Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	THERMODYNAMICS
COURSE CODE	:	BWC 20303
PROGRAMME CODE	:	BWC
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

Q1 (a) The specific volume of 5 kg of water vapor at 1.5×10^5 N/m^2, 440 °C is 0.2160 m^3/kg. Molecular weight of water vapor is 18.02 g/mol. Determine,

(i) the volume in m^3 of the water vapor
(4 marks)

(ii) the amount of water vapor present in moles
(4 marks)

(iii) the number of molecules
(4 marks)

(b) A vertical piston-cylinder assembly containing a gas is placed on a hot plate as **Figure Q1(b)**. The piston initially rests on the stops. With the onset of heating, the gas pressure increases. Calculate the pressure when the piston start rising.
(8 marks)

Q2 A gas in a piston cylinder assembly undergoes an expansion process for which the relationship between pressure and volume is given by

$$PV^n = \text{constant}$$

(a) The final pressure is 2×10^5 N/m^2, the initial volume is 0.1 m^3, and the final volume is 0.04 m^3. Determine the **initial pressure**, and the **work** for the process, in kJ, if

(i) n = 0,
(8 marks)

(ii) n = 1.0
(8 marks)

(b) For each case, justify whether the work is done ON or BY the system.
(4 marks)

Q3 (a) Piston-cylinder assembly undergoes 2 processes, A and B, between the same end states, 1 and 2, where $P_1 = 1 \times 10^5$ N/m^2, $V_1 = 1$m^3, $U_1 = 400$ kJ, $P_2 = 10 \times 10^5$ N/m^2, $V_2 = 0.1$ m^3, $U_2 = 450$ kJ.

Process A: constant-volume process from state 1 to a pressure of 10×10^5 N/m^2, followed by constant-pressure process to state 2
Process B: process from 1 to 2 during which PV= constant

Kinetic and potential effects are ignored. For each process, A and B:

(i) sketch the process on P– V coordinates
(4 marks)

(ii) evaluate work (kJ)
(6 marks)

(iii) evaluate heat transfer (kJ)
(2 marks)

(b) (i) From PV diagrams in **Figure Q3(b)**, how do you interpret the work done by these various paths.

(6 marks)

(ii) How do you conclude your interpretation from part **Q3(b)(i)**.

(2 marks)

Q4 (a) Air enters a one-inlet, one-exit control volume at 6×10^5 N/m^2, 500 K, and 30 m/s through a flow area of 28 cm^2. At the exit, the pressure is 3×10^5 N/m^2, the temperature is 456.5 K, and the velocity is 300 m/s. The air behaves as an ideal gas. For steady-state operation, determine:

(i) the mass flow rate, in kg/s.

(6 marks)

(ii) the exit flow area, in cm^2.

(4 marks)

(b) Liquid water flows isothermally at 20 °C through a one-inlet, one-exit duct operating at steady state. The duct's inlet and exit diameters are 0.02 m and 0.04 m, respectively. At the inlet, the velocity is 40 m/s and pressure is 1 bar. At the exit, determine:

(i) the mass flow rate, in kg/s,

(6 marks)

(ii) velocity, in m/s.

(4 marks)

Q5 As shown in the **Figure Q5**, a reversible power cycle receives energy Q_H by heat transfer from a hot reservoir at T_H and rejects energy Q_C by heat transfer to a cold reservoir at T_C.

(a) Determine, the thermal efficiency, if T_H =1600 K and T_C =400 K.

(4 marks)

(b) Determine, Q_H and Q_C, each in kJ, if T_H =500°C T_C =20°C and W_{cycle}=1000kJ

(8 marks)

(c) Determine, T_H if η=60% and T_C =40°C

(4 marks)

(d) Determine, T_C , if η =40% and T_H =727 K

(4 marks)

– **END OF QUESTIONS** –

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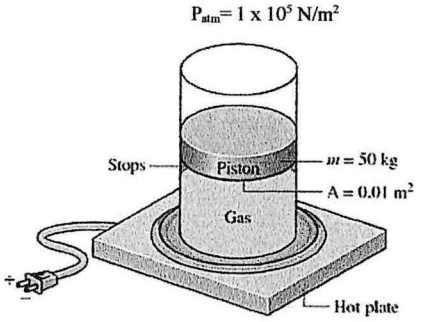

FIGURE Q1(b)

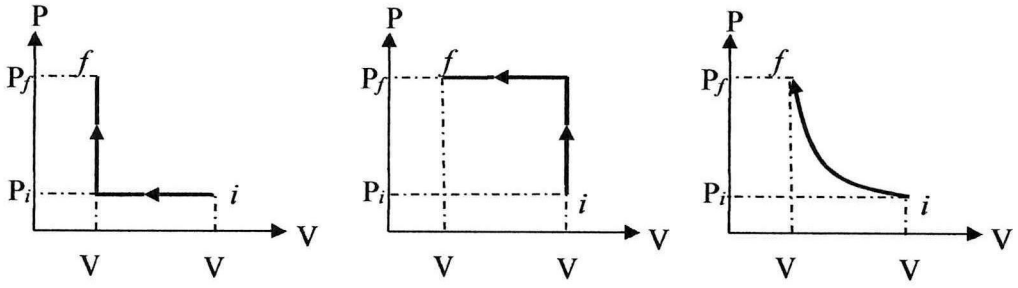

FIGURE Q3(b)

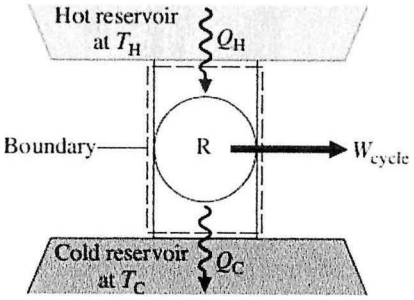

FIGURE Q5