

Question 2

a, i)

$$E = \frac{1}{2} \text{ charge} \times V$$

When

$$V = 8 \text{ kV} = 8 \times 10^3 \text{ V}$$

$$Q = 10 \mu\text{C} = 10 \times 10^{-6} \text{ C}$$

$$E = \frac{1}{2} QV \therefore E = \frac{1}{2} \times (10 \times 10^{-6}) \times (8 \times 10^3) = 0.04 \text{ J}$$

ii)

$$C = 10 \mu\text{F}$$

$$I = 200 \mu\text{A}$$

$$P_{\text{dr}} V = 2000 \text{ V}$$

$$Q = CV \therefore (10 \times 10^{-6}) \times 2000 = 0.02 \text{ C}$$

$$t = \frac{Q}{I} \therefore \frac{0.02}{200 \times 10^{-6}} = 100 \text{ s}$$

b)

Capacitor x

$$C = 1000 \mu\text{F} = 1000 \times 10^{-6} \text{ F}$$

$$Q = CV$$

$$V = 1 \text{ V}$$

capacitor y

$$C = 100 \mu\text{F} = 100 \times 10^{-6} \text{ F}$$

therefore

$$Q_x = (1000 \times 10^{-6}) \times 1 = 1000 \times 10^{-6} \text{ F}$$

$$Q_y = 100 \times 10^{-6} \text{ F}$$

$$\frac{Q_x}{Q_y} = \frac{1000 \times 10^{-6}}{100 \times 10^{-6}} = 10 \text{ F}$$

capacitor x

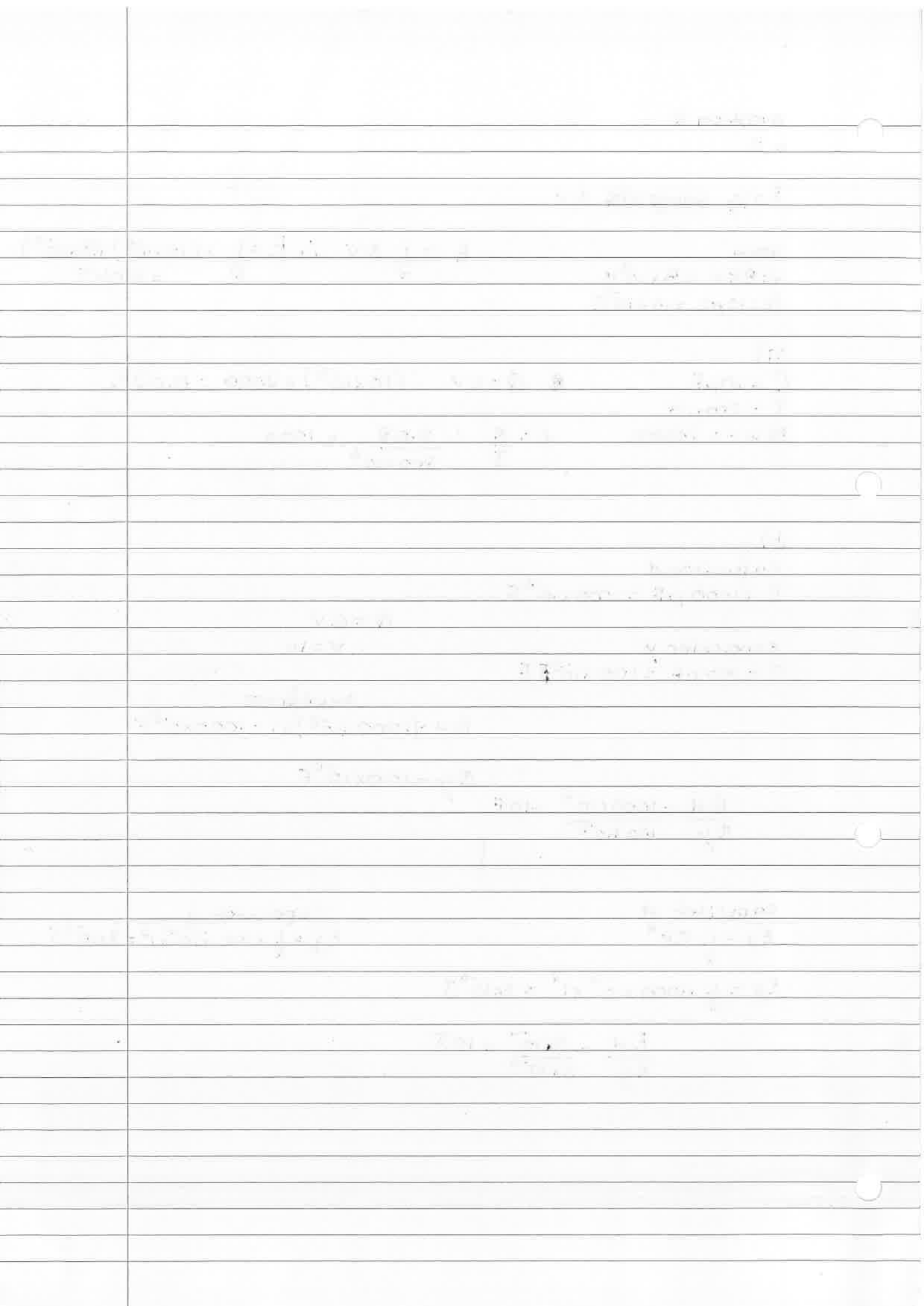
$$E_x = \frac{1}{2} CV^2$$

$$E_x = \frac{1}{2} \times 1000 \times 10^{-6} \times 1^2 = 5 \times 10^{-4} \text{ J}$$

capacitor y

$$E_y = \frac{1}{2} \times 100 \times 10^{-6} \times 1^2 = 5 \times 10^{-5} \text{ J}$$

$$\frac{E_x}{E_y} = \frac{5 \times 10^{-4}}{5 \times 10^{-5}} = 10 \text{ J}$$



COURSE WORK SCIENCE

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Question 1:

$$R = 100 \Omega$$

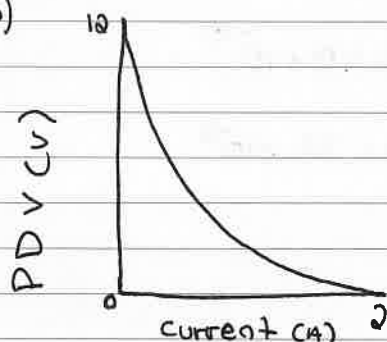
$$e = 9.81 \times 10^{-8} \Omega \text{m}$$

$$D = 0.050 \mu\text{m} = 5 \times 10^{-5} \text{m}$$

$$a) \frac{V}{R} = \frac{12 \text{V}}{16 \Omega} = 0.75 \text{Amps}$$

$$P = I^2 R \therefore 0.75^2 \times 10 = 5.625 \text{W}$$

b)



$$V = E - IR \quad V = 0$$

$$V = 12 - I6 \quad I = 2$$

$$0 = 12 - 6 \times 2$$

$$c) V = IR \therefore I = \frac{V}{R} \Rightarrow \frac{12}{6+6} = 1 \text{Amps}$$

$$P = I \times V \therefore 1 \times 12 = 12 \text{W}$$

$$P = I^2 R = \frac{P}{I^2} = \frac{12}{1^2} = 12 \Omega$$

$$i) R = \frac{eL}{A} \therefore L = \frac{RA}{e} \Rightarrow \frac{100 \times 1.96 \times 10^{-9}}{9.81 \times 10^{-8}} = 2.00 \text{m}$$

$$ii) A \times L = \text{Volume}$$

$$1.96 \times 10^{-9} \times 2.00 = 3.92 \times 10^{-9} \text{m}^3$$

$$iii) m = d \times V \rightarrow \text{volume}$$

density

$$= 21.45 \times 10^3 \times 3.92 \times 10^{-9} = 8.41 \times 10^{-5} \text{kg}$$

$$\frac{1 \text{kg}}{8.41 \times 10^{-5}} = 10.000 \pm$$

$$R = \frac{8.41 \times 10^{-5} \times 10.000}{1} = 84 \text{P}$$

iv)

$$R = 100 \Omega$$

$$W = 4.0 \times 10^{-4} \text{ cm to meters } 4 \times 10^{-6} \text{ m}$$

$$L = 81 \text{ cm} \Rightarrow 0.81 \text{ m}$$

$$\frac{P}{L} = \frac{RA}{L} \quad A = \frac{PL}{R} = \frac{(9.81 \times 10^{-8})(0.81)}{100} = 7.95 \times 10^{-10} \text{ or } 8 \times 10^{-10}$$

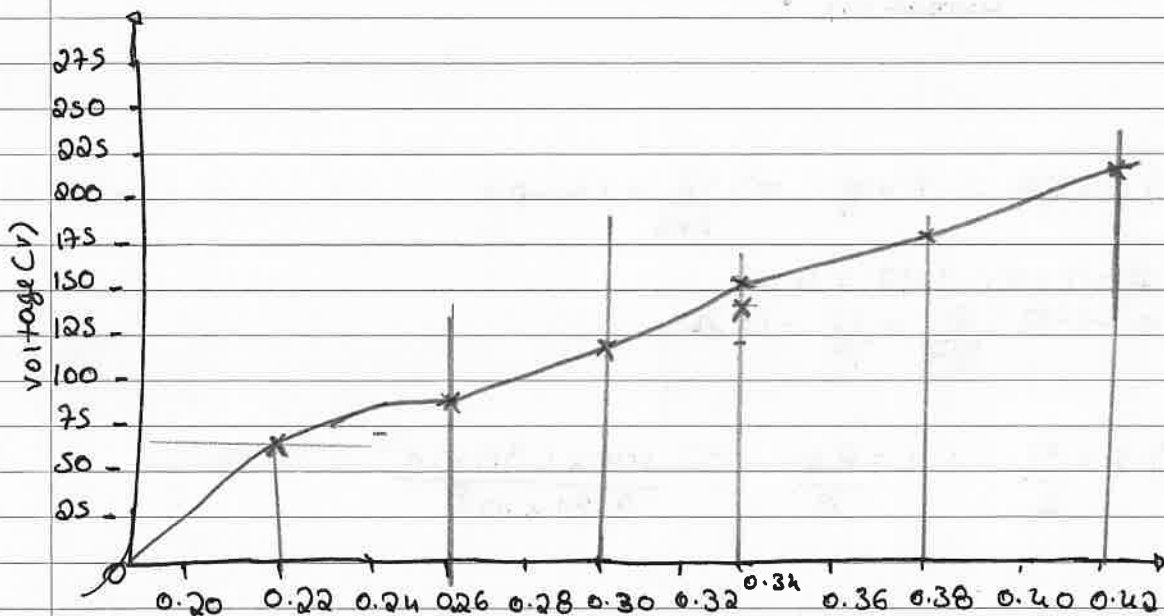
$$A = 8 \times 10^{-10}$$

$$\text{thickness} = \frac{8 \times 10^{-10}}{4 \times 10^{-6}} = 2 \times 10^{-4} \text{ m}$$

$$v) t \times A = V \quad \therefore 2 \times 10^{-4} \times 3.24 \times 10^{-6} = 6.48 \times 10^{-10}$$

$$V \times D = M \quad \therefore 6.48 \times 10^{-10} \times 21.45 \times 10^3 = 1.39 \times 10^{-5}$$

$$1.39 \times 10^{-5} \times 10.000 \text{ kg}^{-1} \text{ g} = 0.14 \text{ p}$$



proportional graphic with straight line indicating
the constant gradient is anywhere in the graphics.

Question 3

initial
 $v_1 = 0.52 \text{ m}^3$
 $P_1 = 1.5 \times 10^5$

final
 $v_2 = 0.2 \text{ m}^3$
 $P_2 = 5 \text{ bar} = 5 \times 10^5$

$$T = 85^\circ\text{C} + 273 = 358 \text{ K}$$

$$R = 0.2598 \text{ according to table}$$

$$a) \quad m = \frac{P_1 v_1}{RT} \Rightarrow m = \frac{(1.5 \times 10^5) \times 0.52}{0.2598 \times 358} = 838.634 \times 10^{-3} = 0.84 \text{ kg}$$

$$b) \quad P_1 v_1^\gamma = P_2 v_2^\gamma \Rightarrow \frac{P_1}{P_2} = \frac{v_2^\gamma}{v_1^\gamma} \Rightarrow$$

take log

$$\log\left(\frac{P_1}{P_2}\right) = \log P_1 - \log P_2$$

$$\log\left(\frac{v_2^\gamma}{v_1^\gamma}\right) = \gamma \log v_2 - \gamma \log v_1 \quad \therefore \gamma = \frac{\log P_1 - \log P_2}{\log v_2 - \log v_1}$$

$$= \log(1.5 \times 10^5) - \log(5 \times 10^5) = \gamma (\log(0.2) - \log(0.52))$$

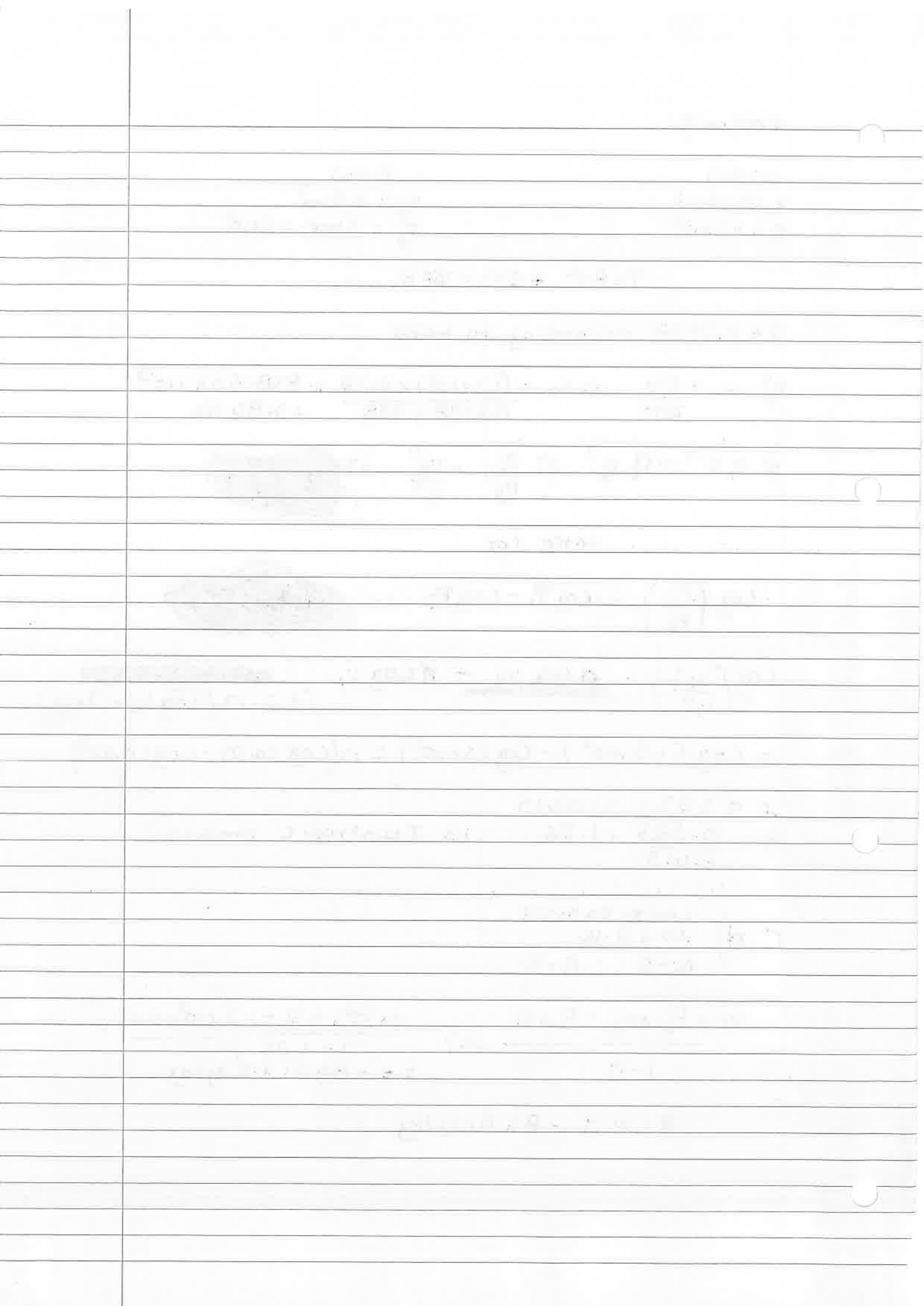
$$= 0.523 = \gamma - 0.415$$

$$\gamma = \frac{0.523}{0.415} = 1.26 \quad \text{is Isentropic process}$$

c, d) Energy Balance
 $\Delta U = Q - W$
 $\Delta U = 0 \quad \therefore Q = W$

$$W = \frac{P_2 v_2 - P_1 v_1}{1 - \gamma} \Rightarrow \frac{5 \times 10^5 \times 0.2 - 1.5 \times 10^5 \times 0.52}{1 - 1.26} = -84.61 \times 10^3 \text{ kJ/kg}$$

$$Q = W = -84.61 \text{ kJ/kg}$$



Question ④

system → Entire Heat Exchange

mass balance : $\dot{m}_1 = \dot{m}_2$
 $\dot{m}_3 = \dot{m}_4$

Energy balance :

$$\dot{Q}_T = \dot{m}_2 (h_2) + \dot{m}_4 (h_4) - \dot{m}_3 (h_3) - \dot{m}_1 (h_1)$$

system → super heated pipe

mass balance : $\dot{m}_1 = \dot{m}_2$

Energy balance :

$$\dot{Q}_i = \dot{m}_2 h_2 - \dot{m}_1 h_1$$

system : the cool water

mass balance : $\dot{m}_3 = \dot{m}_4$

Energy balance : $(-\dot{Q}_T) + \dot{Q}_i = \dot{m}_4 h_4 - \dot{m}_3 h_3$

Superheated water ①

$P_1 = 10 \text{ bar}$

$T_1 = 200^\circ\text{C} \rightarrow \text{K} (200 + 273)$ not needed conversion

based on table A-6

$v_1 = 0.20602 \text{ m}^3/\text{kg}$

$u_1 = 2632.3 \text{ kJ/kg}$

$h_1 = 2878.3 \text{ kJ/kg}$

feed water ③

$T_3 = 50^\circ\text{C}$

$x = 0.2$

$P_3 =$

U
 V

saturated liquid ②

$P_2 = 10 \text{ bar}$

$T_2 = ?$

based on table A-4

~~$v_2 = 0.15437 \text{ m}^3/\text{kg}$~~

~~$u_2 = 2580.8 \text{ kJ/kg}$~~

~~$h_2 = 2777.1 \text{ kJ/kg}$~~

$v_2 = 0.001157$

$u_2 = 880.46$

$h_2 = 882.26$

④

$T_4 = T_2 - 10^\circ$

$x = 0.23$

$\dot{m}_4 = 3 \times 10^5 \text{ g/min}$

a) $T_2 = ?$

I know doesn't mean any sense
but can't remember other way

$T(^{\circ}\text{C})$

$P \text{ kPa}$

$\Delta T \begin{pmatrix} 175 \\ +2 \\ \downarrow \\ 180 \end{pmatrix} \Delta T$

$\Delta P \begin{pmatrix} 892.6 \\ \downarrow \\ 1000 \\ 1002.8 \end{pmatrix} \Delta P$

$S \begin{matrix} \nearrow 110.2 \\ \searrow 107.4 \end{matrix}$

$5 \times 107.4 = \Delta T \cdot 110.2$

$T_2 = 175 + 4.87 = 179.87^{\circ}\text{C}$

$\Delta T = \frac{5 \times 107.4}{110.2} = 4.87$

b) $Q_i = ?$

$h_3 = h_f + x \cdot h_{fg} = 209.34 + 0.22 \times 2382.0$
 $= 685.74 \text{ kJ/kg}$

(h_u)

$h_u = h_f + x \cdot h_{fg} = 718.5 + 0.23 \times 2049.24$
 $= 1189.84 \text{ kJ/kg}$

$T(^{\circ}\text{C})$

$\Delta T \begin{pmatrix} 165 \\ \downarrow \\ 169.87 \\ \downarrow \\ 170 \end{pmatrix} \Delta T$

$h_{fg} \begin{pmatrix} 2065.6 \\ \downarrow \\ 2049.24 \end{pmatrix} \Delta h_{fg}$

$S \begin{matrix} \nearrow 16.8 \\ \searrow \Delta h_{fg} \end{matrix}$

$\frac{4.87 \times 16.8}{5} = \Delta h_{fg} \therefore \Delta h_{fg} = 16.36$

$h_{fg} = 2065.6 - \Delta h_{fg} = 2049.24 \text{ kJ/kg}$

$\Delta T \begin{pmatrix} 165 \\ \downarrow \\ 169.87 \\ \downarrow \\ 170 \end{pmatrix} \Delta T$
 $h_u \begin{pmatrix} 687.24 \\ \downarrow \\ h_f \\ \downarrow \\ 718.08 \end{pmatrix} \Delta h_f$

$21.84 \times 4.87 = 5 \Delta h_f$
 $\Delta h_f = 21.27$

$h_f = 687.24 + 21.27 = 718.51 \text{ kJ/kg}$

$Q_T + Q_i = m_u h_u - m_3 h_3$

$-5 + Q_i = (3 \times 10^5)(1189.84) - (3 \times 10^5)(685.74)$

$-5 + Q_i = 151\,230\,000$

$Q = 151\,230\,000 - 72\,014\,28.571 = 144\,020\,571.4$