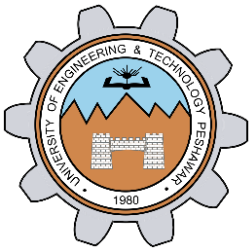
ASSIGNMENT NO 2



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Subject: **Applied physics**

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Q: (A)

In the quark model of fundamental particles, a proton is composed of three quarks: two "up" quarks, each having charge $+\frac{2}{3}e$, and one "down" quark, having charge $-\frac{1}{3}e$. Suppose that the three quarks are equidistant from each other. Take the distance to be 1.32×10^{-15} m and calculate (*a*) the potential energy of the interaction between the two "up" quarks and (*b*) the total electrical potential energy of the system.

Question No "1"

PART - A

(a) Given data :-

First up quarks have charge, $q_1 = \frac{2}{3}e$

second up quarks have charge, $q_2 = \frac{2}{3}e$

Distance, $d = 1.32 \times 10^{-15}$ m

Potential energy, $U = ?$

Solution :-

we know electric potential energy

$$U = k\frac{q_1 q_2}{d}$$

Putting values

$$U = \frac{(9\times10^9)(\frac{2}{3}e)(\frac{2}{3}e)}{1.32\times10^{-15}m}$$

$\therefore e = 1.6\times10^{-19}$

$$U = 7.7\times10^{-14}\ J$$

$$U = \frac{7.7\times10^{-14}\ 1ev}{1.6\times10^{-19}}$$

$$U = 481 kev$$

b) Given data :-

$$q_1 = +\frac{2}{3}e$$

$$q_2 = +\frac{2}{3}e$$

$$q_3 = -\frac{1}{3}e$$

Electric potential energy of system, $U_T = ?$

Solution :-

Energy of the system is

$$U = K\frac{q_1 q_2}{d_1} + K\frac{q_1 q_3}{d_3} + K\frac{q_2 q_3}{d_2}$$

Each charge is separated by equiditance, so $d_1 = d_2 = d_3 = d$

$$U = K\left(\frac{q_1 * q_2 + q_1 q_3 + q_2 q_3}{d}\right)$$

putting values

$$U = K\left(\frac{\left(\frac{2}{3}e\right)\left(\frac{2}{3}e\right) + \left(\frac{2}{3}e\right)\left(-\frac{1}{3}e\right) + \left(\frac{2}{3}e\right)\left(-\frac{1}{3}e\right)}{d}\right)$$

$$U = K\left(\frac{\frac{4}{9}e^2 - \frac{2}{9}e^2 - \frac{2}{9}e^2}{d}\right)$$

$$U = K\left(\frac{4e^2}{9} - \frac{4e^2}{9}/d\right)$$

$$\boxed{U = 0}$$

(B)

A wire 4.0 m long and 6.0 mm in diameter has a resistance of 15 mΩ. A potential difference of 23 V is applied between the ends. (*a*) What is the current in the wire? (*b*) Calculate the current density. (*c*) Calculate the resistivity of the wire material. Can you identify the material? See Table 1.

PART – B

Given data :-

Resistance, $R = 15 m\Omega$

Length of wire, $L = 4 m$

diametre of wire, $d = 6 mm = 6 \times 10^{-3} m$

Potential difference, $dV = 23 V$

a) Current, $I = ?$

b) Current density, $J = ?$

c) Resistivity, $\rho = ?$

Solution :-

a) To find current in the wire, we use ohm's law equation

$$V = IR \Rightarrow I = \frac{V}{R}$$

putting values

$$I = \frac{23}{15 \times 10^{-3}\ \Omega}$$

$$I = 1.5\ K\Omega$$

b) To find current density, we have to find cross section area of wire

$$J = \frac{i}{A} \longrightarrow (1)$$

Area, $A = \frac{1}{4}\pi d^2$

P.T.O

$$A = \frac{1}{4}\pi d^2$$

Putting values

$$A = \frac{1}{4}(3.14)(6\times10^{-3})^2$$

$$A = 28.6\times10^{-6}$$

putting in eq ① and $I = 1.5\,KV$

① ⇒ $$J = \frac{1.5\,KV}{28.6\times10^{-6}}$$

$$J = 0.052\times10^{3+6}$$

$$J = 52\times10^{12}$$

$$\boxed{J = 52\,MA/m^2}$$

c) Equation of resistivity is

$$R = \frac{\rho L}{A}$$

$$\rho = \frac{RA}{L}$$ Putting values

$$\rho = \frac{(15\times10^{-3})(28.6\times10^{-6})}{4\times1}$$

$$\rho = 107.25\times10^{-9}$$

$$\rho = 10.7\times10^{-8}\,\Omega.m$$ → **Platinium**

Identification: -

→ From table 1 in the book, this value of resistivity is equal to the resistivity of Platinum