

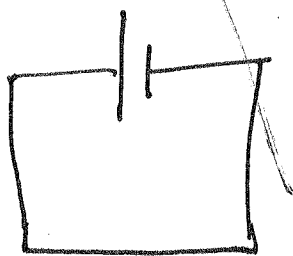
DC THEORY

TUTORIAL

QUESTIONS



A)



Draw arrows on the diagram to show direction of electron flow and conventional current flow.

B) State Ohm's Law + Meaning of Symbols ($V = IR$)

C) State Kirchhoff's First Law $(\sum_{x=0}^n I_x = 0)$ Junction.

D) State Kirchhoff's Second Law $(\sum_{x=0}^n V_x = 0)$ closed loop.

E) what are the fluid analogies of

- Voltage (Pressure)
- Current (Flow)
- resistance (restriction).

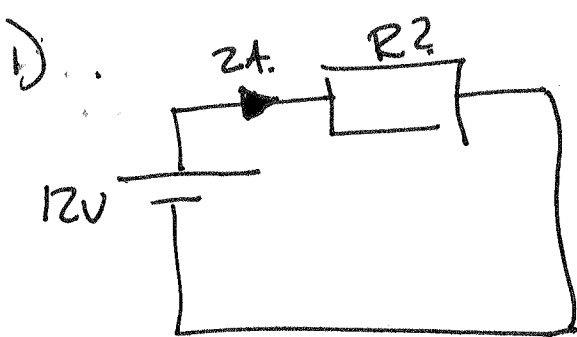
F) i) A long thin aluminium wire has a resistance of 0.1Ω at 0°C . Calculate the resistance at 200°C given the temperature co-efficient is $4 \times 10^{-3} \text{ K}^{-1}$. ($R = R_0(1 + \alpha \Delta T)$)

ii) A similar wire made from an unknown material has a nominal resistance of 0.2Ω at 0°C and a resistance of 0.7Ω at 200°C . Calculate the resistivity of the material. ($R_t = R_0 + R_0 \alpha \Delta T$)

G) Calculate the resistance of a wire which has 0.1 mm dia, and is 10 m long given the constant of resistivity for the material is $2.65 \times 10^{-8} \Omega \text{ m}$. $R = \frac{\rho L}{A}$

H) A charge of 100 coulombs flows through a conductor in 50 seconds. Calculate the current. ($I = Q/t$)

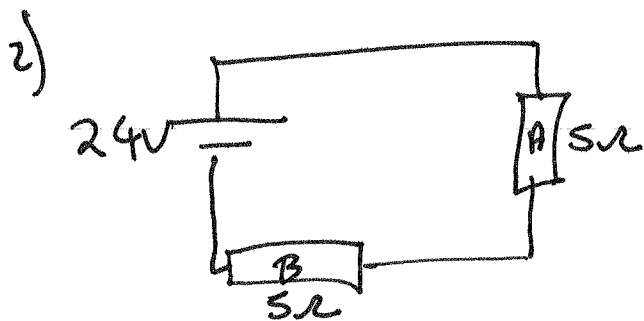
I) A battery stores 12000 J of energy when it has a Potential of 12 V . Calculate the charge stored. ($E = QV$)



- Calculate resistance

$$V = IR$$

$$R = \frac{V}{I} = \frac{12}{2} = 6 \Omega$$

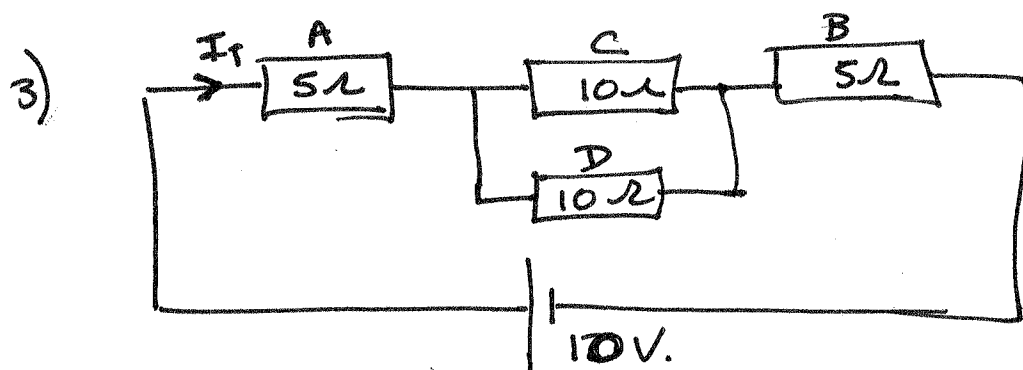


- Calculate current
- Calculate power dissipated across each resistor.

$$R_T = 5 + 5 = 10 \Omega$$

$$V = IR \quad I = \frac{V}{R} = \frac{24}{10} = 2.4 \text{ A}$$

$$P_A = P_B = I^2 R = 2.4^2 \times 5$$



- Calculate power dissipated by each resistor

$$R_T = 5 + \frac{1}{\frac{1}{10} + \frac{1}{10}} + 5 = 5 + 5 + \frac{1}{2/10} = 15 \Omega$$

$$I_T = \frac{V}{R} = \frac{10}{15} = \cancel{6.6} 0.666 \text{ A}$$

$$V_A = 5 \times 0.666 = 3.333 \text{ V}$$

$$V_B = 3.333 \text{ V}$$

$$V_C = 10 - 6.6666 = 3.3333 \text{ V}$$

$$I_C = \frac{V}{R} = \frac{3.333}{10} = 0.333 \text{ A}$$

$$= 0.333 \text{ A}$$

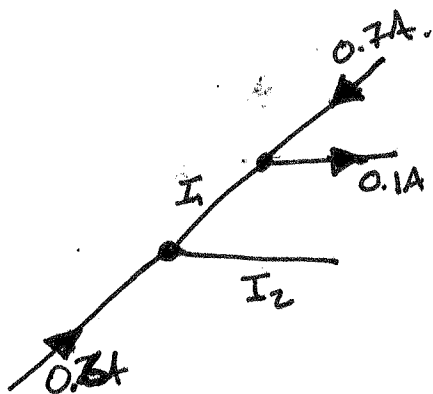
$$P_A = I^2 R = 0.666^2 \times 5$$

$$P_A = P_B = 2.218 \text{ W}$$

$$P_C = I^2 R = 0.333^2 \times 10$$

$$P_C = P_D = 1.11 \text{ W}$$

4)



Calculate I_1 and I_2 .

→ Top Node

$$I_1 + 0.7 - 0.1 = 0.$$

$$I_1 = 0.1 - 0.7 = -0.6 \text{ A.}$$

away from node.

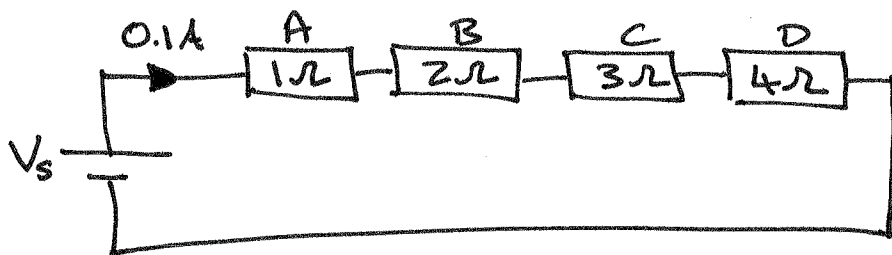
→ Lower Node

$$I_2 + 0.6 + 0.6 = 0$$

$$I_2 = -1.2 \text{ A}$$

Away from node

5)



Calculate supply voltage using

- Total resistance and ohm's law
- Kirchoff's voltage law.

a) $R_T = 1 + 2 + 3 + 4 = 10 \Omega.$

$$V_s = I R_T$$

$$V_s = 0.1 \times 10 = 1 \text{ V.}$$

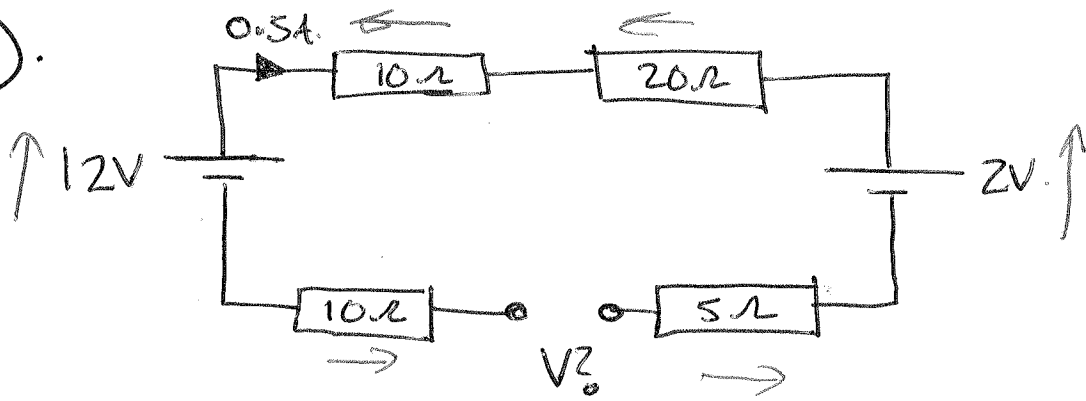
b) $V_s + V_A + V_B + V_C + V_D = 0.$

Resistors → voltage drops
→ negative.

$$V_s - (0.1 \times 1) - (0.1 \times 2) - (0.1 \times 3) - (0.1 \times 4) = 0$$

$$V_s = +0.1 + 0.2 + 0.3 + 0.4 = 1 \text{ V.}$$

6).



$$V = IR$$

$$10\Omega \quad V = 0.5 \times 10 = 5V.$$

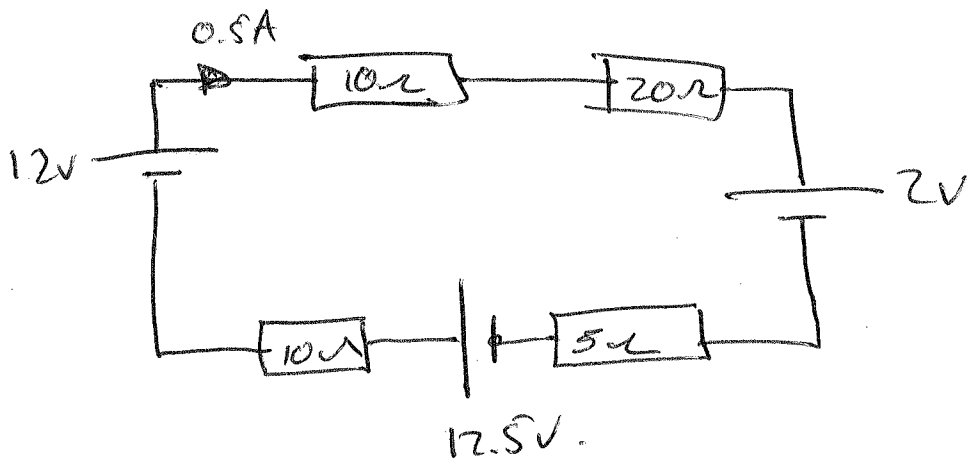
$$20\Omega \quad V = 0.5 \times 20 = 10V$$

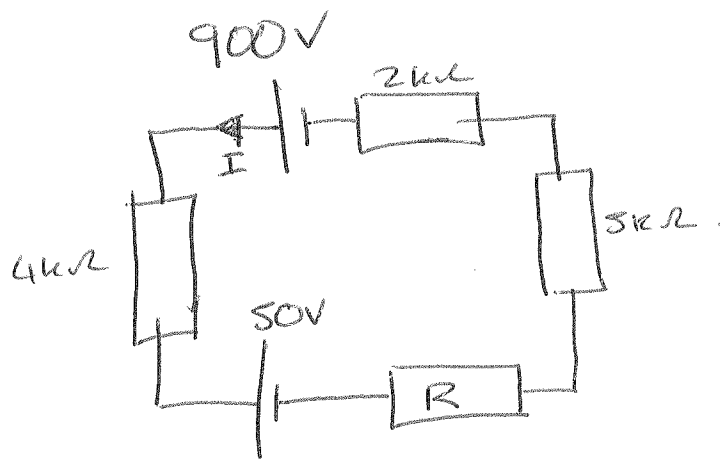
$$5\Omega \quad V = 0.5 \times 5 = 2.5V.$$

$$12V - 5V - 10V - 2 - 2.5 + V - 5 = 0$$

$$V = 5 + 2.5 + 2 + 10 + 5 - 12.$$

$$V = 4.5 + 10 + 10 - 12 = \underline{\underline{12.5V}}, \text{ clockwise.}$$





$$\underline{I = 50 \text{ mA}}$$

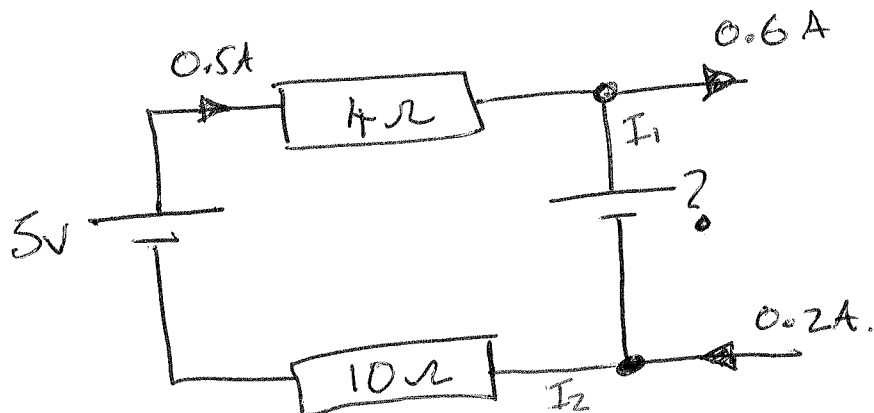
Calculate R. using K2nd law

$$900 - (4 \times 10^3 \times 50 \times 10^{-3}) - 50 - V_R - (5 \times 10^3 \times 50 \times 10^{-3}) - (2 \times 10^3 \times 50 \times 10^{-3}) = 0$$

$$V_R = 300 \text{ V.}$$

$$R = \frac{V}{I} = 6 \times 10^3 \Omega = 6 \text{ k}\Omega.$$

7)



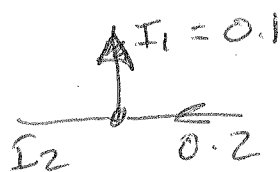
①



$$I_1 + 0.5 - 0.6 = 0$$

$$I_1 = 0.6 - 0.5 = \underline{0.1A} \text{ into junction}$$

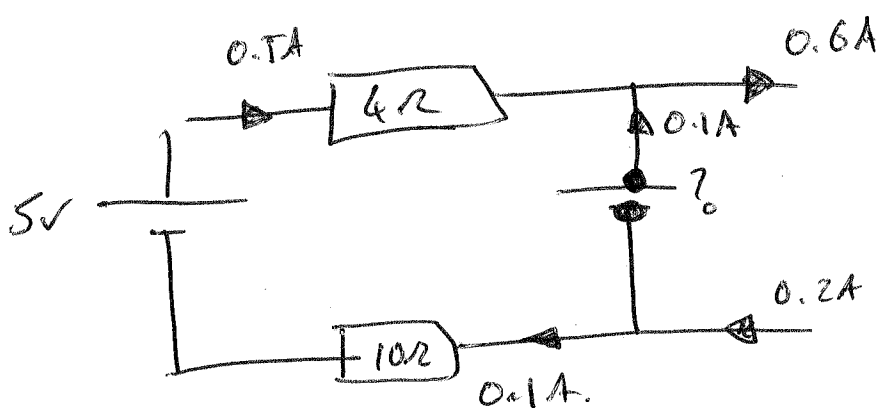
②



$$I_2 + 0.2 - 0.1 = 0$$

$$I_2 = 0.1 - 0.2 = \underline{-0.1A} \text{ out of junction}$$

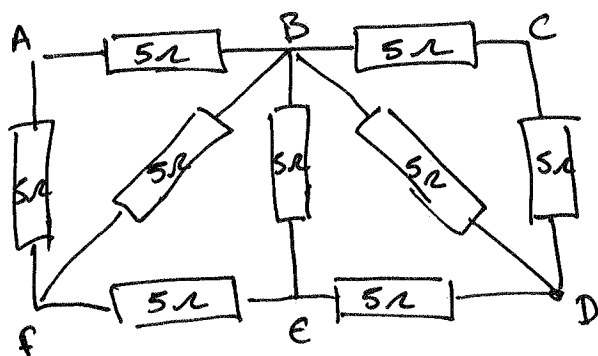
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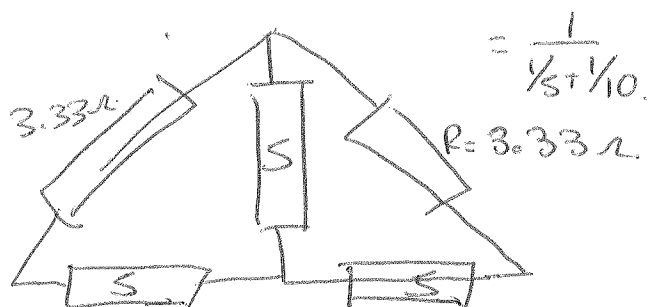
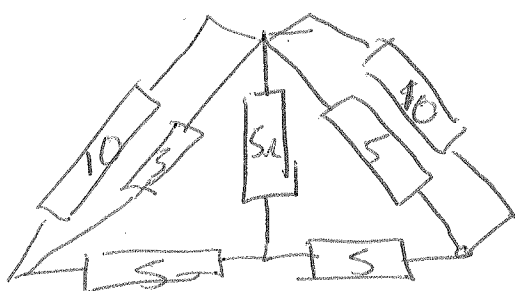
$$5 - (0.5 \times 4) - (0.1 \times 10) + V = 0.$$

$$V = -5 + 2 + 1 = \underline{\underline{-2V}}.$$

8)

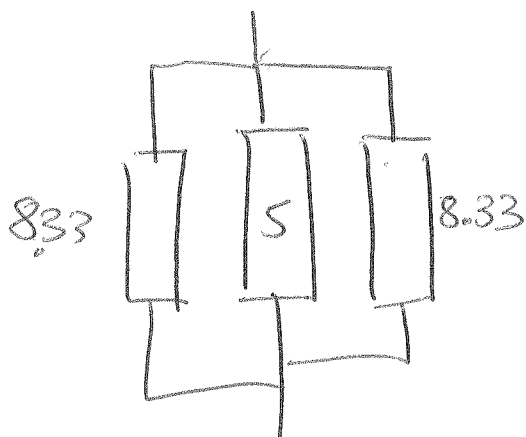


Calculate Resistance be.



$$= \frac{1}{\frac{1}{5} + \frac{1}{10}}$$

$$R = 3.33\Omega$$



$$R_T = \frac{1}{\frac{1}{5} + \frac{1}{8.33} + \frac{1}{8.33}}$$

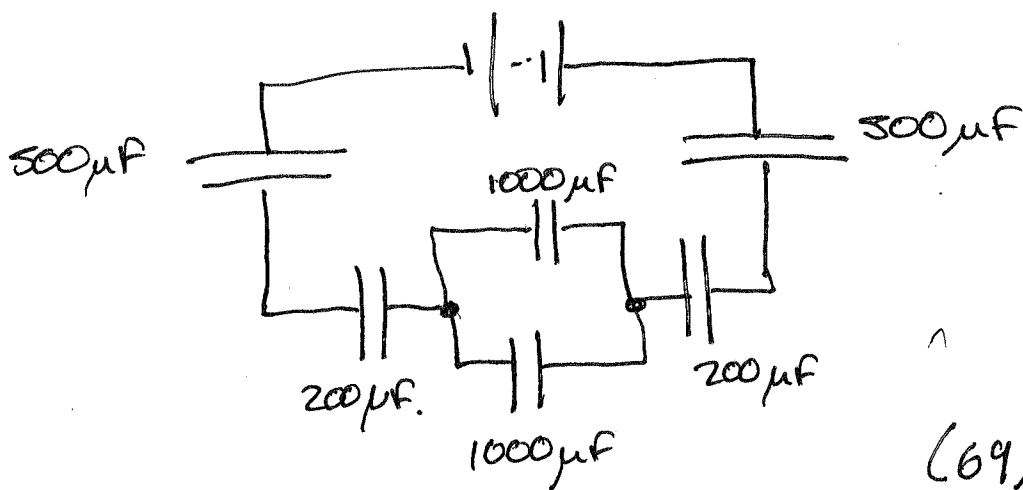
$$R_T = 2.27\Omega$$

9) DC power source has terminal voltage of 12 V. when current of 2A is used terminal voltage falls to 11 V, what is the internal resistance?
 $(R_i = \frac{E - V}{I}, 0.5 \Omega)$.

10) i) Capacitor holds 0.08 C of charge at a terminal voltage of 100V. what is its capacitance? $(Q = CV, 800 \mu F)$.

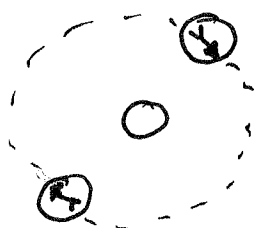
ii) Same capacitor is charged with a 12V. terminal voltage, how much energy is stored? $(E = \frac{CV^2}{2}, 0.0576 J)$.

11) Calculate total capacitance



(69μF).

12) wire carries current



which way is current flowing?

(clockwise = away) into paper.

13)



direction of induced current?

(Fleming's RH rule.
Towards reader)

14)



direction of motion
when current is
supplied

(Fleming's LH rule.
down)

15) 10/1 step down transformer
has a secondary current of 10A.
and a voltage of 200V.

Primary has 1000 turns

Calculate i) No turns on Secondary
ii) ~~R~~ Voltage and current in
primary.

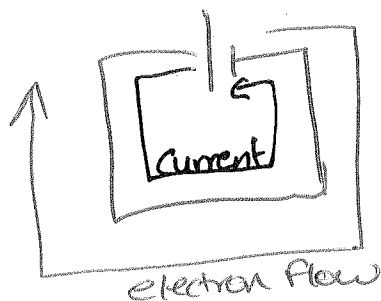
$$\frac{V_p}{V_s} = \frac{I_s}{I_p} = \frac{N_p}{N_s} = 10.$$

$$V_p = 10 V_s = 2000V.$$

$$I_p = \frac{I_s}{10} = \frac{10}{10} = 1A.$$

$$N_s = N_p / 10 = 100 \text{ turns.}$$

A)



B) $V = IR$

V - voltage
 I - Current
 R - Resistance

C) Sum of currents into and out of a node = 0.

$$\sum_{x=0}^n I_x = 0$$

D) Sum of the voltages around a closed loop = 0.

$$\sum_{x=0}^n V_x = 0.$$

E) V - Pressure
 I - flow
 r - restriction / friction.

F) i) $R_0 = 0.1 \Omega$ @ 0°C .
 $R_{200} = ?$

$$\Delta R = \alpha R_0 \Delta T$$

$$R_{200} = 0.1 + (4 \times 10^{-3} \times 0.1 \times 200)$$

$$R_{200} = 0.18 \Omega$$

ii) $R_0 = 0.2 \Omega$
 $R_{200} = 0.7$

$$R_{200} = R_0 + R_0 \alpha \Delta T$$

$$0.7 = 0.2 + 0.2 \times 200 \times \alpha$$

$$\alpha = \frac{0.7 - 0.2}{0.2 \times 200} = 1.25 \times 10^{-2}$$

$$g) R = \frac{P_L}{A} = \frac{2.65 \times 10^{-2} \text{ W}}{\pi (0.05 \times 10^{-3})^2} = 33.74 \Omega$$

$$h) Q = 100 \text{ C}$$

$$t = 50 \text{ s}$$

$$I = \frac{Q}{t} = \frac{100}{50} = 2 \text{ A}$$

$$I) E = 12000 \text{ J}$$

$$V = 12$$

$$\rightarrow E = QV$$

$$Q = \frac{E}{V} = \frac{12000}{12} = 1000 \text{ C}$$