SULIT

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

JABATAN KEJURUTERAAN PETROKIMIA

PEPERIKSAAN AKHIR

SESI I : 2022 / 2023

DGP20052 : THERMODYNAMICS

TARIKH : 14 DISEMBER 2022
MASA : 2.30 PETANG – 4.30 PETANG (2 JAM)

Kertas ini mengandungi **TUJUH (7)** halaman bercetak.

Struktur (4 soalan)

Dokumen sokongan yang disertakan : Formula dan Buku 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 struktur. Jawab* ***SEMUA*** *soalan.*

QUESTION 1
SOALAN 1

CLO1
C1

(a) Label (i), (ii) and (iii) with suitable terms for the close system as shown in Figure 1(a). Then give the definition of each term.
Labelkan (i), (ii) dan (iii) dengan istilah yang sesuai bagi sistem tertutup seperti yang ditunjukkan dalam Rajah 1(a). Kemudian, berikan definisi bagi setiap istilah tersebut.

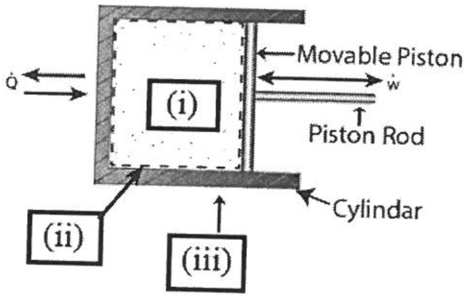

Figure 1(a): Close System / *Rajah 1(a): Sistem Tertutup*

[6 marks]
[6 markah]

CLO1
C2

(b) A perfect gas is a theoretical gas model that is different from real gases in specific ways to make certain calculations easier to handle. Two of the laws describing the behavior of a perfect gas are Boyle's Law and Charles' Law.
Gas unggul ialah model gas teori yang berbeza daripada gas sebenar dengan cara tertentu yang membolehkan pengiraan tertentu lebih mudah dikendalikan. . Dua hukum yang menggambarkan sifat gas unggul ialah Hukum Boyle dan Hukum Charles.

(i) Explain Boyle's Law with the aid of a P-V graph.
Jelaskan Hukum Boyle dengan bantuan graf P-V.

[3 marks]
[3 markah]

(ii) Express the mathematical equation for Boyle's law.

Ungkapkan persamaan matematik bagi Hukum Boyle.

[3 marks]

[*3 markah*]

(iii) A 0.04 m^3 tank of ammonia has a pressure of 12.7 kPa. Simplify the volume of ammonia if its pressure is changed to 8.4 kPa while its temperature remains constant.

Sebuah tangki ammonia 0.04 m^3 mempunyai tekanan 12.7 kPa. Kira isipadu ammonia jika tekanannya ditukar kepada 8.4 kPa manakala suhunya kekal malar.

[3 marks]

[*3 markah*

CLO1
C3

(c) A mass of 0.5 kg perfect gas at a temperature of 37°C and pressure at 3.5 bar, occupied the volume of 0.0984 m^3. If the gas has a value of $C_v = 0.8$ kJ/kg.K, calculate the:

Suatu gas unggul berjisim 0.5 kg pada suhu 37°C dengan tekanan 3.5 bar, memenuhi ruang dengan isipadu 0.0984 m^3. Sekiranya gas tersebut mempunyai nilai Cv = 0.8 kJ/kg.K, kirakan :

(i) molecular weight of the gas, M_w.

berat molekul gas, M_w.

[6 marks]

[*6 markah*]

(ii) specific Heat Ratio, γ

nisbah haba tentu.

[4 marks]

[*4 markah*]

QUESTION 2

SOALAN 2

CLO2
C1

(a) List **FOUR (4)** types of energy that need to be considered in a flow process.

*Senaraikan **EMPAT (4)** jenis tenaga yang perlu dipertimbangkan dalam proses alir.*

[4 marks]

[*4 markah*]

CLO2
C2

(b) Based on Figure 2(b) shown below,

Berdasarkan Rajah 2(b) di bawah,

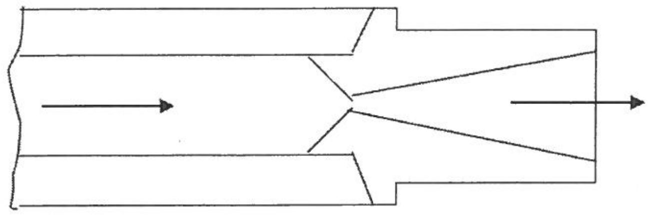

Figure 2(b) : Nozzle / *Rajah 2(b) : Nozzle*

(i) Explain the function of nozzle.

Terangkan secara ringkas fungsi muncung.

[2 marks]
[*2 markah*]

(ii) Outline **TWO (2)** assumptions made for nozzle when steady flow energy equation is applied.

*Gariskan **DUA (2)** andaian yang dibuat untuk muncung apabila persamaan tenaga aliran mantap digunakan.*

[2 marks]
[*2 markah*]

CLO2
C3

(c) 20 kg of fluid per minute goes through a reversible steady flow process. During the passage, the fluid rejects 50 kJ/s of heat and rises through 60 metres. Calculate the work done during the process (W). The inlet and exit conditions of the fluid are stated in Table 2 (c).

20 kg bendalir per minit melalui proses aliran mantap boleh balik. Semasa laluan, bendalir menyingkirkan 50 kJ/s haba dan naik sebanyak 60 meter. Kira kerja yang dilakukan semasa proses (W). Keadaan masukan dan keluaran bendalir adalah seperti yang dinyatakan dalam Jadual 2 (c).

Table 2(c) : Fluid inlet and exit condition
Jadual 2(c): Keadaan masukan dan keluaran bendalir

Fluid inlet conditions *Keadaan masukan bendalir*	Fluid exit conditions *Keadaan keluaran bendalir*
$P_1 = 200$ kPa	$P_2 = 615$kPa
$C_1 = 120$ m/s	$C_2 = 195$ m/s
$V_1 = 0.05$ m^3/kg	$V_2 = 0.2$ m^3/kg
$U_1 = 900$ kJ/kg	$U_2 = 705$ kJ/kg

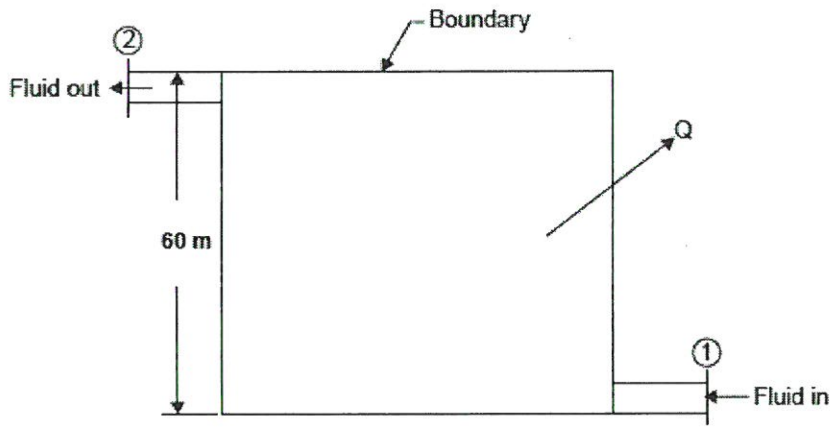

Figure 3(c): Steady flow process / *Rajah 3(c): Proses aliran mantap*

[17 marks]
[*17 markah*]

QUESTION 3
SOALAN 3

CLO2 C1

(a) By using a steam table, state the volume, internal energy, enthalpy, entropy and saturation temperature of the dry saturated steam at pressure 50 bar.

Dengan menggunakan jadual stim, nyatakan isipadu, tenaga dalaman, entalpi, entropi dan suhu tepu bagi stim tepu kering pada tekanan 50 bar.

[5 marks]
[*5 markah*]

CLO2 C3

(b) A mass of gas is heated at a constant pressure of 1.5 bar in a closed system from an initial volume of $0.25m^3$ to a final volume of $0.75m^3$. The initial temperature is $15^\circ C$. Calculate the:

Suatu jisim gas dipanaskan pada tekanan malar 1.5 bar dalam sistem tertutup daripada

isipadu awal $0.25m^3$ kepada isipadu akhir $0.75m^3$. Suhu awal ialah 15°C. Kirakan:

(i) mass of gas and internal energy change.

jisim gas dan perubahan tenaga dalaman.

[8 marks]
[*8 markah*]

(ii) work done and heat transfer.
kerja dilakukan dan haba dipindahkan.

[6 marks]
[6 markah]

(iii) change of entropy.
perubahan entropi.

Take R = 0.3kJ/kgK and c_v = 0.73kJ/kg.
Gunakan R = 0.3kJ/kgK and c_v = 0.73kJ/kg

[6 marks]
[6 markah]

QUESTION 4
SOALAN 4

CLO1
C2

(a) Chemical Equilibria's main application in industrial processes is to maximize the desired product concentration while minimizing the leftover reactants.
Aplikasi utama keseimbangan kimia dalam proses perindustrian adalah untuk memaksimumkan kepekatan produk yang diingini di samping meminimumkan sisa bahan tindak balas.

(i) Explain Gibbs Helmholtz equation and discuss how Gibbs free energy predicts the direction of a chemical reaction.

Terangkan persamaan Gibbs Helmholtz dan bincangkan bagaimana tenaga bebas Gibbs meramalkan arah tindakbalas kimia.

[7 marks]
[7 markah]

(ii) By considering the reaction below:
Dengan mempertimbangkan tindak balas di bawah:

$$PCl_5(g) \leftrightarrow PCl_3(g) + Cl_2(g)$$

Explain whether the equilibrium conditions are homogeneous or heterogeneous. Then calculate the equilibrium constant, Kp for the reaction if the partial pressure for each gas is 2 atm.

Terangkan sama ada keadaan keseimbangan adalah homogen atau heterogen. Kemudian hitung pemalar keseimbangan, Kp bagi tindak balas jika tekanan separa bagi setiap gas ialah 2 atm.

[8 marks]

[*8 markah*]

(iii) By considering the following reaction,

Dengan mempertimbangkan tindak balas berikut,

$$NH_3(g) + HCl\ (g) \longrightarrow NH_4Cl\ (s)$$

Simplify $\Delta G°$ in kJ at 298K and 700K. Then explain whether raising the temperature favor this reaction. Given for the reaction, ΔH = -176.0 kJ and S= -284.8 J/K.

Kira $\Delta G°$ dalam kJ pada 298K dan 700K. Kemudian terangkan sama ada meningkatkan suhu membantu tindakbalas ke hadapan bagi tindakbalas ini. Diberi untuk tindak balas, ΔH = -176.0 kJ dan S = -284.8 J/K.

[10 marks]

[*10 markah*]

SOALAN TAMAT

CHAPTER 1 : BASIC THERMODYNAMICS

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

CHAPTER 2 : 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 ($V_1 = V_2$)**
   - $Q = U_2 - U_1 = mC_v(T_2 - T_1)$
   - $W = 0$

CHAPTER 3 : FLOW PROCESS

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

CHAPTER 4 : PROPERTIES OF STEAM

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

CHAPTER 5 : 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 ($V_1 = V_2$)**
      $W = 0$ $\quad Q = u_2 - u_1$
   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**
      $W = \frac{P_1V_1 - P_2V_2}{n-1}$ $\quad Q = (u_2 - u_1) + W$
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

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

CHAPTER 6 : POWER CYCLES STEAM

- $\eta_c = \frac{(h_1 - h_2) - (h_4 - h_3)}{(h_1 - h_4)}$
- $r_w = \frac{(h_1 - h_2) - (h_4 - h_3)}{(h_1 - h_2)}$
- $S.S.C. = \frac{3600}{(h_1 - h_2) - (h_4 - h_3)}$