

SULIT



BAHAGIAN PEPERIKSAAN DAN PENILAIAN  
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI  
KEMENTERIAN PENGAJIAN TINGGI

JABATAN KEJURUTERAAN PETROKIMIA

PEPERIKSAAN AKHIR  
SESI II : 2021 / 2022

DGP20052 : THERMODYNAMICS

TARIKH : 8 JULAI 2022  
MASA : 8.30 PAGI - 10.30 PAGI (2 JAM)

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Kertas ini mengandungi ENAM (6) halaman bercetak.

Struktur (4 soalan)

Dokumen sokongan yang disertakan : Formula / Buku Jadual Stim

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JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

**INSTRUCTION:**

This section consists of **FOUR (4)** structured questions. Answer **ALL** questions.

**ARAHAN:**

*Bahagian ini mengandungi EMPAT (4) soalan berstruktur. Jawab SEMUA soalan.*

**QUESTION 1****SOALAN 1**

- CLO 1 (a) Define the internal energy, Principal of Energy Conversion and The Charles' Law.

*Definisikan tenaga dalaman, Prinsip Penukaran Tenaga dan Hukum Charles*

[6 marks]

[6 markah]

- CLO 1 (b) Convert the values to the specific units:

C2 *Tukarkan nilai kepada unit yang dinyatakan:*

- i.  $3.2 \text{ mm}^3/\text{mg}$  to  $\text{m}^3/\text{kg}$

*$3.2 \text{ mm}^3/\text{mg}$  kepada  $\text{m}^3/\text{kg}$*

[3 marks]

[3 markah]

- ii.  $0.0078 \text{ GJ/g}$  to  $\text{kJ/kg}$

*$0.0078 \text{ GJ/g}$  kepada  $\text{kJ/kg}$*

[3 marks]

[3 markah]

- iii.  $5.9 \text{ MN/mm}^2$  to  $\text{N/m}^2$

*$5.9 \text{ MN/mm}^2$  to  $\text{N/m}^2$*

[3 marks]

[3 markah]

- CLO 1 (c) A mass of 0.18 kg gas is at a temperature of  $15^\circ\text{C}$ , volume  $0.17 \text{ m}^3$  and pressure  $130 \text{ kN/m}^2$ . If the gas has a value of  $C_v = 720 \text{ J/kg K}$ , calculate the:

*Jisim gas 0.18 kg berada pada suhu  $15^\circ\text{C}$ , isipadu  $0.17 \text{ m}^3$  dan tekanan  $130 \text{ kN/m}^2$ . Jika gas mempunyai nilai  $C_v = 720 \text{ J/kg K}$ , kirakan:*

- i. Gas constant and molecular weight.

*Pemalar gas dan berat molekul.*

[6 marks]

[6 markah]

- ii. Specific heat at constant pressure and specific ratio.

*Haba tentu pada tekanan malar dan nisbah tentu*

[4 marks]

[4 markah]

## QUESTION 2

### SOALAN 2

- CLO 2 (a) Define steady flow and non-steady flow.

*Definiskan aliran sekata dan aliran tak sekata.*

[4 marks]

[4 markah]

- CLO 2 (b) Express TWO (2) assumptions of Steady Flow Energy Equation for:

*Nyatakan DUA(2) anggapan Persamaan Tenaga Aliran Mantap untuk:*

- i. Condenser

*Pemeluwap*

[2 marks]

[2 markah]

- ii. Nozzle

*Nozel*

[2 marks]

[2 markah]

- CLO 2 (c) An adiabatic gas turbine expands air at 1300 kPa and 500°C to 100 kPa and

127°C. The air enters the turbine through a 0.2 m<sup>2</sup> opening with an average velocity of 40 m/s, and exhausts through a 1m<sup>2</sup> opening. Calculate the work output by the turbine in kW. Given : R = 0.287kJ/kg.K C<sub>p</sub>= 1.048 kJ/kg.K

Suatu turbin gas adiabatik mengembang udara pada 1300 kPa dan 500°C kepada 100 kPa dan 127°C. Udara memasuki turbin melalui bukaan  $0.2 \text{ m}^2$  dengan kelajuan purata  $40 \text{ m/s}$ , dan ekzos melalui bukaan  $1\text{m}^2$ . Kirakan kerja keluaran oleh turbin di dalam kW. Diberi:  $R = 0.287 \text{ kJ/kg.K}$      $C_p = 1.048 \text{ kJ/kg.K}$

[17 marks]

[17 markah]

### QUESTION 3

#### SOALAN 3

CLO 2

C1

- (a) Sketch the P-V diagram for steam and label the parts with names in the following brackets. (critical point, saturated dry steam line, compress liquid region, quality steam where  $x = 0$  and superheated steam region)

*Lakarkan rajah P-V untuk stim dan labelkan bahagian tersebut dengan nama dalam kurungan berikut. (titik kritikal, garisan stim tepu kering, kawasan cecair termampat, kualiti stim = 0 dan kawasan panas lampau)*

[5marks]

[5 markah]

CLO 2

C3

- (b) A perfect gas at temperature  $18^\circ\text{C}$  and pressure  $225 \text{ kN/m}^2$ , occupies a volume of  $0.63 \text{ m}^3$  at initial state. The gas is heated at constant pressure until the temperature is  $47^\circ\text{C}$ . Given  $C_p$  for gas as  $0.34 \text{ kJ/kgK}$ , compute:

*Gas sempurna pada suhu  $18^\circ\text{C}$  dan tekanan  $225 \text{ kN/m}^2$ , menduduki isipadu  $0.63 \text{ m}^3$  pada keadaan awal. Gas dipanaskan pada tekanan malar sehingga suhu adalah  $47^\circ\text{C}$ . Diberi  $C_p$  untuk gas sebagai  $0.34 \text{ kJ/kgK}$ , kirakan:*

- i. The final volume of the gas

*Jumlah isipadu gas akhir*

[8 marks]

[8 markah]

- ii. The work done during the process

*Kerja yang dilakukan semasa proses*

[6 marks]

[6 markah]

- iii. The heat transferred during the process

*Haba dipindahkan semasa proses*

[6 marks]

[6 markah]

#### QUESTION 4

#### SOALAN 4

CLO 1

C2

- (a) Explain when a reaction is described as “having reached equilibrium” regarding the forward and reverse reaction rates and the amounts or concentrations of the reactants and the products.

*Terangkan apabila tindak balas dinyatakan sebagai “setelah mencapai keseimbangan” mengenai kadar tindak balas berbalik dan kepekatan bahan tindak balas dan produk tindak balas.*

[7 marks]

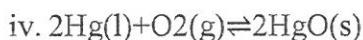
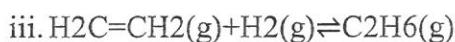
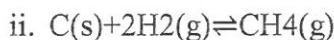
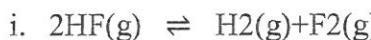
[7 markah]

CLO 1

C2

- (b) Explain the following equilibrium conditions are homogeneous or heterogeneous?

*Jelaskan keadaan keseimbangan berikut adalah homogen atau heterogen?*



[8 marks]

[8 markah]

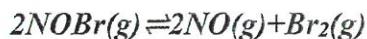
CLO 1

C2

(c) Express  $K_c$  and  $K_p$  for each reaction

at  $27^\circ\text{C}$ , the equilibrium concentration of  $\text{NO} = 1.29 \text{ M}$ ,  $\text{Br}_2 = 10.52 \text{ M}$ , and  $\text{NOBr} = 0.423 \text{ M}$ .

*Ungkapkan nilai  $K_c$  dan  $K_p$  untuk setiap tindak balas*



*pada  $27^\circ\text{C}$ , kepekatan keseimbangan of  $\text{NO}$  adalah  $1.29 \text{ M}$ ,  $\text{Br}_2 = 10.52 \text{ M}$  dan  $\text{NOBr} = 0.423 \text{ M}$*

[10 marks]

[10 markah]

**SOALAN TAMAT**

BASIC THERMODYNAMICS

$$\begin{aligned} \bullet P_v &= mRT \\ \bullet U_2 - U_1 &= Q - W \\ \bullet \frac{P_1 V_1}{T_1} &= \frac{P_2 V_2}{T_2} \\ \bullet R &= \frac{R}{M} \end{aligned}$$

$$\bullet \tilde{R} = C_p - C_v$$

$$\bullet \gamma = \frac{C_p}{C_v}$$

NON FLOW PROCESS1. Isothermal Process ( $T_1 = T_2$ )

$$\begin{aligned} \bullet U_2 - U_1 &= 0 \\ \bullet Q &= W \\ \bullet W &= P_1 V_1 \ln\left(\frac{V_2}{V_1}\right) \quad @ \quad W = P_1 V_1 \ln\left(\frac{P_1}{P_2}\right) \end{aligned}$$

## 2. Adiabatic Process (Seentropi)

$$\begin{aligned} \bullet U_2 - U_1 &= mC_v(T_2 - T_1) \\ \bullet W &= \frac{P_1 V_1 - P_2 V_2}{\gamma - 1} = \frac{mR(T_1 - T_2)}{\gamma - 1} \\ \bullet Q &= 0 \end{aligned}$$

$$\bullet \frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

## 3. Polytropic Process

$$\begin{aligned} \bullet U_2 - U_1 &= mC_V(T_2 - T_1) \\ \bullet W &= \frac{P_1 V_1 - P_2 V_2}{n-1} = \frac{mR(T_1 - T_2)}{n-1} \\ \bullet Q &= \frac{\gamma-n}{\gamma-1} \times W \end{aligned}$$

$$\bullet \frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} = \left(\frac{V_1}{V_2}\right)^{n-1}$$

4. Constant Pressure Process ( $P_1 = P_2$ )

$$\begin{aligned} \bullet Q &= mC_P(T_2 - T_1) \\ \bullet U_2 - U_1 &= Q - W = mC_V(T_2 - T_1) \\ \bullet W &= P(V_2 - V_1) = mR(T_2 - T_1) \end{aligned}$$

5. Constant Volume Process ( $V_1 = V_2$ )

$$\begin{aligned} \bullet Q &= U_2 - U_1 = mC_V(T_2 - T_1) \\ \bullet W &= 0 \end{aligned}$$

FLOW PROCESS

$$\begin{aligned} \bullet Q - W &= \dot{m} \left[ (h_2 - h_1) + \left( \frac{C_2^2 - C_1^2}{2000} \right) + \left( \frac{Z_2 - Z_1}{1000} \right) g \right] \\ \bullet h_2 - h_1 &= (U_2 - U_1) + (P_2 v_2 - P_1 v_1) = C_p (T_2 - T_1) \\ \bullet \dot{m} &= \frac{CA}{v} \end{aligned}$$

PROPERTIES OF STEAM

$$\begin{aligned} \bullet V &= x(V_g) \\ \bullet h &= h_f + x(h_{fg}) \\ \bullet h &= U + P_v \end{aligned}$$

$$\bullet U = U_f + x(U_g - U_f)$$

$$\bullet S = S_f + x(S_{fg})$$

2<sup>nd</sup> LAW THERMODYNAMICS

## 1. STEAM

a. Constant Pressure Process ( $P_1 = P_2$ )

$$W = P(V_2 - V_1) = Q - (u_2 - u_1)$$

$$Q = h_2 - h_1$$

b. Constant Volume Process ( $V_1 = V_2$ )

$$W = 0 \quad Q = u_2 - u_1$$

c. Isothermal Process ( $T_1 = T_2$ )

$$Q = T(s_2 - s_1) \quad W = Q - (u_2 - u_1)$$

## d. Adiabatic Process (Seentropi)

$$s_1 = s_2 \quad Q = 0 \quad W = u_1 - u_2$$

## e. Polytropic Process

$$W = \frac{P_1 V_1 - P_2 V_2}{n-1} \quad Q = (u_2 - u_1) + W$$

## 2. PERFECT GAS

a. Constant Pressure Process ( $P_1 = P_2$ )

$$s_2 - s_1 = mC_p \ln\left(\frac{T_2}{T_1}\right)$$

b. Constant Volume Process ( $V_1 = V_2$ )

$$s_2 - s_1 = mC_v \ln\left(\frac{T_2}{T_1}\right)$$

c. Isothermal Process ( $T_1 = T_2$ )

$$s_2 - s_1 = mR \ln\left(\frac{V_2}{V_1}\right) = mR \ln\left(\frac{P_1}{P_2}\right)$$

## d. Polytropic Process

$$s_2 - s_1 = mR \ln\left(\frac{V_2}{V_1}\right) - mC_v \ln\left(\frac{T_1}{T_2}\right)$$

Or

$$s_2 - s_1 = mR \ln\left(\frac{P_1}{P_2}\right) - mC_p \ln\left(\frac{T_1}{T_2}\right)$$

CHEMICAL EQUILIBRIUM

$$\bullet \Delta S = Q_p (S_p - S_A)$$

$$\bullet \Delta G = \Delta G^\circ + RT \ln K$$

$$\bullet d(\ln K) = \frac{\Delta H}{RT}$$

