SULIT

POLITEKNIK MALAYSIA

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)

Kertas ini mengandungi **ENAM (6)** halaman bercetak.

Struktur (4 soalan)

Dokumen sokongan yang disertakan : Formula / Buku Jadual Stim

---

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
C1

(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
C2

(b) Convert the values to the specific units:

Tukarkan nilai kepada unit yang dinyatakan:

i. 3.2 mm^3/mg to m^3/kg

3.2 mm^3/mg kepada m^3/kg

[3 marks]
[*3 markah*]

ii. 0.0078 GJ/g to kJ/kg

0.0078 GJ/g kepada kJ/kg

[3 marks]
[*3 markah*]

iii. 5.9 MN/mm^2 to N/m^2

5.9 MN/mm^2 to N/m^2

[3 marks]

[*3 markah*]

CLO 1
C3

(c) A mass of 0.18 kg gas is at a temperature of 15°C, volume 0.17 m^3 and pressure 130 kN/m^2. If the gas has a value of Cv = 720 J/kg K, calculate the:

Jisim gas 0.18 kg berada pada suhu 15°C, isipadu 0.17 m^3 dan tekanan 130 kN/m^2. Jika gas mempunyai nilai Cv = 720 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
C1

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

Definisikan aliran sekata dan aliran tak sekata.

[4 marks]
[4 markah]

CLO 2
C2

(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
C3

(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^2 opening with an average velocity of 40 m/s, and exhausts through a 1m^2 opening. Calculate the work output by the turbine in kW. Given : R = 0.287kJ/kg.K Cp= 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 m^2 dengan kelajuan purata 40 m/ s, dan ekzos melalui bukaan 1m^2. Kirakan kerja keluaran oleh turbin di dalam kW. Diberi: R = 0.287kJ/kg.K Cp = 1.048 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°C and pressure 225 kN/m^2, occupies a volume of 0.63 m^3 at initial state. The gas is heated at constant pressure until the temperature is 47°C. Given C_p for gas as 0.34 kJ/kgK, compute:

Gas sempurna pada suhu 18°C dan tekanan 225 kN / m^2, menduduki isipadu 0.63 m^3 pada keadaan awal. Gas dipanaskan pada tekanan malar sehingga suhu adalah 47°C. Diberi C_p untuk gas sebagai 0.34 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?

i. $2HF(g) \rightleftharpoons H2(g)+F2(g)$

ii. $C(s)+2H2(g) \rightleftharpoons CH4(g)$

iii. $H2C=CH2(g)+H2(g) \rightleftharpoons C2H6(g)$

iv. $2Hg(l)+O2(g) \rightleftharpoons 2HgO(s)$

[8 marks]

[*8 markah*]

CLO 1
C2

(c) Express K_c and Kp for each reaction

$$2NOBr(g) \rightleftharpoons 2NO(g)+Br_2(g)$$

at 27°C, the equilibrium concentration of NO = 1.29 M, Br_2 = 10.52 M, and NOBr = 0.423 M.

Ungkapkan nilai K_c dan Kp untuk setiap tindak balas

$$2NOBr(g) \rightleftharpoons 2NO(g)+Br_2(g)$$

pada 27°C, kepekatan keseimbangan of NO adalah 1.29 M, Br2 = 10.52 M dan NOBr = 0.423 M

[10 marks]

[*10 markah*]

SOALAN TAMAT

BASIC THERMODYNAMICS

- $PV = mRT$
- $R = C_p - C_v$
- $U_2 - U_1 = Q - W$
- $\gamma = \frac{C_p}{C_v}$
- $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
- $R = \frac{R_o}{M}$

NON FLOW PROCESS

1. **Isothermal Process ($T_1 = T_2$)**
   - $U_2 - U_1 = 0$
   - $Q = W$
   - $W = P_1V_1 \ln\left(\frac{V_2}{V_1}\right)$ @ $W = P_1V_1 \ln\left(\frac{P_1}{P_2}\right)$
2. **Adiabatic Process (Seentropi)**
   - $U_2 - U_1 = mC_v(T_2 - T_1)$
   - $W = \frac{P_1V_1 - P_2V_2}{\gamma - 1} = \frac{mR(T_1 - T_2)}{\gamma - 1}$
   - $Q = 0$
   - $\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$
3. **Polytropic Process**
   - $U_2 - U_1 = mC_V(T_2 - T_1)$
   - $W = \frac{P_1V_1 - P_2V_2}{n-1} = \frac{mR(T_1 - T_2)}{n-1}$
   - $Q = \frac{\gamma - n}{\gamma - 1} \times W$
   - $\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} = \left(\frac{V_1}{V_2}\right)^{n-1}$
4. **Constant Pressure Process ($P_1 = P_2$)**
   - $Q = mC_P(T_2 - T_1)$
   - $U_2 - U_1 = Q - W = mC_V(T_2 - T_1)$
   - $W = P(V_2 - V_1) = mR(T_2 - T_1)$
5. **Constant Volume Process ($V_1 = V_2$)**
   - $Q = U_2 - U_1 = mC_V(T_2 - T_1)$
   - $W = 0$

FLOW PROCESS

- $Q - W = \dot{m}\left[(h_2 - h_1) + \left(\frac{C_2^2 - C_1^2}{2000}\right) + \left(\frac{Z_2 - Z_1}{1000}\right)g\right]$
- $h_2 - h_1 = (U_2 - U_1) + (P_2v_2 - P_1v_1) = C_p(T_2 - T_1)$
- $\dot{m} = \frac{CA}{v}$

PROPERTIES OF STEAM

- $V = x(V_g)$
- $h = h_f + x(h_{fg})$
- $h = U + Pv$
- $U = U_f + x(U_g - U_f)$
- $S = S_f + x(S_{fg})$

2nd 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 ($V_1 = V_2$)**
   $W = 0$ $Q = u_2 - u_1$
   c. **Isothermal Process ($T_1 = T_2$)**
   $Q = T(s_2 - s_1)$ $W = Q - (u_2 - u_1)$
   d. **Adiabatic Process (Seentropi)**
   $s_1 = s_2$ $Q = 0$ $W = u_1 - u_2$
   e. **Polytropic Process**
   $W = \frac{P_1V_1 - P_2V_2}{n-1}$ $Q = (u_2 - u_1) + W$
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

- $\Delta S = Q_p (S_P - S_A)$
- $\Delta G = \Delta G^O + RT \ln K$
- $\frac{d(\ln K)}{dT} = \frac{\Delta H}{RT^2}$