Physics

XII - PHYSICS
2020 - 2021
Important Solutions
XII - PHYSICS - Unit 1, 2, 3
Test

26.09.2020

1) calculate the number of electrons in one coulomb of negative charge.

2) A sample of HCl gas is placed in a uniform electric field of magnitude 3×10^4 NC^{-1}. The dipole moment of each HCl molecule is 3.4×10^{-30} Cm. Calculate the maximum torque experienced by each HCl molecule.

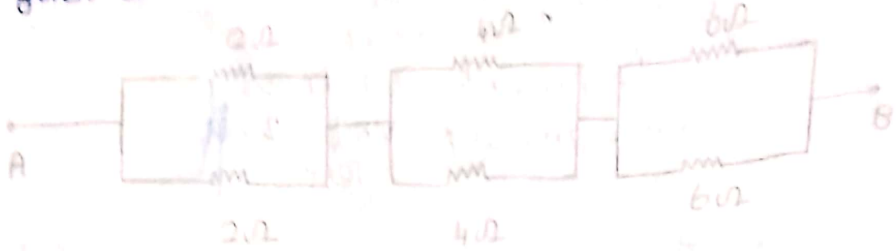
3) Consider a point charge $+q$ placed at the origin and another point charge $-2q$ placed at a distance $9m$ from the charge $+q$. Determine the point between the two charges at electric potential is zero.

4) A water molecule has an electric dipole moment of 6.3×10^{-30} Cm. A sample contains 10^{22} water molecules, with all the dipole moments aligned parallel to the external electric field of magnitude 3×10^5 NC^{-1}. How much more work is required to rotate all the water molecules from $\theta = 0^\circ$ to 90°.

5) A parallel plate capacitor has square plates of side 5cm and separated by a distance of 1mm. (a) Calculate the capacitance of this capacitor. (b) If a 10V battery is connected to the capacitor, what is the charge stored in any one of the plates? ($\epsilon_0 = 8.85 \times 10^{-12}$ N^{-1}m^{-2}C^2).

6) Determine the number of electrons flowing per second through a conductor, when current of 32A flows through it.

7) Calculate the equivalent resistance between A and B in the given circuit



8) In a wheatstone's bridge $P = 100\Omega$, $Q = 1000\Omega$ and $R = 40\Omega$. If the galvanometer zero deflection, determine the value of S.

9) what is the value of x when the wheatstone's network is balanced?

$P = 500\Omega$, $Q = 800\Omega$, $R = x + 400$, $S = 1000\Omega$.

10) In a meter bridge experiment with a standard resistance of 15Ω in the right gap, the ratio of balancing length is 3:2 Find the value of their other resistance.

11) In a meter bridge experiment, the value of resistance in the resistance box connected in the right gap is 10Ω. The balancing length is $l_1 = 55$ cm. Find the value of unknown resistance.

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

13) Compute the magnetic length of a uniform bar magnet if

the geometrical length of the magnet is 12 cm. Mark the positions of magnetic pole points.

14) The repulsive force between two magnetic poles in air is 9×10^{-3} N. If the two poles are equal in strength and are separated by a distance of 10 cm, calculate the pole strength of each pole.

15) The total number of electrons in the human body is typically in the order of 10^{28}. Suppose, due to some reason, you and your friend 1% lost of this number of electrons. Calculate the electrostatic force between you and your friend separated by a distance of 1m. Compare this with your friend weight. Assume mass of each person is 60 kg and use point charge approximation.

26.09.2020

Physics

17) number of electrons = ?

one coulomb of negative charge $q = -1C$

Quantisation of charge,

$$q = ne$$

$q \rightarrow$ charge

$n \rightarrow$ number of electrons

$e \rightarrow$ charge of an electron

$$e = -1.6 \times 10^{-19} C$$

$$q = ne$$

$$n = \frac{q}{e}$$

$$n = \frac{-1C}{-1.6 \times 10^{-19} C}$$

$$= \frac{1}{1.6} \times 10^{19}$$

$$n = \frac{1 \times 10}{1.6 \times 10} \times 10^{19}$$

$$n = \frac{10}{16} \times 10^{19}$$

$$= \frac{5}{8} \times 10^{19}$$

$$= 0.625 \times 10^{19}$$

$$n = 6.25 \times 10^{18} \text{ electrons}$$

0.625
8 | 50
48
20
16
40
40
0

2)

uniform electric field

$E = 3 \times 10^4 \, NC^{-1}$

dipole moment

$P = 3.4 \times 10^{-30} Cm$

maximum (90°)

Torque = ?

$\tau = PE\sin\theta$

τ → Torque

P → dipole moment

E → Electric field

$\tau = PE\sin\theta$

$= 3.4 \times 10^{-30} \times 3 \times 10^4 \times \sin 90^\circ$ $\quad \sin 90^\circ = 1$

$= 3.4 \times 10^{-30} \times 10^4 \times 3 \times 1$

$= 3.4 \times 3 \times 10^{-30+4}$ $\quad \frac{3.4 \times 3}{10.2} / 1$

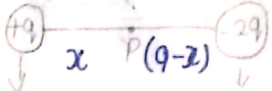
$\boxed{\tau = 10.2 \times 10^{-26} \, Nm.}$

3)

Point charge (+q), Point charge (-2q)

distance, 9m

electric potential is zero.



$\frac{q}{x}$ $\qquad$ $\left(\frac{-2q}{9-x}\right)$

$E = \frac{1}{4\pi\epsilon_0}\left(\frac{q}{x} - \frac{2q}{9-x}\right) = 0$

D. Ravindi

$\frac{1}{4\pi\varepsilon_0}$ = Constant

$$\frac{q}{x} - \frac{2q}{q-x} = 0$$

$$\frac{q}{x} = \frac{2q}{q-x}$$

$$\frac{1}{x} = \frac{2}{q-x}$$

Inverse,

$$\frac{x}{1} = \frac{q-x}{2}$$

$$2x = q - x$$

$$2x + x = q$$

$$3x = q$$

$$x = \frac{q}{3}$$

$$x = 3m$$

The point between the two charges at electric potential is zero is $x = 3m$

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4) Electric dipole moment

$$p = 6.3 \times 10^{-30} \text{ Cm}$$

10^{22} water molecules

Electric field

$$E = 3 \times 10^5 \text{ NC}^{-1}$$

$\theta = 0^\circ$ to 90°

$$\boxed{W = \Delta V}$$

$$W = U(90^\circ) - U(0^\circ)$$

$U = -PE\cos\theta$

$W = -PE\cos(90^\circ) - -PE\cos(0^\circ)$ $\quad \cos 90^\circ = 0$, $\cos 0^\circ = 1$

$= -PE(0) + PE(1)$

$= 0 + PE$

$\boxed{W = PE}$

$W = 6.3 \times 10^{-30} \times 3 \times 10^{5}$ $\quad \frac{6.3 \times 3}{18.9}$

$W = 18.9 \times 10^{-30+5}$

$\boxed{W = 18.9 \times 10^{-25} J}$

For 10^{22} water molecules, total work done is

$W_{total} = 18.9 \times 10^{-25} \times 10^{22}$

$W_{tot} = 18.9 \times 10^{-25+22}$

$\boxed{W_{tot} = 18.9 \times 10^{-3} J}$

5)

Square Plates of side, 5cm

$A = (5cm)^2$

$A = (5 \times 10^{-2} m)^2$

$A = 25 \times 10^{-4} m^2$

distance 1mm

$d = 1mm$

$m \rightarrow$ milli

$m = 10^{-3}$

$d = 1 \times 10^{-3} m$

$V = 10\,V$

(a) Capacitance of a capacitor is

$$C = \frac{\varepsilon_0 A}{d}$$

$C \rightarrow$ capacitance

$\varepsilon_0 \rightarrow$ permittivity of free space

$A \rightarrow$ cross sectional Area

$d \rightarrow$ distance

$\varepsilon_0 = 8.85 \times 10^{-12}\ N^{-1} m^{-2} C^2$

$$C = \frac{8.85 \times 10^{-12} \times (25 \times 10^{-4})}{1 \times 10^{-3}}$$

$$= \frac{8.85 \times 25 \times 10^{-12} \times 10^{-4}}{10^{-3}}$$

$$\begin{array}{r} 8.85 \times 25 \\ \hline 4425 \\ 1770 \\ \hline 221.25 \end{array}$$

$$C = 221.2 \times 10^{-16} \times 10^{+3}$$

$$C = 221.2 \times 10^{-16+3}$$

$$C = 221.2 \times 10^{-13}$$

$$C = 22.12 \times 10^{-12} F$$

$p \rightarrow$ Pico

$p = 10^{-12}$

$$C = 22.12\ pF$$

(b) Charge stored in any one of the plate is

$$Q = CV$$

$Q = 22.12 \times 10^{-12} \times 10$

$Q = 221.2 \times 10^{-12} C$

$Q = 221.2 \text{ pC}$

22.12 × 10
0000
22 12
221.20

6) current 32 A

$I = 32 A$

number of electrons = ?

$n = ?$

per second

$t = 1s$

$I = \frac{q}{t}$

I → current

q → charge

t → time

quantisation of charge,

$q = ne$

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

$n = \frac{It}{e}$

$e = 1.6 \times 10^{-19} C$

e → charge of an electron

$n = \frac{32 \times 1}{1.6 \times 10^{-19}}$

$= \frac{2}{0.1} \times \frac{1}{10^{-19}}$

$n = \frac{20}{10} \times \frac{1}{10^{-19}}$

$$n = \frac{2}{10^{-1} \times 10^{-19}}$$

$$= \frac{2 \times 10}{10^{-19}}$$

$$n = \frac{20}{10^{-19}} \uparrow$$

$$n = 20 \times 10^{19}$$

$$n = 2 \times 10^{20} \text{ electrons}$$

7)

Parallel connection

$R_1 = 2\Omega$

$R_2 = 2\Omega$

$$\frac{1}{R_{P1}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$= \frac{1}{2} + \frac{1}{2}$$

$$= \frac{1+1}{2}$$

$$\frac{1}{R_{P1}} = \frac{2}{2}$$

$R_{P1} = 1\Omega$

Parallel connection

$R_1 = 4\Omega$

$R_2 = 4\Omega$

$$\frac{1}{R_{P2}} = \frac{1}{R_1} + \frac{1}{R_2}$$

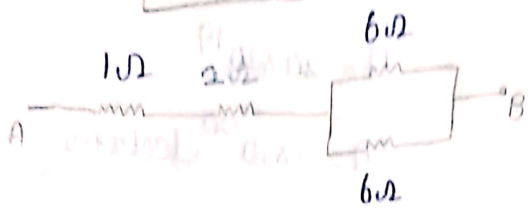
$$\frac{1}{R_{P2}} = \frac{1}{4} + \frac{1}{4}$$

$$= \frac{1+1}{4}$$

$$\frac{1}{R_{P_2}} = \frac{2}{4}$$

$$\frac{1}{R_{P_2}} = \frac{1}{2}$$

$$R_{P_2} = 2\,\Omega$$



Parallel connection

$$R_1 = 6\,\Omega$$

$$R_2 = 6\,\Omega$$

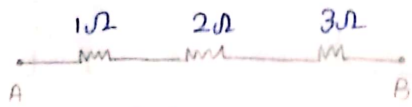
$$\frac{1}{R_{P_3}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$= \frac{1}{6} + \frac{1}{6}$$

$$\frac{1}{R_{P_3}} = \frac{2}{6}$$

$$\frac{1}{R_{P_3}} = \frac{1}{3}$$

$$R_{P_3} = 3\,\Omega$$



The equivalent resistance R is given by

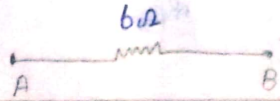
$$R = R_1 + R_2 + R_3$$

$$= (1+2+3)\,\Omega$$

$$R = 6\,\Omega$$

The equivalent resistance between A and B is

6Ω



8) Wheatstone's bridge,

$P = 100\,\Omega$, $Q = 1000\,\Omega$, $R = 40\,\Omega$,

$S = ?$

$$\frac{P}{Q} = \frac{R}{S}$$

$$\frac{P}{Q} = R\left(\frac{1}{S}\right)$$

$$\frac{P}{QR} = \frac{1}{S}$$

$$S = \frac{QR}{P}$$

$$S = \frac{1000 \times 40}{100}$$

$$S = 10 \times 40$$

$$S = 400\,\Omega$$

9) Wheatstone's bridge,

$P = 500\,\Omega$, $Q = 800\,\Omega$, $R = x + 400$,

$S = 1000\,\Omega$,

$x = ?$

$$\frac{P}{Q} = \frac{R}{S}$$

$$\frac{500}{800} = \frac{x+400}{1000}$$

$$\frac{5}{8} = \frac{x+400}{1000}$$

$$\frac{5 \times 1000}{8} = x + 400$$

$$\frac{5000}{8} = x + 400$$

$$625 = x + 400$$

$$x = 625 - 400$$

$$\boxed{x = 225\ \Omega}.$$

10) resistance $15\ \Omega$.

$$Q = 15\ \Omega$$

balancing length $l_1 : l_2 = 3 : 2$

$$\frac{l_1}{l_2} = \frac{3}{2} \quad , P = ?$$

$$\boxed{\frac{P}{Q} = \frac{l_1}{l_2}}$$

$$\frac{P}{15} = \frac{3}{2}$$

$$P = \frac{3}{2} \times 15$$

$$P = 7.5 \times 3$$

$$\boxed{P = 22.5\ \Omega}$$

The value of other resistance P is $22.5\ \Omega$.

11) resistance $10\ \Omega$

$$Q = 10\ \Omega$$

balancing length $l_1 = 55\ cm$.

$$l_2 = 100 - l_1$$

$$\boxed{\frac{P}{Q} = \frac{l_1}{l_2}}$$

constant

$$\frac{P}{Q} = \frac{l_1}{100 - l_1}$$

$$\frac{P}{10} = \frac{55}{100 - 55}$$

$$P = 10 \times \frac{55}{45}$$

$$P = \frac{10 \times 55}{45}$$

$$P = \frac{550}{45}$$

$$\boxed{P = 12.2\ \Omega}$$

The value of unknown resistance P is 12.2 Ω.

12] Resistance 10 Ω

$R = 10\ \Omega$

Current 5A

$I = 5A$

$t = 5$ minutes

$t = 5 \times 60\ s$

$$\boxed{H = I^2 Rt}$$

H → Heat
I → current
R → Resistance
t → time

$H = (5)^2 \times 10 \times (5 \times 60)$

$= 25 \times 10 \times 300$

$= 250 \times 300$

$H = 75000\ J$

(or) $H = 75 \times 10^3\ J$

$\boxed{H = 75\ KJ}$

K → Kilo

$K = 10^3$

13) Geometrical length of bar magnet is 12 cm

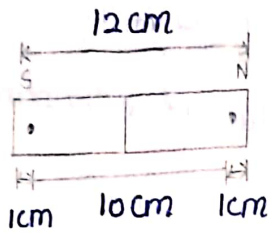
$$\text{magnetic length} = \frac{5}{6} \times (\text{Geometrical length})$$

$$= \frac{5}{6} \times 12^{2}$$

$$= 5 \times 2$$

$$\boxed{\text{Magnetic length} = 10\,\text{cm}}.$$

For the figure, the dot implies the pole points.



14) Repulsive force

$$F = 9 \times 10^{-3}\ N$$

Two poles

$$q_{m_A} q_{m_B} = q_m q_m = q_m^2$$

$\downarrow$

equal

Two pole strength

$$\boxed{F = k \frac{q_{m_A} q_{m_B}}{r^2}}$$

F → Force

K → constant

$q_{mA}\ q_{mB}$ → two magnetic pole

r → distance

$r = 10\,cm$

$r = 10 \times 10^{-2}\,m$

K = constant

$$K = \frac{\mu_0}{4\pi}$$

μ_0 → permeability of free space

$$\mu_0 = 4\pi \times 10^{-7} \text{ h/m}$$

h → henry

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

$$K = 10^{-7}$$

$$F = K \frac{q_{mA} q_{mB}}{r^2}$$

$$F = 10^{-7} \frac{q_m^2}{r^2}$$

$$9 \times 10^{-3} = 10^{-7} \frac{q_m^2}{(10 \times 10^{-2})^2}$$

$$9 \times 10^{-3} = 10^{-7} \times \frac{q_m^2}{100 \times 10^{-4}}$$

$$9 \times 10^{-3} \times 100 \times 10^{-4} = 10^{-7} \times q_m^2$$

$$900 \times 10^{-7} = 10^{-7} \times q_m^2$$

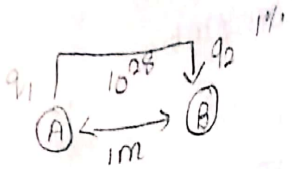
$$q_m^2 = 900$$

$$q_m = \sqrt{900}$$

$$q_m = 30 \text{ NT}^{-1}$$

T → Tesla

15)



$$F = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^2} \qquad r = 1m$$

$$\therefore \frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \, N$$

$$q_1 = 10^{28} \times 1\%$$

$$q_1 = 10^{28} \times \frac{1}{100}$$

$$= 10^{28} \times \frac{1}{10^2}$$

$$= 10^{28} \times 10^{-2}$$

$$\boxed{q_1 = 10^{26} C}$$

$$q_2 = 10^{28} \times 1\%$$

$$= 10^{28} \times \frac{1}{100}$$

$$= 10^{28} \times 10^{-2}$$

$$\boxed{q_2 = 10^{26} C}$$

$$F = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^2}$$

$$= \frac{9 \times 10^9 \times 10^{26} \times 10^{26}}{(1)^2}$$

$$F = \frac{9 \times 10^{61}}{1}$$

$$\boxed{F = 9 \times 10^{61} \, N}$$

2
26
26
9
61

$W = mg$

$m = 60\ kg$

$m \rightarrow$ mass

$g \rightarrow$ acceleration due to gravity

$g = 9.8\ ms^{-2}$

$W = 60 \times 9.8 = 588.0$

$\begin{array}{r} 98 \times 60 \\ \hline 588.04 \end{array}$

$W = 588\ N.$

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