Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER I
SESSION 2020/2021

COURSE NAME	:	THERMODYNAMICS
COURSE CODE	:	BWC 20303
PROGRAMME CODE	:	BWC
EXAMINATION DATE	:	JANUARY/FEBRUARY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS **OPEN BOOK EXAMINATION**

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

Q1 (a) The specific volume of 8 kg of water vapor at 1.5×10^5 N/m^2, 440 °C is 0.4320 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)

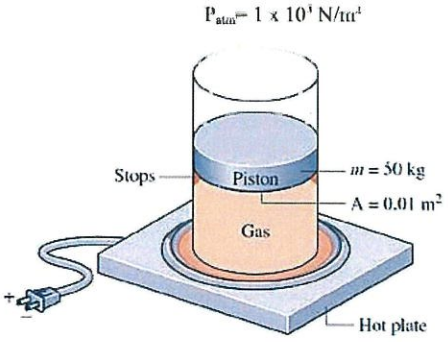

Figure Q1(b)

Q2 A gas in a piston cylinder assembly undergoes an expansion process for which the relationship between P–pressure and V=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 $P_1 = 2 \times 10^5$ N/m^2, $V_1 = 2$m^3, $U_1 = 800$ kJ, $P_2 = 20 \times 10^5$ N/m^2, $V_2 = 0.2$ m^3, $U_2 - 900$ kJ.

Process A: constant-volume process from state 1 to a pressure of 20 x 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) Carbon monoxide gas (CO) contained within a piston-cylinder assembly undergoes three processes in series.

Process 1-2: Constant pressure expansion at 5 N/m^2 from $V_1 = 0.2$ m^3 to $V_2 = 1$ m^3.

Process 2-3: Constant volume cooling from state 2 to state 3 where $P_3 = 1$ N/m^2.

Process 3-1: Compression from state 3 to the initial state during which the pressure-volume relationship is PV = constant.

Sketch the processes in series on *P-V* coordinates and evaluate the work for each process, in kJ.

(8 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 A power cycle receives energy Q_H by heat transfer from a hot reservoir at T_H = 1200K and rejects energy Q_C by heat transfer to a cold reservoir at T_C = 400K. For each of the following cases, determine whether the cycle operates reversibly, operates irreversibly, or is impossible.

(a) Q_H =900 kJ, W_{cycle} =450 kJ

(5 marks)

(b) Q_H – 900 kJ, Q_C– 300 kJ

(5 marks)

(c) W_{cycle} = 600 kJ, Q_C = 400 kJ

(5 marks)

(d) η = 70%

(5 marks)

– **END OF QUESTIONS** –