



12 Pages

1. Please give the information requested in the boxes below.
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3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
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1	Student Number	173733
2	Title of Examination Paper	THERMO 2
3	Module Code	SGDM 5012
4	Date and Time of Examination	17/1/20 9:30
5	Examination Venue	C27
6	Seat Number	
7	Number of Answer Books handed in	

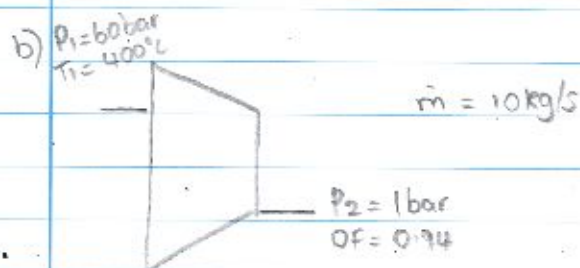
[illegible]

(Gweler yr ochr arall am y fersiwn Cymraeg)

- 1a) Isentropic Efficiency = The actual work output of the turbine if it goes through an isentropic process between its inlet and exit.
- $$\eta = \frac{h_1 - h_2}{h_1 - h_2'}$$

(3)

An ideal cycle happens over a longer duration.



- i) $P = \dot{m} w$
 $w = h_1 - h_2$ ✓
 $h_1 = 3175$ $h_2 = 2545$ ✓
 $\therefore P = 3175 - 2545 = 630 \text{ kJ/kg}$
 $P = 10 \times 630$ ✓
 $P = 6300 \text{ W}$

(5)

- ii) $P = 4.5 \text{ bar}$ $T = 150^\circ\text{C}$ ✓

(5)

- iii) $\eta = \frac{h_1 - h_2}{h_1 - h_2'} = \frac{630}{3175 - 2380} \times 100 = 79.24\%$ ✓

(5)

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$$4000 \text{ kN} = 4 \text{ bar}$$

$$45.30 + 463.34 = \frac{P_2}{900 \times 9.81} + 649.27 + 12 + 1.2$$

$$508.64 = \frac{P_2}{900 \times 9.81} + 662.47$$

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2a)



$$P_1 = 4000 \text{ kN/m}^2 (4 \text{ bar})$$

$$\dot{Q} = 100 \text{ L/s}$$

$$\rho = 900 \text{ kg/m}^3$$

$$\text{Inlet } \phi = 120 \text{ mm}$$

$$\text{Outlet } \phi = 100 \text{ mm}$$

$$h_f = 1.2 \text{ m}$$

$$C = \frac{\dot{Q}}{A}$$

$$A_1 = \pi \times 0.06^2 = 0.011 \text{ m}^2$$

$$A_2 = \pi \times 0.05^2 = 7.85 \times 10^{-3}$$

$$C_1 = 9090.9 \text{ m/s}$$

$$C_2 = 12738.85 \text{ m/s}$$

$$\frac{P_1}{\rho g} + \frac{C_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{C_2^2}{2g} + z_2 + h_f$$

$$\frac{4 \times 10^5}{900 \times 9.81} + \frac{9090.9^2}{2 \times 9.81} + 0 = \frac{P_2}{900 \times 9.81} + \frac{12738.85^2}{2 \times 9.81} + 12 + 1.2$$

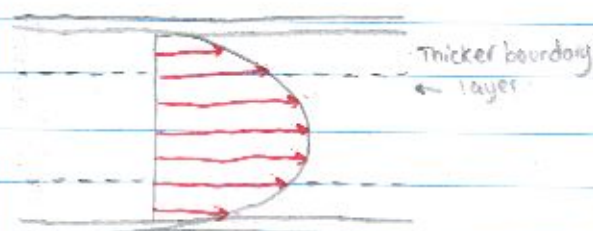
X

Litres into m/s ???

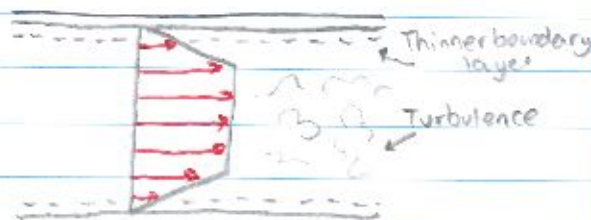
b) The upper critical Reynolds number tells us whether the flow is turbulent or not. It also tells us about the size of the boundary layer.

The lower critical number also tells us how turbulent the flow is, and is usually laminar.

Osborne Reynolds conducted an experiment where he introduced a dye into a water system. At the end of the system was a flow control valve which was used to control the water velocity. The behaviour of the dye when introduced to the flow told him whether it was turbulent or laminar.



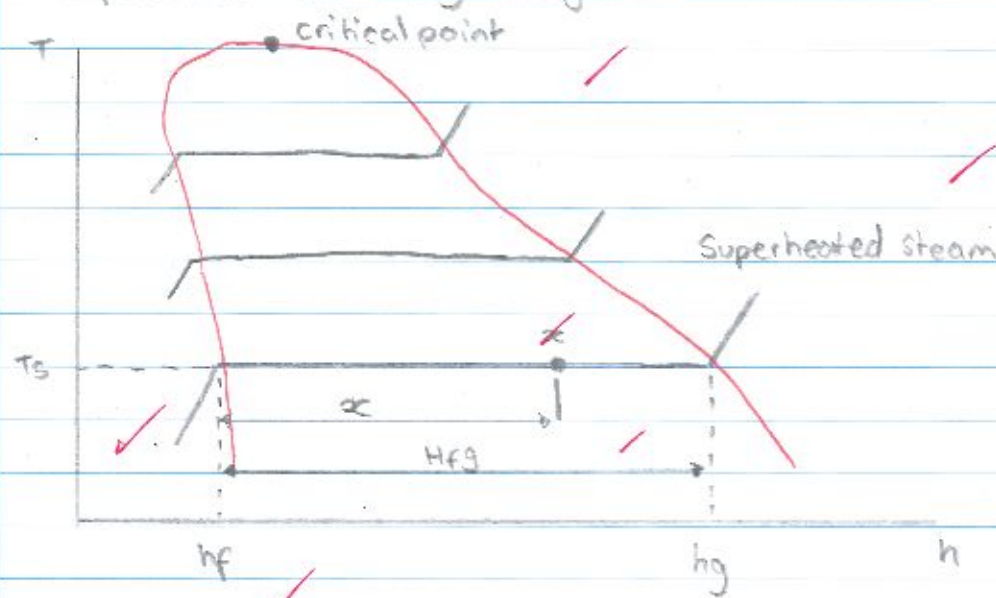
Laminar Flow



Turbulent Flow

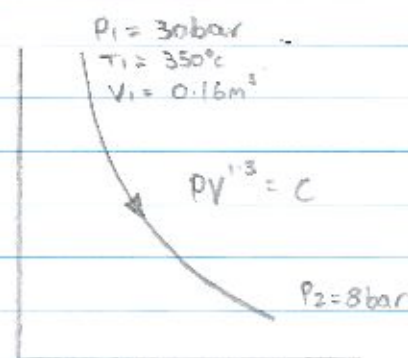
3)

Temperature - Enthalpy diagram



(5)

b)



$$i) P_1 V_1^{1.3} = P_2 V_2^{1.3} = 30 \times 10^5 \times 0.16^{1.3} = 8 \times 10^5 \times V_2^{1.3}$$

$$V_2 = 1.3 \sqrt[1.3]{0.34} = 0.44 \text{ m}^3$$

$$\text{mass of steam} = \frac{V_1}{v_1} = \frac{0.16}{0.0905} = 1.76 \text{ kg}$$

$$ii) \text{Dryness Fraction} = \frac{V_2}{v_2} = \frac{0.44}{0.2403} = 1.83 \text{ dry}$$

$$V_g @ 8 \text{ bar} = 0.2403$$

$$iii) \text{Specific WD} = \frac{P_1 V_1 - P_2 V_2}{n-1} = \frac{30 \times 10^5 \times 0.0905 - 8 \times 10^5 \times 0.2403}{1.3-1}$$

$$\text{Specific WD} = 22.4125 \text{ or } 22.4 \text{ kJ}$$

(1)

$$PV = mRT$$

$$BP = \frac{P_{atm} \cdot A \cdot L \cdot N}{2}$$

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4)



$$N = 2500 \text{ RPM}$$

$$\phi = 110 \text{ mm} \quad L = 100 \text{ mm} \quad A/F = 14/1$$

$$sfc = 0.364 \text{ kg/kWh} \quad P_{atm} = 1.01$$

$$T = 15^\circ \text{C} \quad CV = 44,200 \text{ kJ/kg} \quad R = 287$$

i) Brake Thermal Efficiency = $\frac{BP}{FP}$

$$\text{Brake Power} = T \cdot \omega$$

$$\omega = \frac{2500 \times 2\pi}{60} = 261.79$$

$$BP = 220 \times 261.79 = 57593.8 \text{ W or } 57.59 \text{ kW}$$

$$FP = m_f \times CV = 5.82 \times 10^{-3} \times 44,200 = 257.37 \text{ kW}$$

$$\therefore \text{BTE} = \frac{57.59}{257.37} = 22.37\%$$

$$m_f = sfc \times BP$$

$$m_f = 0.364 \times 57.59$$

$$m_f = 5.82 \times 10^{-3}$$

ii) Volumetric Efficiency = $\frac{\text{Total volume induced into cylinder}}{\text{Swept volume}}$

$$\text{fuel} = 5.82 \times 10^{-3} \text{ kg}$$

$$\text{air} = 14 \times 5.82 \times 10^{-3} = 0.08148 \text{ kg}$$

$$\text{Total} = 0.0873 \text{ kg}$$

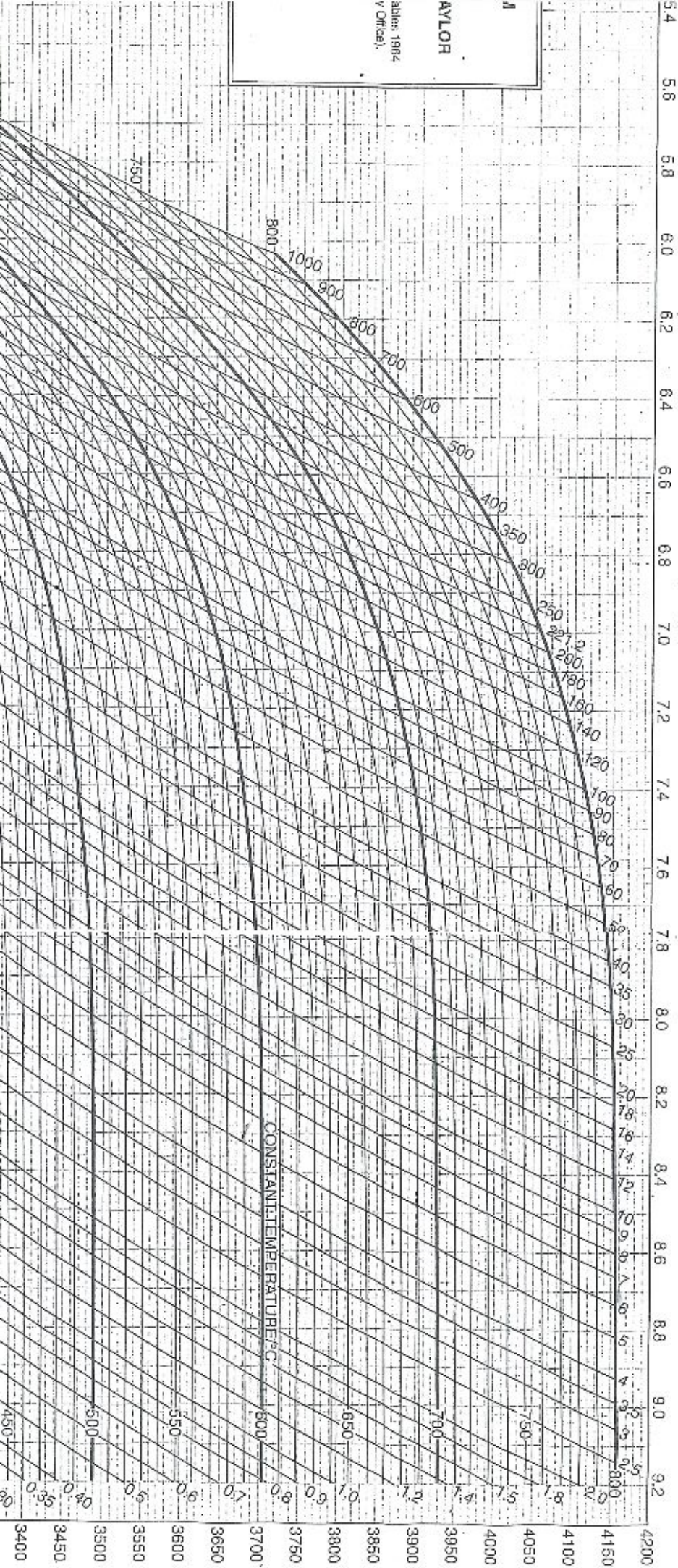
$$PV = mRT \text{ so } V = \frac{mRT}{P} = \frac{0.0873 \times 287 \times 287}{1.01 \times 10^5} = 0.071 \text{ m}^3$$

$$\text{Swept volume} = A \times L \text{ so } (\pi \times 0.055^2) \times 0.1 = 9.5 \times 10^{-4} \times \frac{2500}{60 \times 2}$$

$$SV = 0.019 \text{ m}^3$$

$$VE = \frac{0.071}{0.019} \times 100 = 37.6\%$$

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Tables 1984
V Office)

AYLOR

A