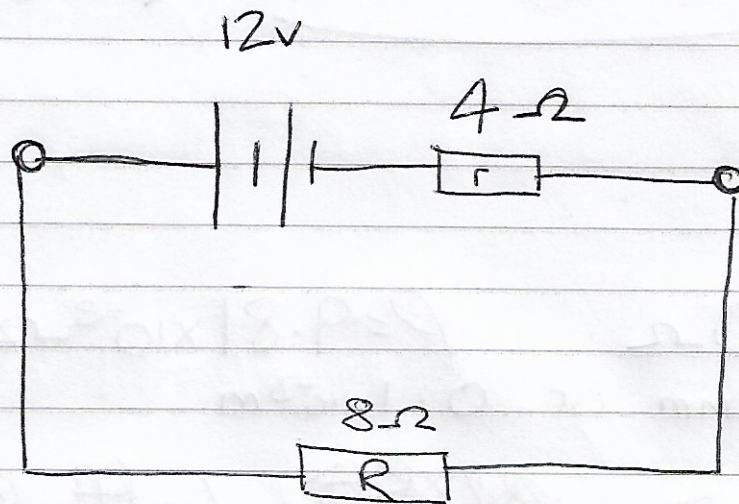


Electronics & thermodynamics assignment

Q1)



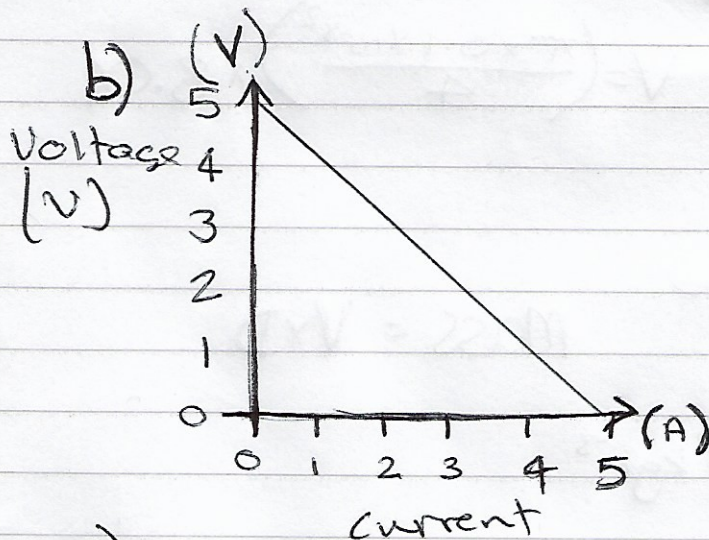
$$a) \quad \mathcal{E} = IR + Ir \quad \text{or} \quad \mathcal{E} = I(R+r)$$

$$\mathcal{E} = I(R+r) \rightarrow I = \frac{\mathcal{E}}{(R+r)}$$

$$I = \frac{12}{(8+4)} \quad I = 1A$$

$$P = I^2 R \quad P = 1^2 \times 8$$

$$P = 8W$$



c) ~~Q1~~ (A)

$$P = I^2 R \quad (1)$$

$$I = \frac{\mathcal{E}}{(R+r)} \quad (2)$$

$$(1) + (2) \quad P = \left(\frac{\mathcal{E}}{(R+r)} \right)^2 R \rightarrow P = \frac{\mathcal{E}^2}{(R+r)^2} R$$

$$P = \frac{\mathcal{E}^2 R}{(R+r)^2}$$

$$R = r \quad \text{so} \quad P = \frac{\epsilon^2 r}{(r+r)^2}$$

$$P = \frac{\epsilon^2}{4r}$$

i) $R = 100 \Omega$ $\rho = 9.81 \times 10^{-8} \Omega \text{m}$
 $d = 0.1 \text{mm}$ or $0.1 \times 10^{-3} \text{m}$

$$R = \frac{\rho L}{A} \rightarrow \cancel{R = \frac{\rho L}{A}} \quad L = \frac{RA}{\rho} \quad (1)$$

$$A = \frac{\pi d^2}{4} \quad (2)$$

$$(2) + (1) \rightarrow L = \frac{R \frac{\pi d^2}{4}}{\rho} = \frac{100 \times \left(\frac{\pi \times 0.1 \times 10^{-3}^2}{4} \right)}{9.81 \times 10^{-8}} = L$$

$$L = 8.01 \text{m}$$

ii) $V = A \times L \quad (1) \quad A = \frac{\pi d^2}{4} \quad (2)$

$$(2) + (1) \quad V = \left(\frac{\pi d^2}{4} \right) \times L \quad V = \left(\frac{\pi \times 0.1 \times 10^{-3}^2}{4} \right) \times 8.01$$

$$V = 6.29 \times 10^{-8} \text{m}^3$$

iii) $D = 21.45 \times 10^3 \text{kgm}^{-3}$ $\text{Mass} = V \times D$

$$6.29 \times 10^{-8} \text{m}^3 \times 21.45 \times 10^3 \text{kgm}^{-3}$$

$$\text{Mass} = 1.35 \times 10^{-3} \text{kg}$$

$$1.35 \times 10^{-3} \times 10,000 = \pounds 13.50$$

$$iv) R = 125 \Omega \quad L = 75 \text{ cm} \quad W = 3.5 \times 10^{-4} \text{ cm}$$

$$\rho = 9.81 \times 10^{-8} \Omega \cdot \text{m} \quad H = ?$$

$$L = \frac{RA}{\rho} \rightarrow L = \frac{R(W \times H)}{\rho} \rightarrow LP = R(W \times H)$$

$$LP = RW \times RH \rightarrow \frac{LP}{RW} = RH \quad \left(\frac{LP}{RW} \right) \frac{1}{R} = H$$

$$\left(\frac{75 \times 9.81 \times 10^{-8}}{125 \times 3.5 \times 10^{-4}} \right) \div 125 = 1.35 \times 10^{-6} \text{ cm}$$

$$v) V = A \times L \quad V = (W \times H) L$$

$$V = (3.5 \times 10^{-4} \times 1.35 \times 10^{-6}) 75 \quad V = 3.54 \times 10^{-8}$$

$$\text{Mass} = V \times D \quad 3.54 \times 10^{-8} \times 21.45 \times 10^3$$

$$\text{Mass} = 7.59 \times 10^{-4} \text{ kg}$$

$$7.59 \times 10^{-4} \times 10,000 = \text{£ } 7.59$$

$$D) L = 1 \text{ km or } 1000 \text{ m} \quad d = 7.4 \text{ mm or } 0.0074 \text{ m}$$

$$R = ?$$

$$R = 3.3 \Omega$$

$$R = \frac{\rho L}{A} \rightarrow \frac{\rho A}{L} = R \rightarrow \frac{\rho \left(\frac{\pi d^2}{4} \right)}{L} = R$$

$$\frac{3.3 \left(\frac{\pi (0.0074)^2}{4} \right)}{1000} = 1.42 \times 10^{-7} \Omega \cdot \text{m}$$

ii) the resistivity of the two materials is different. the current is trying to take the easier route meaning less current will travel through the steel.

iii) $P = \frac{V^2}{R}$

Steel $R = 3.3 \Omega$

aluminium $R = 1.1 \times 6 = 6.6 \Omega$

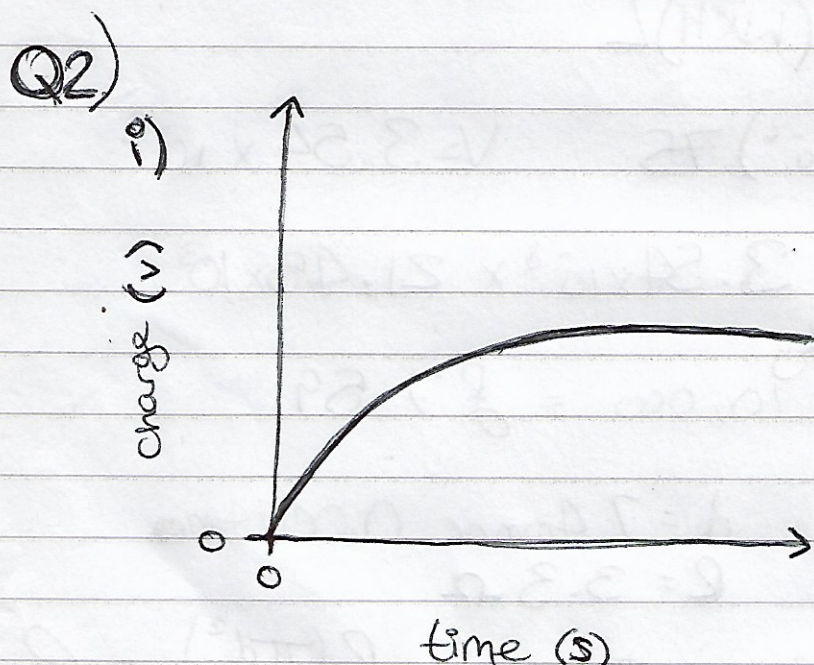
Cable $= 3.3 + 6.6 = 9.9 \Omega$

$R = 9.9 \Omega$

$V = 75 \text{ V}$

$P = \frac{75^2}{9.9}$

$P = 568.19 \text{ W}$



ii) As the gap between the diaphragm plates decreases, Capacitance increases, allowing a charging current to continue. as the gap increases, Capacitance decreases, starting discharge. This causes a fluctuation of Potential difference across the resistor

b) $Q = 0.22 \text{ f}$ $V = 95 \times 10^{-3} \text{ V}$

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

$C = \frac{0.22}{95 \times 10^{-3}}$

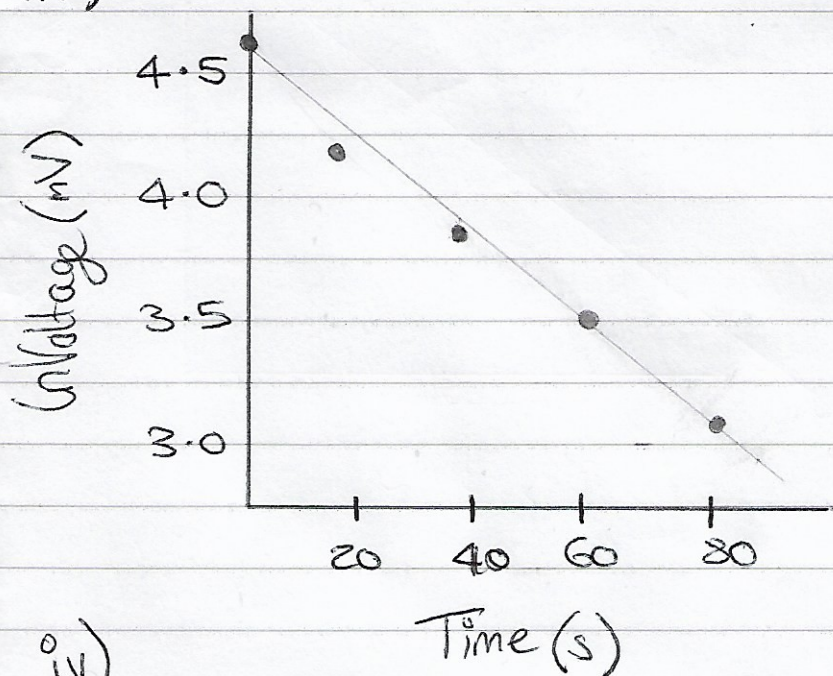
$C = 2.32 \text{ C}$

i) the Voltmeter is measuring total DC drop. A capacitor is an alternating current.

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Time	Voltage (mV)	ln Voltage (mV)
0	95	4.55
20	67	4.20
40	46	3.83
60	33	3.50
80	22	3.09

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A log graph is the inverse to an exponential graph. So the straight line decrease on the above graph is the same as a curved decrease on an exponential graph using the original voltage figures.

$$v) V = V_0 e^{-\frac{t}{RC}}$$

$$\ln V = \ln V_0 - \frac{t}{RC}$$

$$\ln \frac{V}{V_0} = -\frac{t}{RC}$$

$$R = \frac{-t}{\ln\left(\frac{V}{V_0}\right)C}$$

~~$$R = \frac{-t}{\ln\left(\frac{V}{V_0}\right)C}$$~~

$$R = \frac{-20}{\ln\left(\frac{67 \times 10^{-3}}{95 \times 10^{-3}}\right) \times 0.22}$$

$$R = 260.35 \Omega$$

Q3)

Saturated 3kg 1.6Mpa x0.4	Superheated 2.7kg 1.2Mpa 120°C	Mixed $m_a + m_b = 5.7\text{kg}$ 0.9Mpa
TANK A	TANK B	FINAL STATE

	P(kPa)	v(m³/kg)	T(°C)	u(kJ/kg)	x	M(kg)	V(m³)
TANK A	1600	5.41×10^{-3}	57.88	184.05	0.4	3	0.016
TANK B	1200	0.024	120	325.03		2.7	0.065
FINAL	900	0.014	35.51	188.16		5.7	0.081

$$V(\text{m}^3) = m \cdot v$$

$$u(\text{kJ/kg}) = u_f + x \cdot u_{fg}$$

$$v(\text{m}^3/\text{kg}) = v_f + x \cdot v_{fg}$$

$$a) \quad y = y_f + (x \cdot y_{fg})$$

$$y_{fg} = y_g - y_f$$

$$y_{fg} = 248.85 - 100.83$$

$$y_{fg} = 148.01$$

$$y = 188.16$$

$$y_f = 100.83$$

$$y = y_f + (x \cdot y_{fg})$$

$$x = \frac{(y - y_f)}{y_{fg}}$$

$$x = \frac{(188.16 - 100.83)}{148.01}$$

$$x = 0.59$$

b)

$$U_2 - U_1 = Q - W$$

$$W = 0$$

$$U_2 - U_1 = Q \quad (1)$$

$$U_1 = (m_a \times u_a) + (m_b \times u_b) \quad (2)$$

$$U_2 = (m_a + m_b) u_2 \quad (3)$$

$$(1) + (2) + (3)$$

$$[(m_a + m_b) u_2] - [(m_a \times u_a) + (m_b \times u_b)] = Q$$

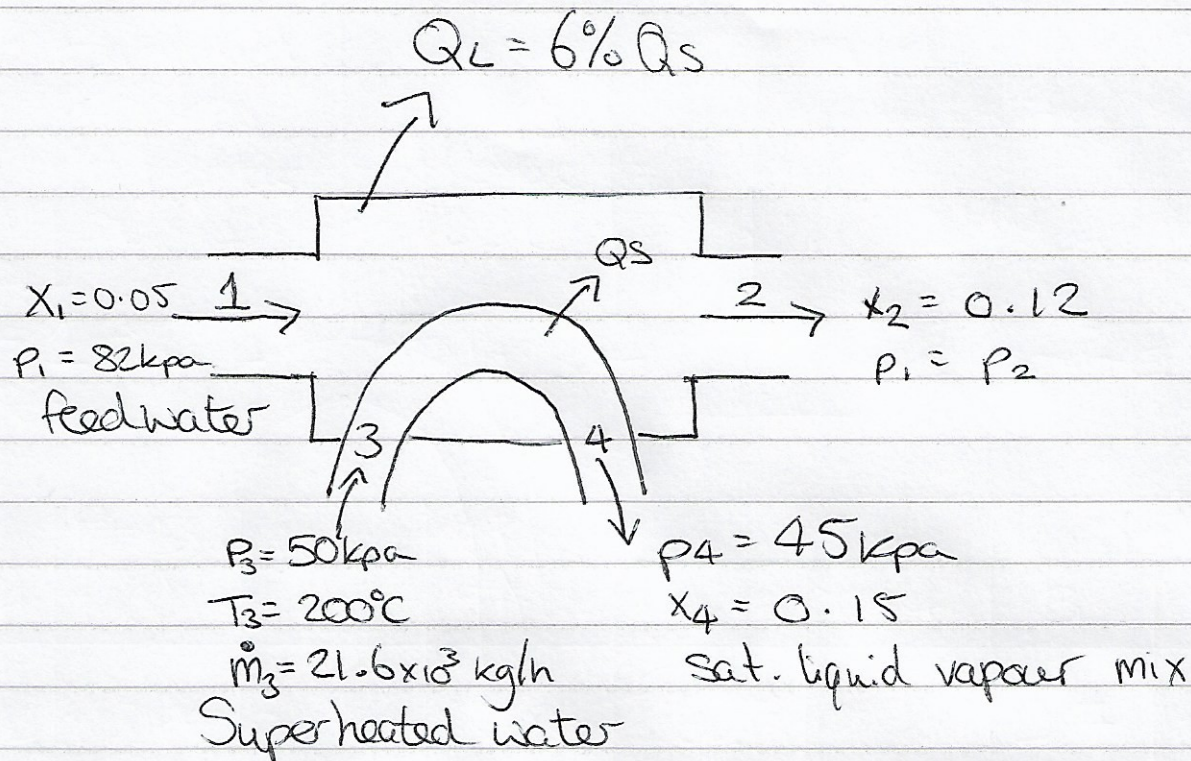
$$[(3 + 2.7) \times 188.16] - [(3 \times 184.05) + (2.7 \times 325.03)] = Q$$

$$(5.7 \times 188.16) - (552.15 + 877.58) = Q$$

$$1072.51 - 1429.73 = Q$$

$$-357.22 = Q$$

Q4)



a) $Q_S = \dot{m}_p (h_4 - h_3)$ pipe balance = $\dot{m}_3 = \dot{m}_4 (\dot{m}_p)$

$h = h_f + (x \cdot h_{fg})$

$h_f = 329.55 \text{ kJ/kg}$

$h_{fg} = 2311.31 \text{ kJ/kg}$

$h_4 = 676.25 \text{ kJ/kg}$

$x = 0.15$

$h_3 = 2855.8 \text{ kJ/kg}$

$\dot{m}_3 = 21.6 \times 10^3 \text{ kg/h} \div 3600 = 6 \text{ kg/s}$

$Q_S = 6 \times (676.25 - 2855.8)$

$Q_S = -13077.3 \text{ J/s}$

b) $Q_L = \dot{m}_w (h_2 - h_1) \therefore \dot{m}_w = \frac{Q_L}{(h_2 - h_1)}$

$h = h_f + (x \cdot h_{fg})$

$h_1 = 394.44 + (0.05 \times 2271.81)$

$h_1 = 508.03 \text{ kJ/kg}$

$h_2 = 394.44 + (0.12 \times 2271.81)$

$h_2 = 667.06 \text{ kJ/kg}$

$Q_L = -13077.3 \times 0.06$

$Q_L = -784.64 \text{ J/s}$

$\dot{m}_w = \frac{Q_L}{(h_2 - h_1)} \therefore \dot{m}_w = \frac{784.64}{(667.06 - 508.03)} \dot{m}_w = 4.93 \text{ kg/s}$