

12 Pages

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
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.
6. No part of this book is to be torn out; it must be handed in complete.
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1	Student Number	204485
2	Title of Examination Paper	THERMO 2
3	Module Code	SG-DM 5012
4	Date and Time of Examination	09:30 17/1/2020
5	Examination Venue	
6	Seat Number	
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
1	13
2	16
3	17
4	25
Total	71%

- i) **Isentropic efficiency** is the degree of degradation in a system. It is a comparison between the actual output of a system and the output of a system in an ideal scenario measured as a percentage.

①

b) $P_1 = 60 \text{ bar}$ $T_1 = 400^\circ\text{C}$

$P_2 = 1 \text{ bar}$

$P = \dot{m} \times W$

$W = h_1 - h_2$

$h_1 = 3180 \text{ kJ/kg}$ ✓

$W = 3180 \text{ kJ/kg} - 2540 \text{ kJ/kg}$

$h_2 = 2540 \text{ kJ/kg}$ ✓

$W = 640 \times 10^3 \text{ J/kg}$

$h_2' = 2370 \text{ kJ/kg}$ ✓

$\dot{m} = 10$

$P = 10 \times 6.4 \times 10^3$

$P = 6.4 \times 10^4 \text{ W}$ ✓

⑤

- ii) The pressure expansion will occur is 4.3 bar and at approximately 120° as this is when it passes the saturation line

②

iii) $\frac{h_1 - h_2}{h_1 - h_2'} = \frac{3180 - 2540}{3180 - 2370} \times 100$

79.01% ✓

⑤

13

2a) $P_1 = 400 \text{ kN/m}^2$ $Q = 100 \text{ L/s}$ $Z_2 = 12 \text{ m}$
 $\theta_1 = 0.12$ $\text{Losses} = 1.2 \text{ m}$
 $\theta_2 = 0.1$ $\rho = 900 \text{ kg/m}^3$

$$\frac{P_1}{\rho g} + \frac{C_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{C_2^2}{2g} + Z_2 + \text{Losses}$$

~~$A_1 = C_1 A$~~

~~$A_2 = C_2 A$~~

~~$Q = C + A$~~

$$\dot{M} = \rho C A$$

$$A_1 = \frac{\pi \times 0.12^2}{4}$$

$$A_1 = 0.011 \text{ m}^2$$

$$A_2 = \frac{\pi \times 0.1^2}{4}$$

$$A_2 = 0.0079 \text{ m}^2$$

~~$C_1 = \frac{Q}{A_1}$~~

~~$C_2 = \frac{Q}{A_2}$~~

~~$C_1 = \frac{Q}{A_1}$~~

~~$C_2 = \frac{Q}{A_2}$~~

~~$C_1 = \frac{100 \text{ L/s}}{0.011 \text{ m}^2}$~~

~~$C_1 = 9090.9 \text{ s}^{-2}$~~

~~$C_2 = 12658.23 \text{ m/s}^2$~~

~~$$\frac{400 \times 10^3}{900 \times 9.81} + \frac{9090.9^2}{2 \times 9.81} + 0 = \frac{P_2}{900 \times 9.81} + \frac{12658.23^2}{2 \times 9.81} + 12 + 1.2$$~~

~~$$4212301.31 = \frac{P_2}{8829} + 8166706.77 + 13.2$$~~

~~$P_2 = 8154458.65$~~

$$\dot{M} = \rho C A$$

$$C = \frac{\dot{M}}{\rho A}$$

$$C_1 = \frac{100}{900 \times 0.011}$$

$$C_2 = \frac{100}{900 \times 0.0079}$$

$$C_1 = 10.1$$

$$C_2 = 14.065$$

2a Continued

$$\frac{400 \times 10^3}{400 \times 9.81} + \frac{10.1^2}{2 \times 9.81} + 0 = \frac{P_2}{400 \times 9.81} + \frac{14.065^2}{2 \times 9.81} + 13.2$$

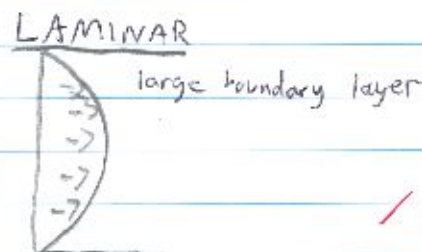
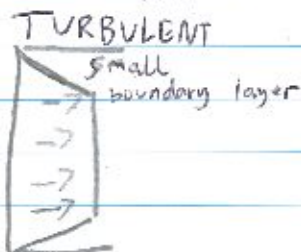
$$50.5 \quad \quad \quad = \frac{P_2}{8829} + 23.28 \quad \text{ECF}$$

$$27.21 = \frac{P_2}{8829}$$

$$240300.8 = P_2$$

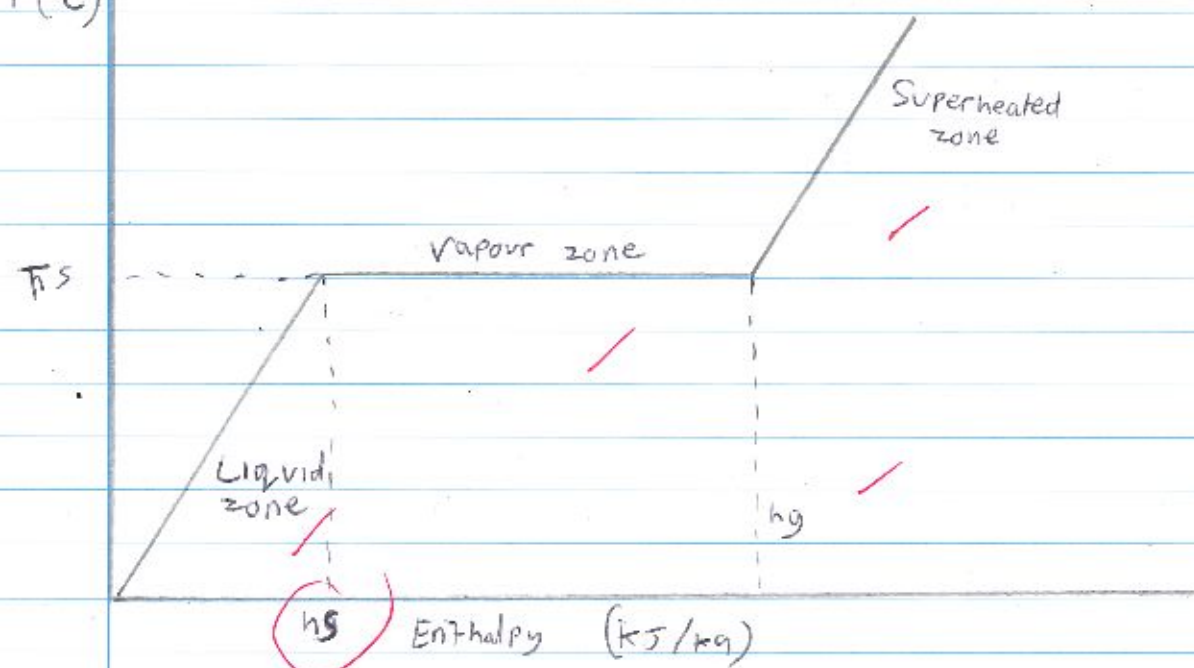
$$240 \text{ kN/m}^2 = P_2$$

- b) The significance of the Reynolds is that it shows whether the flow in a system is laminar or turbulent. The flow in a system becomes laminar when the Reynolds number is below 2000. Between 2000 and 4000 there is an area where it is both laminar and turbulent. When it passes 4000 this flow then becomes turbulent. Through Reynolds experiments of putting a stream of dye into a flow of liquid it was determined that any system with a large pipe, a high velocity or a dense liquid would be turbulent. However if these values were small and the product was very viscous there would generally be laminar flow. This formula was derived from the experiments $Re = \frac{\rho v d}{\mu}$



It was found that the friction factor has less effect on turbulent flow as it reaches 99% of its max velocity much faster

3a)

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

(2)

b) $P_1 = 30 \text{ bar}$ $T = 350^{\circ}\text{C}$ $V_1 = 0.16 \text{ m}^3$ $P V^{1.3} = C$
 $P_2 = 6 \text{ bar}$

$$\text{Mass} = \frac{V_1}{v_g}$$

$$\text{Mass} = \frac{0.16}{0.0905}$$

$$\text{mass} = 1.77 \text{ kg}$$

(5)

1) $P_1 V_1^{1.3} = P_2 V_2^{1.3}$
 $30 \times 10^5 \times 0.0905^{1.3} = 6 \times 10^5 V_2^{1.3}$

$$132057.94 = 6 \times 10^5 V_2^{1.3}$$

$$0.22 = V_2^{1.3}$$

$$0.3120 \text{ m}^3 = V_2$$

$$6 \text{ bar} \quad v_g = 0.3156$$

$$v_2 = 0.312$$

$$\text{dryness factor} = \frac{v_2}{v_g}$$

$$= \frac{0.312}{0.3156}$$

$$\text{dryness factor} = 0.989$$

$$\text{iii) } WD = \frac{P_1 V_1 - P_2 V_2}{n - 1}$$

$$= \frac{30 \times 10^5 \times 0.0905 - 6 \times 10^5 \times 0.312}{1.3 - 1}$$

$$281 \times 10^3 = WD$$

$$281 \text{ KJ}$$

(5)

(5)

17

4

$$T = 220 \quad 2500 \text{ RPM} \quad 14/1$$

$$\phi = 0.11 \quad L = 0.1 \quad SFC = 0.364 \times 10^3$$

$$BP = TW$$

$$BP = 220 \times \left(\frac{2500 \times 2\pi}{60} \right)$$

$$BP = 57595.87 \text{ W}$$

$$= 57.6 \text{ kW}$$

$$BTE = \frac{BP}{CV \times MF}$$

$$MF = SFC \times BP$$

$$MF = \frac{0.364 \times 57.6}{3600}$$

$$MF = 5.824 \times 10^{-3}$$

$$BTE = \left(\frac{57.6 \times 10^3}{14,200 \times 10^3 \times 5.824 \times 10^{-3}} \right) \times 100$$

$$BTE = 22.4\%$$

11) $\frac{\text{Volume air fuel mix}}{\text{Stroke volume}}$

$$PV = MRT$$

$$V = \frac{MRT}{P}$$

$$V = \frac{5.824 \times 10^{-3} \times 287 \times 288}{1.01 \times 10^5}$$

$$V = 4.78 \times 10^{-3}$$

$$4.78 \times 10^{-3} \times 15 \quad (\text{For total air fuel mix})$$

$$0.072 \div 4 \quad (\text{Per cylinder})$$

$$0.018$$

4 (ii)
continued

$$\left(\frac{\pi \times 0.11^2}{4} \right) \times 0.1 = (\text{Cylinder volume})$$

$$0.95 \times 10^{-3} = \text{Cylinder volume}$$

$$100 \times \left(\frac{0.018}{0.95 \times 10^{-3} + \left(\frac{2500}{60 \times 2} \right)} \right) = \text{Vol Efficiency}$$

$$90.94\%$$

$$= \text{Vol Efficiency}$$

(5)

(5)

25

DEAN. SAUNDERS

