0.125A$

5) Find the heat energy produced in a resistance of 10 Ω when 5 A current flows through it for 5 minutes.

Answer : R = 10 Ω, I = 5 A, t = 5 minutes = 5 × 60 s

H = I^2 R t

= 5^2 × 10 × 5 × 60

= 25 × 10 × 300

= 25 × 3000

= 75000 J (or) 75 kJ

6) A potentiometer wire has a length of 4 m and resistance of 20 Ω. It is connected in series with resistance of 2980 Ω and a cell of emf 4 V. Calculate the potential along the wire.

Answer : :The length of the potential wire 1= 4 m

Resistors of the potential $r = 20\Omega$
Resistor connected $R = 2980\Omega$
emf of the cell E =4V
To find:
potential along wire V = ?
Effective resistor = r & R are connected in series
= 2980 + 20 = (r +R)
= 3000Ω
Current flowing through the wire $I = \frac{\xi}{R}$

$$I = \frac{4}{3000}$$

Potential drop acress the wire V = I x r

$$V = \frac{4}{3000} \times 20 = \frac{8}{300} volt$$

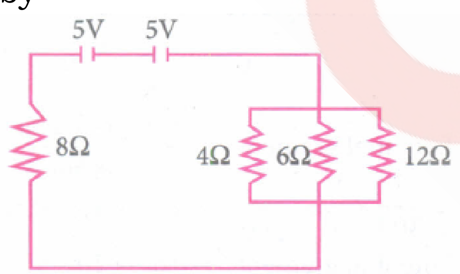
$$Potentialgradient = \frac{Potential \quad drop}{length} \frac{V}{l}$$

= $\frac{8}{300} \times \frac{1}{4} = \frac{2}{300} = 0.66 \times 10^{-2} V m^{-1}$

Potential gradient = 0.66 x 10^{-2}V m^{-1}

7) Two cells each of 5V are connected in series across a 8 Ω resistor and three parallel resistors of 4 Ω, 6 Ω and 12 Ω. Draw a circuit diagram for the above arrangement. Calculate i) the current drawn from the cell (ii) current through each resistor

Answer : Equivalent resistors of R'of 4, 6. 12 resistors connected in parallel is given by



$$\frac{1}{R'} = \frac{1}{4} + \frac{1}{6} + \frac{1}{12}$$

Resistor of parallel combination R'=2Ω
Total resistor i.e.8Ω is connected in series with R'

$R_S = 8 + R'$
$R_2 = 8 + 2 = 10\Omega$
$\therefore R_S = 10\Omega$

Net voltage (emf) V = 10 [$\because$ cells are connected in series total emf $\varepsilon + \varepsilon = 2\varepsilon$
Circuit in through circuit $I = \frac{V}{R}$ (from ohm's law)

$I = \frac{10}{10}; I = 1A$

So the circuit through each cell and 80 resistor is lA.

Potential drop across the parallel combination of three resistors is V' = I R' = 1 x 2 = 2 V

$\therefore$ Current in 4 Ω resistor $I = \frac{2}{4} = 0.5A \left[I = \frac{V}{R}\right]$

Current in 6 Ω resistor, $I = \frac{2}{6} = 0.33A$

Current in12 resistor, $I = \frac{2}{12} = \frac{1}{6} = 0.17A$

8) An electron moving perpendicular to a uniform magnetic field 0.500 T undergoes circular motion of radius 2.80 mm. What is the speed of electron?

Answer : Charge of an electron q = -1.60×10^{-19} C $\Rightarrow |q| = 1.60 \times 10^{-19} c$

Magnitude of magnetic field B = 0.500 T

Mass of the electron, m = 9.11×10^{-31} kg

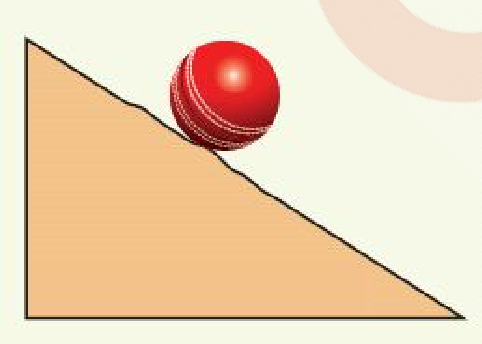
Radius of the orbit, r = 2.50 mm = 2.50×10^{-3} m

Velocity of the electron,v =$|q| \frac{rB}{m}$

v=1.60x10-19=$\frac{2.50\times10^{-3}\times0.500}{9.11\times10^{-31}}$

v=$2.195\times10^{8}ms^{-1}$

9) mass of 100 g and radius 20 cm. A flat compact coil of wire with turns 5 is wrapped tightly around it with each turns concentric with the sphere. This sphere is placed on an inclined plane such that plane of coil is parallel to the inclined plane. A uniform magnetic field of 0.5 T exists in the region in vertically upward direction. Compute the current I required to rest the sphere in equilibrium.



Answer : The sphere is in translational equilibrium, thus

f_s - mg sinθ = 0 ...(1)

The sphere is in rotational equilibrium. If torques are taken about the centre of the sphere, the magnetic field produces a clockwise torque of magnitude

i.e τ =mB sinθ [μ=NIA]

The frictional force (f_s) produces a anticlockwise torque of magnitude τ = f_sR, where R is the radius of the sphere. Thus

fsR - mB sinθ =0 ......(2)

From (1) and (2) [i.e f_s = mg sinθ substituting in (2)] mg sinθ R - μB sinθ mg R =μB

Substituting μ

mgR =NIAB

I=$\frac{mgR}{NBA}$ [where A is the area of the sphere A=πR2]

∴ I =$\frac{mg}{\pi RBN}$

Given:

mass ofthe sphere μ = 100g = 100 x 10^{-3} kg

Radius of the sphere R = 20 cm = 20 x 10^{-2}m

No. of turns of wire wrapped N = 5

Magnetic field B = 0.5 T

Current required to rest the sphere in equilibrium

$$I = \frac{100\times10^{-3}\times10^{2}}{\pi\times5\times20\times10^{-2}\times0.5}$$

I=$\frac{2}{\pi}$.

10) A coil of 200 turns carries a current of 4 A. If the magnetic flux through the coil is 6 x 10^{-5} Wb, find the magnetic energy stored in the medium surrounding the coil.

Answer : Given: No. of turns of coil N= 200

Current passing through coil I = 4A

Magnetic flux through coil Φ= 6 x 10^{-5} Wb

To find:

Magnetic energy stored in the medium surrounding the coil = $\frac{1}{2}LI^2$

Self inductance L =$\frac{N\Phi}{I}$

Solution:

∴ energy UB =$\frac{1}{2}$.NΦ.I

=$\frac{1}{2}$ x 200 x 6 x 10^{-5} x 4

=24 x 10^{-3}