Ans to the que No - 1

Given,

$V = 9\ V$

$C_2 = 3\ \mu F$

$C_4 = 4\ \mu F$

$Q_a = 12\ \mu C$

$Q_b = 8\ \mu C$

The voltage across C_4 is given by,

$$V_4 = \frac{Q_b}{C_4}$$

$$= \frac{8\mu C}{4\mu F}$$

$$= 2\ V$$

The voltage across C_2 is given by,

$$V_2 = \frac{Q_a}{C_2}$$

$$= \frac{12\ \mu C}{3\ \mu F}$$

$$= 4\ V$$

(a) The capacitance C_1 is given by,

$$C_1 = \frac{Q_a}{V_1}$$

$$= \frac{12\,\mu C}{3\,V}$$

$$= 4\,\mu F$$

$$\therefore C_1 = 4\,\mu F$$

(b) The charge across C_3 is,

$$Q_3 = Q_a - Q_b$$

$$= 12\,\mu C - 8\,\mu C$$

$$= 4\,\mu C$$

$\therefore$ The capacitance C_3 is given by

$$C_3 = \frac{Q_3}{V_4}$$

$$= \frac{4\,\mu C}{2\,V}$$

$$= 2\,\mu F$$

$$\therefore C_3 = 2\,\mu F$$

Ans to the que No - 2

Given,

$V_A - V_B = 3\,nV = 3 \times 10^{-9}\,V$

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

$r = 2\,mm = 2 \times 10^{-3}\,m$

$t = 3\,ms = 3 \times 10^{-3}\,s$

$\rho = 1.69 \times 10^{-8}\,\Omega m$

We know, $Q = It$

Now, $I = \dfrac{V_a - V_B}{R}$ and $R = \rho \dfrac{l}{A}$

So, $Q = \dfrac{(V_A - V_B)}{\rho l} A t$

$$= \frac{(V_a - V_B) \times \pi r^2 \times t}{\rho l}$$

$$= \frac{3 \times 10^{-9}\,V \times \pi \times (2 \times 10^{-3})^2 \times 3 \times 10^{-3}\,s}{1.69 \times 10^{-8}\,\Omega m \times 2 \times 10^{-2}\,m}$$

$$= 3.35 \times 10^{-7}\,C$$

Ans to the que No - 3

Given,

$R_1 = 2\,\Omega$

$R_2 = 2\,\Omega$

$R_3 = 2\,\Omega$

$R_4 = 16\,\Omega$

$R_5 = 8\,\Omega$

$R_6 = 4\,\Omega$

$i_6 = 1.4\ A$

Here, $i_5 = i_6 = 1.4\ A$

from Ohm's law,

$V = iR$

$\therefore V_6 = i_6 R_6$

$= 1.4\ A \times 4\,\Omega$

$= 5.6\ V$

$V_5 = i_5 R_5$

$= 1.4\ A \times 8\,\Omega$

$= 11.2\ V$

R_{56} in series,

$$R_{56} = R_5 + R_6$$
$$= 8\Omega + 4\Omega$$
$$= 12\Omega$$

$$V_{56} = V_5 + V_6$$
$$= 11.2\ V + 5.6\ V$$
$$= 16.8\ V$$

$$i_{56} = i_5 = i_6 = 1.4\ A$$

Now, R_4 and R_{56} in Parallel,

$$\frac{1}{R_{456}} = \frac{1}{R_4} + \frac{1}{R_{56}}$$
$$= \frac{1}{16}\Omega + \frac{1}{12}\Omega$$
$$= \frac{7}{48}\Omega$$

$$\therefore R_{456} = \frac{48}{7} = 6.86\Omega$$

$$V_{456} = V_{56} = 16.8\ V$$

$$i = \frac{V}{R}$$

$$i_4 = \frac{V_{456}}{R_{456}} = \frac{16.8\ V}{6.86\ \Omega}$$
$$= 2.45\ A$$

Now, R_2 and R_{456} in series,

$$R_{2456} = R_2 + R_{456}$$
$$= 2\,\Omega + 6.86\,\Omega$$
$$= 8.86\,\Omega$$

$$i_2 = i_4 = 2.45\ A$$

$$V_{2456} = i_2 \times R_{2456}$$
$$= 2.45A \times 8.86\,\Omega$$
$$= 21.7\ V$$

Now, R_3 and R_{2456} in Parallel,

$$\frac{1}{R_{23456}} = \frac{1}{R_3} + \frac{1}{R_{2456}}$$
$$= \frac{1}{2}\,\Omega + \frac{1}{8.86}\,\Omega$$
$$= \frac{0.6129}{1}\,\Omega$$

$$\therefore R_{23456} = 1.63\,\Omega$$

$$V_{2456} = V_{23456} = 21.7\ V$$

$$i_3 = \frac{V_{23456}}{R_{23456}}$$

$$= \frac{21.7\ V}{1.63\ \Omega}$$

$$= 13.3\ A$$

$$i_1 = i_3 = 13.3\ A$$

$$V_1 = i_1 R_1$$

$$= 13.3\ A \times 2\Omega$$

$$= 26.6\ V$$

$\therefore$ emf of battery, $E = V_1 + V_{23456}$

$$= 26.6\ V + 21.7\ V$$

$$= 48.3\ V$$

Ans to the que No - 4

Given,

$V = 550 \ ms^{-1}$

$B = 0.045 \ T$

$m = 6.6 \times 10^{-27} \ kg$

$q = 3.2 \times 10^{-19} \ C$

$\theta = 52^\circ$

(a) The force acting on the proton due to the magnetic field is,

$F = qv \times B \times \sin\theta$

$= 3.2 \times 10^{-19} \ C \times 550 \ ms^{-1} \times 0.045 \ T \times \sin 52^\circ$

$= 6.24 \times 10^{-18} \ N$

(b) Using Newton's second law,

$$f = ma$$

$$\Rightarrow a = \frac{f}{m}$$

$$= \frac{6.24 \times 10^{-18} \text{ N}}{6.6 \times 10^{-27} \text{ kg}}$$

$$= 9.45 \times 10^{8} \text{ ms}^{-2}$$

(c) The force is perpendicular to the velocity so that the speed of the alpha particle will stay same. Thus the acceleration direction is perpendicular to the velocity. So, the force will change the direction of the velocity not the magnitude. That's why speed will stay the same.