

Complete, fold and seal
(see note 2 below)

FORENAME(S): Harley

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.**

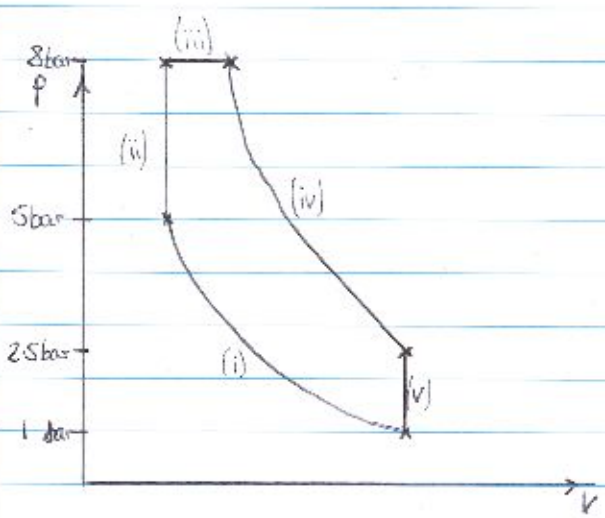
1	Student Number	199282
2	Title of Examination Paper	Thermofluids I
3	Module Code	~~SGDM~~ SGDM4004
4	Date and Time of Examination	16/1/20 9:30
5	Examination Venue	
6	Seat Number	
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
2	10
4	16
1	14
Total	40/75

(Gweler yr ochr arall am y fersiwn Cymraeg)

2.

a)



i) $P_1 V_1^{1.1} = P_2 V_2^{1.1}$
 $\frac{P_1 V_1^{1.1}}{P_2} = V_2^{1.1}$
 $\sqrt[1.1]{\frac{P_1 V_1^{1.1}}{P_2}} = V_2$
 $V_2 = \sqrt[1.1]{\frac{1 \times 10^5 \times 0.65^{1.1}}{5 \times 10^5}}$
 $V_2 = 0.15 \text{ m}^3$

$WD = \frac{P_1 V_1 - P_2 V_2}{n-1}$
 $= \frac{(1 \times 10^5 \times 0.65) - (5 \times 10^5 \times 0.15)}{1.1 - 1}$
 $= -100 \times 10^3 \text{ J}$

ii) $WD = P_1 V_1 - P_2 V_2 = (5 \times 10^5 \times 0.15) - (8 \times 10^5 \times 0.15)$
 $= -45 \times 10^3 \text{ J}$

iii) $WD = 0$

iv) $P V^{2.2} = C$
 $\frac{P_1 V_1^{2.2}}{P_2} = V_2^{2.2}$
 $\sqrt[2.2]{\frac{P_1 V_1^{2.2}}{P_2}} = V_2$
 $V_2 = \sqrt[2.2]{8}$

iv) $P_1 V_1^{2.2} = P_2 V_2^{2.2}$
 $V_1 = \sqrt[2.2]{\frac{P_2 V_2^{2.2}}{P_1}}$
 $V_1 = \sqrt[2.2]{\frac{8 \times 10^5 \times 2.5 \times 10^{-5} \times 0.65}{8 \times 10^5}}$
 $V_1 = 0.48 \text{ m}^3$

$WD = \frac{P_1 V_1 - P_2 V_2}{n-1}$
 $WD = \frac{(8 \times 10^5 \times 0.48) - (2.5 \times 10^5 \times 0.65)}{2.2 - 1}$
 $= 184.6 \times 10^3 \text{ J}$

$$\begin{aligned}
 v) \quad WD &= P_1 V_1 - P_2 V_2 \\
 &= (2.5 \times 10^5 \times 0.65) - (1 \times 10^5 \times 0.65) \\
 &= 97.5 \times 10^3 \text{ J}
 \end{aligned}$$

x

$$\begin{aligned}
 \text{Net work for cycle} &= WD_i + WD_{ii} + WD_{iii} + WD_{iv} + WD_v \\
 &= -100 \times 10^3 - 45 \times 10^3 + 0 + 184.6 \times 10^3 + 97.5 \times 10^3 \\
 &= 137.1 \times 10^3 \text{ J}
 \end{aligned}$$

x

b) Work is done by the system as the total work done for the cycle is positive.

(2)

10

4.

a) A perfect gas is a gas that obeys the gas laws and has no internal energy.

(2)

The specific heats of a perfect gas is the energy required to raise the temperature of the gas.

b) A closed system does not allow any energy/heat to enter or exit the system.

(1)

Open systems allow energy and heat to enter and exit the system

(1)

Closed system = Cylinder ✓

Open system = Boiler ✓

c) $T_1 = 423K$ $T_2 = \infty$ $\gamma = \frac{C_p}{C_v}$ $\gamma = \frac{1.075 \times 10^3}{0.78 \times 10^3}$
 $P_1 = 10 \text{ bar}$ $P_2 = ?$
 $V_1 = 0.25 \text{ m}^3$ $V_2 = 0.85 \text{ m}^3$ $\gamma = 1.38$ ✓

(2)

i) $P_1 V_1^\gamma = P_2 V_2^\gamma$ $\frac{10 \times 10^5 \times 0.25^{1.38}}{0.85^{1.38}} = P_2$ $1.84 \text{ bar} = P_2$ ✓
 $\frac{P_1 V_1^\gamma}{V_2^\gamma} = P_2$

(3)

ii) $\frac{T_1}{T_2} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$ ~~$\frac{423}{T_2} = \left(\frac{0.25}{0.85}\right)^{1.38-1}$~~ ~~$T_2 = \frac{423}{\left(\frac{0.25}{0.85}\right)^{0.38}}$~~
 $T_2 = \frac{T_1}{\left(\frac{V_1}{V_2}\right)^{\gamma-1}}$ $T_2 = \frac{423}{\left(\frac{0.25}{0.85}\right)^{1.38-1}}$ $T_2 = 265.7 \text{ K}$ ✓

(3)

iii) $WD = \frac{P_2 V_2 - P_1 V_1}{\gamma}$ ~~$= \frac{(1.84 \times 10^5 \times 0.85) - (10 \times 10^5 \times 0.25)}{1.38}$~~ ✓
 $= -67.8 \times 10^3 \text{ J}$

(2)

$$\text{iv) } PV = nRT$$

$$\begin{aligned} R &= C_p - C_v \\ &= 1.075 - 0.78 \\ &= 0.295 \end{aligned} \quad \frac{PV}{RT} = n$$

$$\frac{(10 \times 10^5 \times 0.25)}{(0.295 \times 423)} = n$$

$$n = 2.003 \text{ kg}$$

(4)

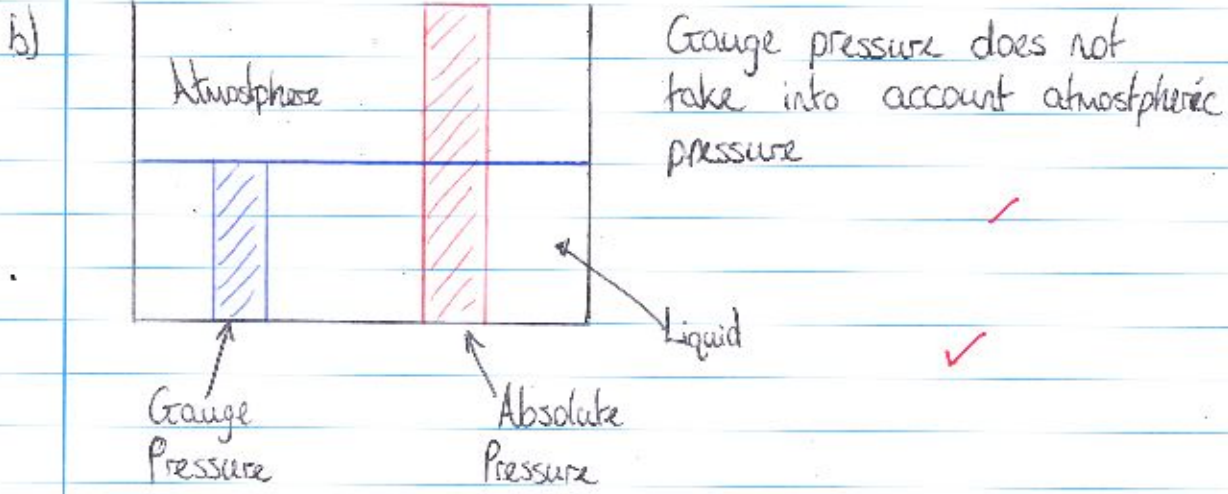
16

i.

a) Pressure

a) Pressure head is the height the pressure within a system will force water up a vertical measurement pipe.

(2)



(3)

c) Gauge Pressure = $h \cdot g \cdot \rho$
(Pa)
 h = height of water above measurement point (m)
 g = gravity (ms^{-2})
 ρ = Density of fluid (kgm^{-3})

(4)

d)

$$\frac{P}{h \cdot g} = \rho$$
$$\frac{28 \times 10^3}{2 \times 9.81} = 1427.1 \text{ kgm}^{-3}$$
$$P_2 = 12 \times 9.81 \times 1427.1 = 1680 \text{ kPa}$$

(5)

e)

$$P_1 = 400 \text{ kPa} \quad P_2 = x$$
$$d_1 = 0.15 \text{ m} \quad d_2 = 0.1 \text{ m}$$

$$A_1 = \pi r^2$$
$$= 0.018 \text{ m}^2$$
$$A_2 = 0.0079 \text{ m}^2$$

$$P = F/A$$
$$R_1 \times P_1 \times A_1 = F$$
$$72 \times 10^3 \times F$$

$$a = F \times v$$
$$a = 72 \times 10^3 \times 0.025 = 180 \text{ ms}^{-2}$$

e) $P_1 = 400 \text{ kN/m}^2$ $P_2 = x$ Flow rate = $0.025 \text{ m}^3 \text{ s}^{-1}$
 $d_1 = 0.15 \text{ m}$ $d_2 = 0.1 \text{ m}$

$$A_1 = \pi r^2$$

$$= \pi \times 0.075^2$$

$$= 0.018 \text{ m}^2$$

$$A_2 = \pi r^2$$

$$= \pi \times 0.05^2$$

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

$$P = \frac{F}{A}$$

$$P_1 A = F$$

$$400 \times 0.018 = F$$

$$400 \times 10^3 \times 0.018 = F$$

$$\underline{7.2 \text{ kN} = F}$$

$$P_2 = \frac{F}{A}$$

$$= \frac{7.2 \times 10^3}{0.0079}$$

$$= 911.4 \text{ kN/m}^2$$

$$\underline{= 911.4 \text{ kN/m}^2}$$

6

14