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ENG SCIENCE 2 - M4X00386

QUESTION ONE.

a) $8\Omega + 4\Omega = 12\Omega$

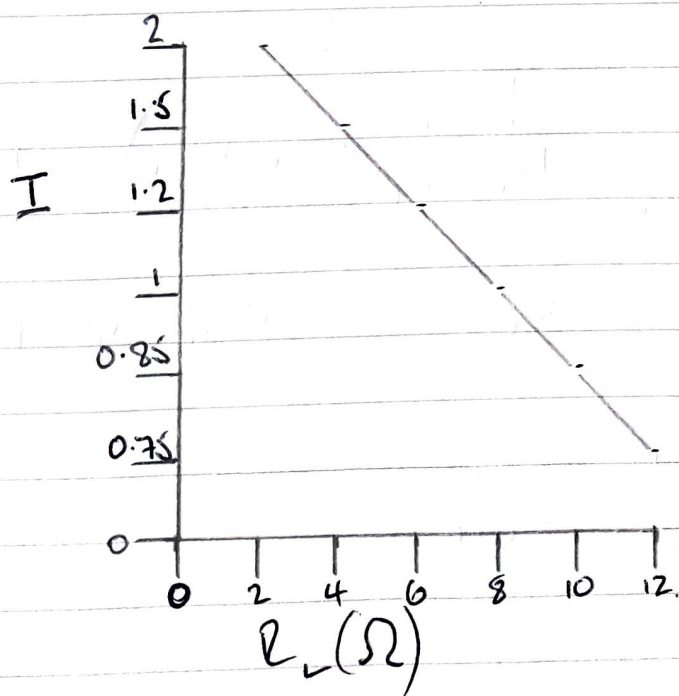
$V = 12 \therefore 12V = 1 \times 12\Omega$

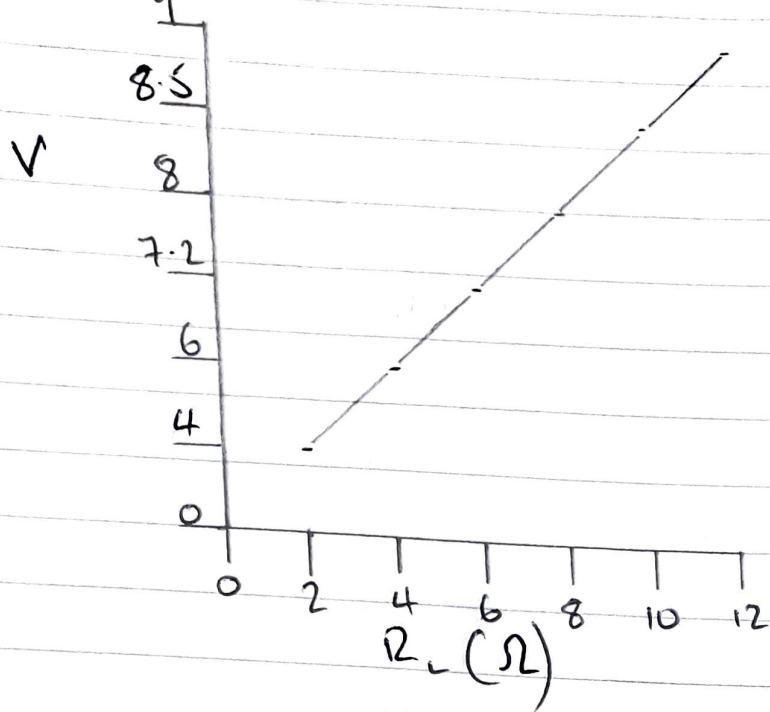
$I = \frac{12}{12} = 1A.$

$P = I^2 R_T \therefore P = 1 \times 1 \times 12 = 12W$

b)

$R_L (\Omega)$	$R_T = \frac{R_L + 4}{4}$	$I = \frac{V}{R_T}$	$V = IR_L$
2	6	2	4
4	8	1.5	6
6	10	1.2	7.2
8	12	1	8
10	14	0.85	8.5
12	16	0.75	9





c) $R_T = R_L + r$ ($R_L = 4\Omega$ for maximum power)
 $I = \frac{V}{R_L + r} \therefore I = \frac{V}{R_T}$

$$P = I^2 R_{L+r} \therefore P = I^2 R_T = \left(\frac{V}{R_L + r}\right)^2 R_T$$

$$P = \frac{V^2}{\frac{r^2}{R_L} + 2r + R_L}$$

$$\frac{dP}{dR_L} = \frac{V^2}{\frac{r^2}{R_L} + 2r + R_L} \quad \frac{d}{dR_L} \left(\frac{r^2}{R_L} + 2r + R_L \right) = 0$$

$$\frac{r^2}{R_L^2} = 1 \therefore r = R_L \quad (R_L = 4\Omega \text{ max power})$$

$$P_{\max} = \frac{V^2}{R_T} = \frac{V^2}{R_L + r} = \frac{12^2}{4+4}$$

$$P_{\max} = \frac{144}{8} = 18 \text{ W}$$

$$\begin{aligned}
 i) \quad R &= 100 \Omega \\
 \rho &= 9.81 \times 10^{-8} \Omega \text{m} \\
 d &= 0.1 \text{mm} \therefore d = 1 \times 10^{-4} \text{m} \\
 A &= \pi r^2 \therefore A = \pi (1 \times 10^{-4} \div 2)^2 = \underline{\underline{7.85 \times 10^{-9} \text{m}^2}}
 \end{aligned}$$

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

$$\frac{100 \times 7.85 \times 10^{-9}}{9.81 \times 10^{-8}} = L = 8.00 \text{m}$$

$$\begin{aligned}
 ii) \quad \text{VOLUME} &= \pi r^2 L \\
 \therefore V &= 7.85 \times 10^{-9} \times 8.00 = \underline{\underline{6.28 \times 10^{-8} \text{m}^3}}
 \end{aligned}$$

$$\begin{aligned}
 iii) \quad \text{MASS} &= \text{DENSITY} \times \text{VOLUME} \\
 \therefore \text{MASS} &= (21.45 \times 10^3) \times (6.28 \times 10^{-8}) = 1.35 \times 10^{-3} \\
 \text{COST} &= \text{COST/Kg} \times \text{MASS} \\
 \therefore \text{COST} &= (10 \times 10^3) \times (1.35 \times 10^{-3}) = \underline{\underline{13.50}}
 \end{aligned}$$

$$\begin{aligned}
 iv) \quad \text{RESISTANCE} &= \frac{\rho L}{A} \therefore \frac{\rho L}{\rho L} = \frac{RL}{\rho L} = \frac{1}{t} \therefore \text{~~1/t~~} \\
 t &= \frac{\rho L}{RL}
 \end{aligned}$$

$$t = \frac{(9.81 \times 10^{-8}) \times (0.75)}{(125) \times (3.5 \times 10^{-6})} = 1.68 \times 10^{-4} \text{m}$$

$$\begin{aligned}
 v) \quad \text{VOLUME} &= Lwt \therefore V = \text{~~8.00~~} (0.75) \times (3.5 \times 10^{-6}) \times (1.68 \times 10^{-4}) \\
 &= 4.41 \times 10^{-10} \text{m}^3
 \end{aligned}$$

$$\text{MASS} = (21.45 \times 10^3) \times (4.41 \times 10^{-10}) = 9.46 \times 10^{-6}$$

$$\begin{aligned}
 \text{COST} &= (10 \times 10^3) \times (9.46 \times 10^{-6}) = 0.095 \\
 &= 9.5p.
 \end{aligned}$$

$$d) \ i) \ D = 7.4 \text{ mm} \therefore r = \frac{d}{2} = 3.7 \text{ mm}$$

$$\text{Area} = \pi (3.7 \times 10^{-3})^2 = 4.30 \times 10^{-5} \text{ m}^2$$

$$R = \frac{\rho L}{A} \therefore \rho = \frac{RA}{L} = \rho = \frac{(3.3) \times (4.3 \times 10^{-5})}{1000}$$

$$= \underline{\underline{1.42 \times 10^{-7}}}$$

ii) STEEL WIRES CARRY LESS CURRENT THAN ALUMINIUM BECAUSE IT IS A BETTER CONDUCTOR.

THE SURROUNDING ALUMINIUM WIRES HAS A GREATER CROSS-SECTIONAL AREA, MAKING IT SIX TIMES GREATER THAN THE STEEL WIRE.

iii)

$$\text{RESISTANCE OF THE ALUMINIUM CABLES} = \frac{1}{\frac{1}{1.1}} + \frac{1}{\frac{1}{1.1}} + \frac{1}{\frac{1}{1.1}} + \frac{1}{\frac{1}{1.1}} + \frac{1}{\frac{1}{1.1}} + \frac{1}{\frac{1}{1.1}} = 6\left(\frac{1}{1.1}\right) = 5.45$$

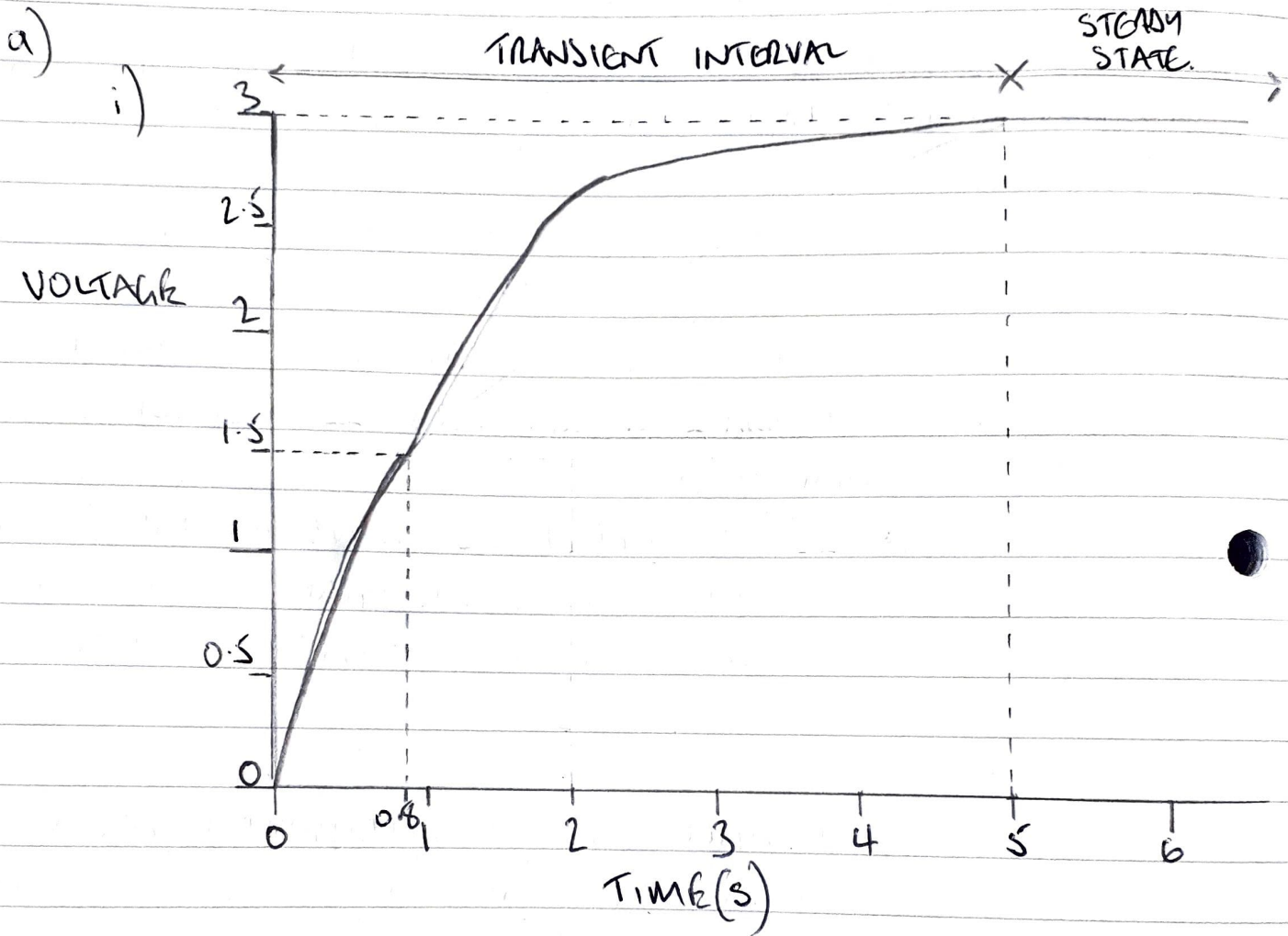
$$\therefore R_A = \frac{1}{5.45} = 0.183 \Omega$$

$$\text{RESISTANCE OF STEEL} = 3.3 \Omega$$

$$\frac{1}{0.183} + \frac{1}{3.3} = 5.77 \therefore \frac{1}{5.77} = 0.173 \Omega$$

$$V = IR \therefore R = \frac{V^2}{I} = \frac{(75)^2}{0.173} = 32.51 \times 10^3 \Omega$$

QUESTION TWO



- ii) IN ORDER TO CREATE A CHANGE IN C , WHICH WILL ALSO EFFECT V , THE DIAPHRAGM WILL NEED TO MOVE. THIS WILL ALSO CAUSE R TO CHANGE ~~AS THERE WILL BE A~~ AS THE CHANGE IN C WILL CREATE THIS. AS C AND V CHANGE SIMULTANEOUSLY $V_C + IR$ IS CONSTANT. ALSO, AS C CHANGES, SO Q WILL CHANGE. AND AS Q FLOWS THROUGH R , $V = IR$ ~~FOR~~ = RESISTOR FOR SIGNAL.

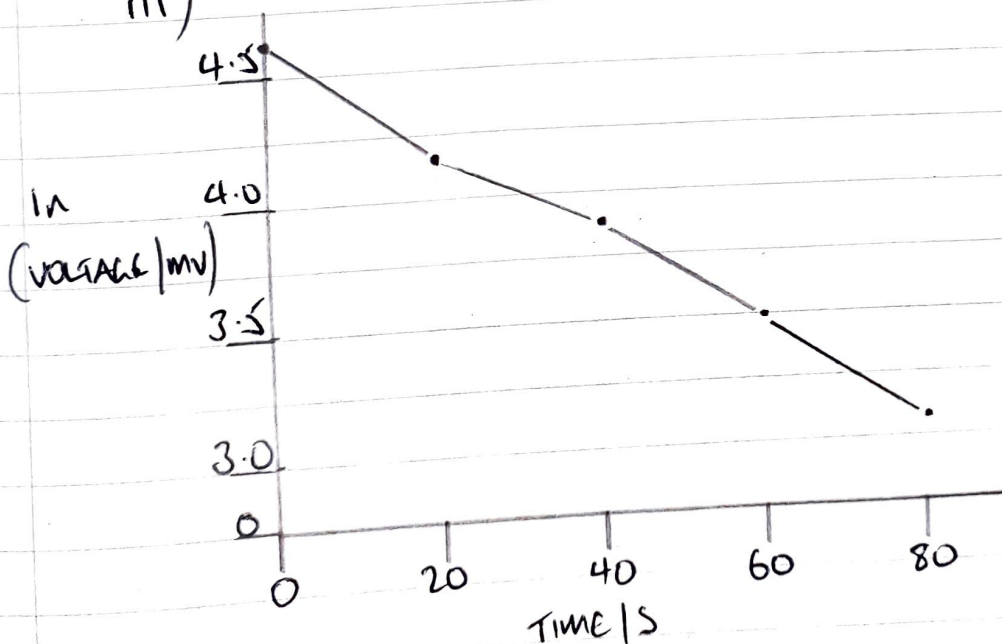
b) $Q = CV$: $Q = (0.22) \times (95 \times 10^{-3}) C = 0.021 C$

i) If $V = IR$, IN ORDER FOR V TO STAY CONSTANT, I MUST BE LOW.
THEREFORE THIS READING MUST BE VERY HIGH RESISTANCE BECAUSE VOLTMETERS DON'T DRAW MUCH CURRENT.

ii)

TIME / S	VOLTAGE / mV	$\ln(\text{VOLTAGE / mV})$
0	95	4.55
20	67	4.20
40	46	3.83
60	33	3.50
80	22	3.09

iii)



iv) AS THE GRAPH SHOWS A NEGATIVE GRADIENT, THIS WILL SHOW THAT THE VOLTAGE IS DECREASING. THE STRAIGHT LINES WILL SHOW THAT IT IS BEING DONE EXPONENTIALLY.

$$v) V = V_0 e^{-t/RC} \therefore V = \frac{95}{2.718} = 34.95 \text{ mV}$$

$$\text{GRADIENT OF GRAPH} = \frac{-1}{RC}$$
$$RC = \frac{1.46}{80} = 0.018 \therefore \frac{-1}{0.018} = -55.5 \quad \begin{array}{l} \text{DUE TO THE} \\ \text{GRAPH} \\ \text{DECREASING} \end{array}$$

$$t = RC \therefore R = \frac{t}{C} = \frac{55.5}{0.22} = 252.27 \Omega$$