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EXAM #2

PH 222-2A

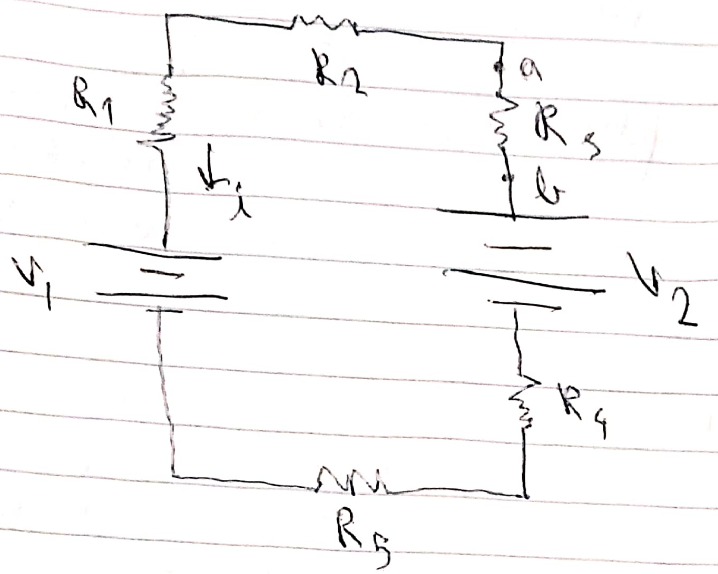
1 Ans. Answer is option C - Bulb A will be off and ~~bulb~~ B will be brighter.

When switch is open, current will pass through bulb A and then B, but when switch is closed, current will pass through the switch instead of bulb A, then through bulb B because greater current flows through region with low resistance. Since the switch closed provides no resistance all the current from the source passes through the switch and no current flows through bulb A so bulb A is off. The bulb B will become brighter as all the current passes through bulb B after passing through the closed switch.

2 Ans. Answer is option A - No resistors are connected in series.

All the three resistors are in parallel combination. If we apply Kirchoff's voltage law in any direction and in any loop, then current is not the same. In all three resistors, current is different.

3. Ans. The given circuit is as follows:-



$R_1 = 10\ k\Omega$
$R_2 = 5\ k\Omega$
$R_3 = 15\ k\Omega$
$R_4 = 10\ k\Omega$
$R_5 = 5\ k\Omega$
$V_1 = 10V$
$V_2 = 20V$

Suppose i is the current flowing through the battery V_1.

Applying KVL in loop :-

$$V_1 = -iR_1 - iR_2 - iR_3 + V_2 - iR_4 - iR_5$$

$$10 = -i(10 + 5 + 15 + 10 + 5)$$

$$i = \frac{-10}{45}\ mA$$

$\therefore\ i = -0.222\,mA$

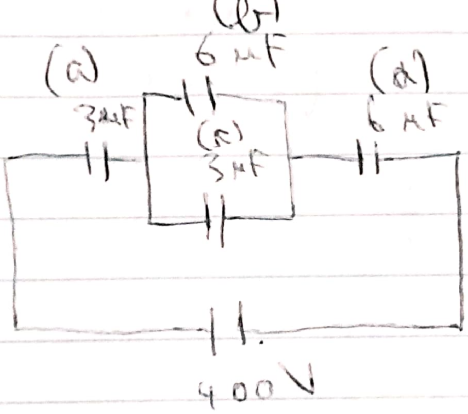
Power on resistor $R_3 = I^2 R_3$

Here I = current through resistor R_3.

$$P = \left(\frac{10}{45}\right)^2 15 = 0.74\ m\,watt.$$

$$P = 0.74\,mW$$

4 Ans.



Let 3 μF be (a), 6 μF be (b), 3 μF be (c) and 6 μF be (d).

$$C'_{eq} = 6+3 = 9\ \mu F \text{ (for parallel)}$$

$$\frac{1}{C''_{eq}} = \frac{1}{9} + \frac{1}{3} + \frac{1}{6} = \frac{2+6+3}{18}$$

3 | 9, 3, 6
3 | 3, 1, 2
2 | 1, 1, 2
1, 1, 1
18

④

$C''_{eq} = \frac{18}{11}$ μF (for series)

(e) Total energy = $\frac{1}{2} C''_{eq} V^2 = \frac{1}{2} \times \frac{18}{11} \times 400 \times 400 \times 10^{-6}$

$= 1.3 \times 10^{-1}$

5 Ans. The equivalent capacitance of the capacitors when they are in parallel combination is as follows:-

$C_{equ} = C_1 + C_2$

The equivalent capacitance of the capacitors when they are connected in series combination is as follows :-

$\frac{1}{C_{equ}} = \frac{1}{C_1} + \frac{1}{C_2}$

$C_{equ} = \frac{C_1 C_2}{C_1 + C_2}$

Capacitance of the capacitor is :-

$C = \frac{Q}{V}$

According to Kirchhoff's loop rule,

$\Sigma V = 0$

when two capacitors C_1 and C_2 are connected with voltage source V, then voltage across the capacitor C_1 is as follows:-

$$V_{c_1} = \frac{C_2 V}{C_1 + C_2}$$

The voltage across the capacitor C_2 is:-

$$V_{c_2} = \frac{C_1 V}{C_1 + C_2}$$

(a) The capacitors $4\mu F$ and $2\mu F$ are connected in series when switch is open. The voltage across the capacitor $C_1 = 4\mu F$ is:-

$$V_{c_1} = \frac{C_2 V}{C_1 + C_2}$$

Substituting $4\mu F$ for C_1, $2\mu F$ for C_2 and $300V$ for V, we get:-

$$V_{c_1} = \left(\frac{2\mu F}{2\mu F + 4\mu F}\right) \times 300V = \underline{\underline{100V}}$$

The voltage across the capacitor C_2 is :-

$$V_{C_2} = \frac{C_1 V}{C_1 + C_2}$$

substituting $4\,\mu F$ for C_1, $2\,\mu F$ for C_2 and $300\,V$ for V, we get :-

$$V_{C_2} = \left(\frac{4\mu F}{2\mu F + 4\mu F}\right) \times 300\,V$$

$$= \underline{200\,V}$$

Using Kirchhoff's loop rule to the circuit across junctions B and D in the figure given in the question, we get :-

$$-V_{C_1} - (V_E - V_D) + V_{C_2} = 0$$

$$V_E - V_D = V_{C_2} - V_{C_1}$$

substituting $100\,V$ for V_{C_1} and $200\,V$ for V_{C_2} :-

$$V_E - V_D = 200\,V - 100\,V$$

$$= \underline{100\,V}$$

∴ The potential difference between D & E is 100V

(ii) The capacitors 4μF and 2μF are connected in parallel on both sides when the switch is closed.

$C_{24} = 4\mu F + 2\mu F$
$= 6\mu F$

The voltage across the point E is

$$V_E = \left(\frac{C_{24}}{C_{24}+C_{24}}\right)V$$

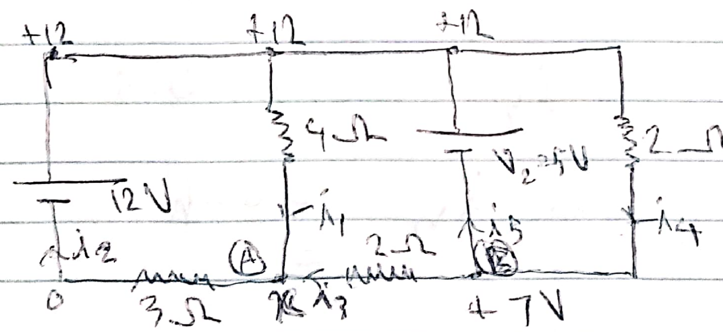
Substituting 6μF for C_{24} and 300V for V.

$$V_E = \left(\frac{6\mu F}{6\mu F+6\mu F}\right)(300V)$$

$= 150V$

∴ The potential at point E after the switch is closed is 150V.

6. Ans



(8)

By nodal analysis, for calculating the potential 'x' at point 'A' :-

$$\frac{(x-7)}{2} + \frac{(x-12)}{4} + \frac{(x-0)}{3} = 0$$

$$\frac{6(x-7) + 3(x-12) + 4x}{12} = 0$$

$$6x - 42 + 3x - 36 + 4x = 0$$

$$13x = 78$$

$$x = 6V$$

(a) $i_2 = \frac{6-0}{3} = 2$ amp

$i_1 = \frac{12-6}{4} = \frac{3}{2}$ amp $= 1.5$ amp.

$i_3 = \frac{7-6}{2} = \frac{1}{2} = 0.5$ amp.

$i_4 = \frac{i_2 - 7}{2} = 2.5$ amp.

At point 'B', $i_4 = i_5 + i_3$

$i_5 = 2.5 - 0.5$

$\therefore i_5 = 2$ amp

(b) Power supplied by V_1 :-

$P_1 = 12 \times 2 = \underline{24 \text{ watt}}$

Power supplied by V_2 :-

$P_2 = 5 \times 2 = \underline{10 \text{ watt}}$