

Complete, fold and seal
(see note 2 below)

FORENAME(S): LUKASZ

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.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. **Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.**

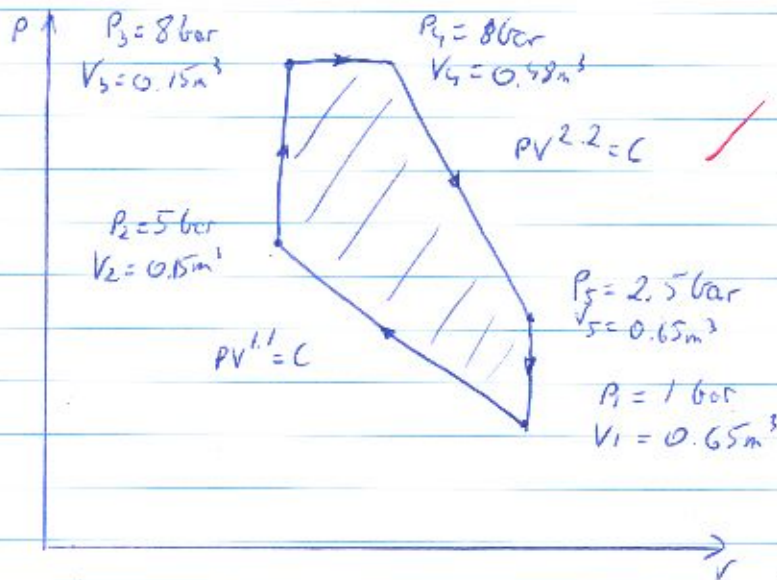
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3	Module Code	SGDM 4004
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5	Examination Venue	
6	Seat Number	
7	Number of Answer Books handed in	

[illegible]

60%

Q 2.

a)



net W.D. = ?

$$W.D._{1-2} = \frac{P_1 V_1 - P_2 V_2}{1.1 - 1}$$

$$V_2 = ?$$

$$P_1 V_1^{1.1} = P_2 V_2^{1.1}$$

$$(1 \times 10^5) \times 0.65^{1.1} = (5 \times 10^5) \times V_2^{1.1}$$

$$62259.4 = (5 \times 10^5) \times V_2^{1.1}$$

$$\frac{62259.4}{5 \times 10^5} = V_2^{1.1}$$

$$0.124 = V_2^{1.1}$$

$$\sqrt[1.1]{0.124} = V_2$$

$$V_2 = \underline{0.15 \text{ m}^3}$$

$$W_{D_{1-2}} = \frac{(1 \times 10^5) \times 0.65 - (5 \times 10^5) \times 0.15}{1.1 - 1}$$

$$W_{D_{1-2}} = - \frac{10000}{0.1}$$

$$W_{D_{1-2}} = -100000 \text{ J}$$

$$W_{D_{2-3}} = 0 \text{ J} \quad \text{constant volume}$$

$$W_{D_{3-4}} = P(V_4 - V_3)$$

$$V_4 = ?$$

$$W_{D_{4-5}} = \frac{P_4 V_4 - P_5 V_5}{2.2 - 1}$$

$$V_4 = ?$$

$$P_4 V_4^{2.2} = P_5 V_5^{2.2}$$

$$(18 \times 10^5) \times V_4^{2.2} = (12.5 \times 10^5) \times 0.65$$

$$18 \times 10^5 \times V_4^{2.2} = 162500 \quad \times$$

$$V_4^{2.2} = \frac{162500}{18 \times 10^5}$$

$$V_4^{2.2} = 0.203$$

$$V_4 = \sqrt[2.2]{0.203}$$

$$V_4 = 0.48 \text{ m}^3 \quad \times$$

3

3

$$W_{D_{4-5}} = \frac{(8 \times 10^5) \times 0.48 - (2.5 \times 10^5) \times 0.65}{2.2 - 1}$$

$$W_{D_{4-5}} = \frac{221500}{1.2}$$

$$W_{D_{4-5}} = \underline{184583.3 \text{ J}}$$

$$W_{D_{3-4}} = P(V_4 - V_3)$$

$$W_{D_{3-4}} = (18 \times 10^5) \times (0.48 - 0.15)$$

$$W_{D_{3-4}} = \underline{264000 \text{ J}}$$

$$W_{D_{5-1}} = \underline{0 \text{ J}} \text{ constant volume}$$

$$\text{total net W.D} = -100000 + 0 + 264000 + 184583.3 + 0 =$$

$$\text{total net W.D} = \underline{438583.3 \text{ J}} \text{ or } 438.6 \text{ kJ}$$

6) It is the work done by the system, positive value of ~~positive net W.D value means that~~ total W.D

Q.4.

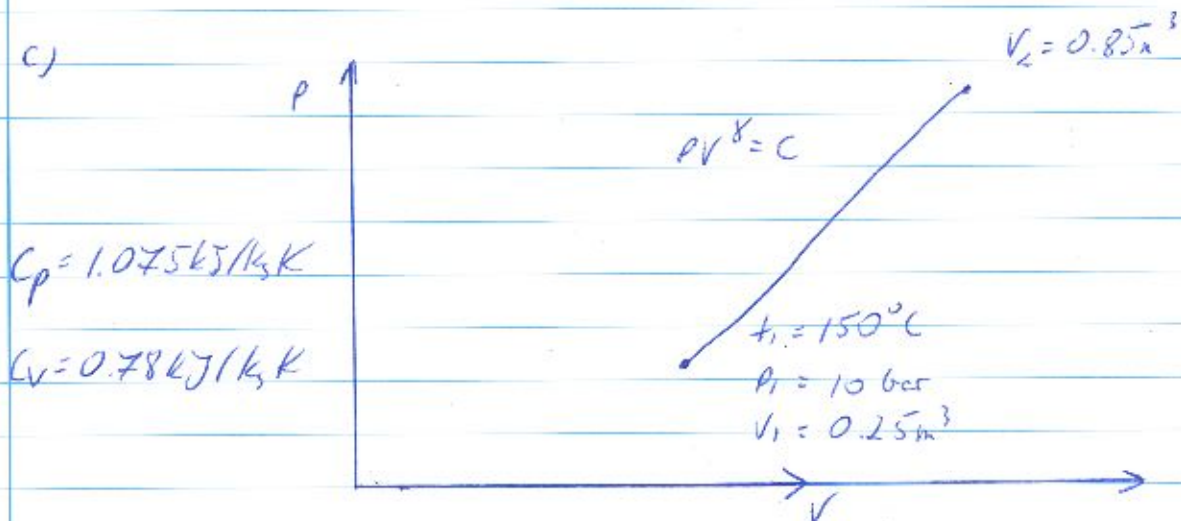
a) perfect gas - is a gas that obey ideal gas law in which specific heat values are constant. (2)

specific heat - is a heat required to increase certain amount of substance by 1 Kelvin. ✓

b) ~~transmission~~ power generated by open system is onto another system, example turbine. (1)

power generated by closed system stays in the system. (1)

c)



$$P_2 = ?$$

$$P_1 V_1^x = P_2 V_2^x$$

$$x = ?$$

$$x = \frac{C_p}{C_v} = \frac{(1.075 \times 10^3)}{(0.78 \times 10^3)} = 1.378 \quad /$$

$$P_1 V_1^{1.378} = P_2 V_2^{1.378}$$

$$(10 \times 10^5) \times 0.25^{1.378} = P_2 \times 0.85^{1.378}$$

$$148033.9 = P_2 \times 0.799$$

$$\frac{148033.9}{0.799} = P_2$$

$$P_2 = 185273.9 \text{ N} \text{ or } \underline{18.53 \text{ bar}}$$

(3)

ii) $t_2 = ?$

$$\frac{t_1}{t_2} = \left(\frac{V_2}{V_1} \right)^{\gamma-1}$$

$$\frac{423}{t_2} = \left(\frac{0.85}{0.25} \right)^{1.378-1}$$

$$\frac{423}{t_2} = 3.4^{0.378}$$

$$\frac{423}{t_2} = 1.588$$

$$\frac{423}{1.588} = t_2$$

$$t_2 = \underline{266.4 \text{ K}}$$

(3)

iii) ~~W~~ $W = \frac{P_1 V_1 - P_2 V_2}{\gamma - 1}$

$$W = \frac{(10 \times 10^5) \times 0.25 - (18.53 \times 10^5) \times 0.85}{1.378 - 1}$$

$$W = - \frac{1325050}{0.378}$$

$$W = -3505423.3 \text{ J}$$

(0)

$$(V) \quad m = ?$$

$$PV = nRT$$

$$R = ?$$

$$R = C_p - C_v$$

$$R = (1.075 \times 10^3) - (0.78 \times 10^3) = 295$$

$$P_1 V_1 = nRT_1$$

$$(10 \times 10^5) \times 0.25 = n \times 295 \times 423$$

$$250000 = n \times 124785$$

$$\frac{250000}{124785} = n$$

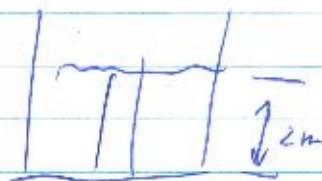
$$\underline{n = 2 \text{ kg}}$$

(4)

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Q7.

$$d_1 \quad p_6 = 28 \text{ kPa}$$



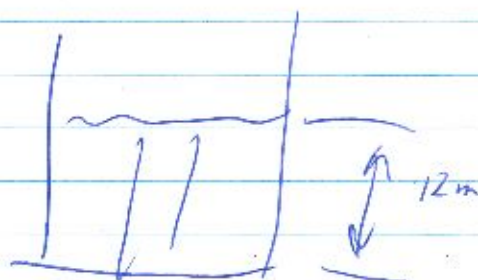
$$p_6 = \rho g h$$

$$(28 \times 10^3) = \rho \times 9.81 \times 2$$

$$(28 \times 10^3) = \rho \times 19.62$$

$$\frac{(28 \times 10^3)}{19.62} = \rho$$

$$\rho = 1427 \text{ kg/m}^3$$



$$p_6 = \rho g h$$

$$p_6 = 1427 \times 9.81 \times 12$$

$$p_6 = 167986.4 \text{ Pa or } \underline{167.9 \text{ kPa}}$$



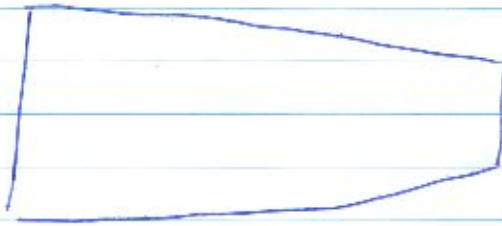
5

e)

$$P_1 = 400 \text{ kN/m}^2$$

~~ent~~

$$d_{1c} = 0.15 \text{ m}$$



$$d_{2c} = 0.1 \text{ m}$$

$$\dot{m} = 0.025 \text{ m}^3/\text{s}$$

$$\rho = 1000 \text{ kg/m}^3$$

$$P_2 = ?$$

$$\dot{m} = \rho C_1 A_1$$

$$\rho C_1 A_1 = \rho C_2 A_2$$

$$0.025 = 1000 \times C_1 \times (\pi \times 0.075^2)$$

$$0.025 = C_1 \times 17.671$$

$$\frac{0.025}{17.671} = C_1$$

$$C_1 = 1.415 \times 10^{-3} \text{ m/s}$$

$$0.025 = 1000 \times C_2 \times (\pi \times 0.05^2)$$

$$0.025 = 785 C_2$$

$$\frac{0.025}{785} = C_2$$

$$C_2 = 0.003 \text{ m/s}$$

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

$$\frac{(400 \times 10^3)}{1000 \times 9.81} + \frac{(1.415 \times 10^{-3})^2}{2 \times 9.81} = \frac{P_2}{1000 \times 9.81} + \frac{0.003^2}{2 \times 9.81}$$

$$40.775 + (1.02 \times 10^{-7}) = \frac{P_2}{9810} + (4.587 \times 10^{-7})$$

$$4.159 \times 10^{-6} = \frac{P_2}{9810} + (4.587 \times 10^{-7})$$

$$(4.159 \times 10^{-6}) - (4.587 \times 10^{-7}) = \frac{P_2}{9810}$$

$$3.7003 \times 10^{-6} = \frac{P_2}{9810}$$

$$3.7003 \times 10^{-6} \times 9810 = P_2$$

$$P_2 = 0.036 \text{ N}$$

$$P_2 = 0.036 \text{ N}$$

a) pressure head - $h = \frac{P}{\rho g}$

is the pressure measured at the

is the pressure at the measurement point.

c) $P_G = \rho g h$

ρ - density kg/m^3

g - gravity (9.81 N)

h - height (depth) (m)

3

1

4

13

Q 3

c)

$$T_1 = 200^\circ\text{C}$$

$$P_1 = 7 \text{ bar}$$

$$P_1 = 7 \text{ bar}$$

$$T_1 = 200^\circ\text{C}$$

$$C_1 = 1$$

$$P_2 = 1 \text{ bar}$$

$$PV^{1.25} = C$$

$$C_2 = ?$$