INSTRUCTION:

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

ARAHAN :

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

QUESTION 1
SOALAN 1

CLO1 C1

a) State **TWO (2)** differences between mass and weight.

Senaraikan ***DUA(2)*** *perbezaan di antara jisim dan berat.*

[4 marks]

[4 *markah*]

CLO1 C2

b) Liquid methanol is flowing through a pipe at a rate of 225 m^3/hr

Cecair metanol mengalir dalam paip dengan kadar 225 m^3*/hr.*

i) Calculate the mass flow rate of this stream in kg/min.

Kirakan kadar alir jisim bagi aliran ini dalam kg/min.

[6 marks]

[6 *markah*]

ii) Calculate the molar flow rate in mol/s.

Kirakan kadar alir molar dalam mol/s.

[4 marks]

[4 *markah*]

[Molecular weight of Methanol = 32g/mol; Specific gravity of methanol = 0.791]

[Berat molekul Metanol = 32g/mol; Spesifik graviti methanol = 0.791]

CLO1
C3

c) The mass fractions of components of a gas mixture at pressure of 2400kPa are given in Table 1(c). The molecular weight of N_2, He, CH_4 and C_2H_6 are 28.0, 4.0, 16.0 and 30.0 kg/kmol respectively. Take 200 kg of mixture as basis.
Pecahan mol bagi komponen bagi campuran gas pada tekanan 2400kPa diberikan di Jadual 1(c). Berat molekul bagi N_2, He, CH_4, dan C_2H_6 masing-masing ialah 28.0, 4.0, 16.0 dan 30.0 kg/kmol. Ambil 200 kg campuran sebagai asas.

Table 1(c)/*Jadual 1(c)*

Gases	**% by mass (*mengikut jisim*)**
N_2	8
He	15
CH_4	50
C_2H_6	28

i) Calculate the mole fraction of each component.
Kirakan pecahan mol bagi setiap komponen.

[9 marks]
[*9 markah*]

ii) Calculate the molecular weight of the gas mixture.
Kirakan berat molekul bagi campuran gas tersebut.

[2 marks]
[*2 markah*]

QUESTION 2
SOALAN 2

CLO2
C1

(a) Process is an operation which could cause physical or chemical change in the material being processed. The process stated below are examples of processes carried out in units. Define the following processes:
Proses adalah satu operasi yang boleh menyebabkan perubahan fizikal atau kimia dalam bahan yang telah diproses. Proses yang dinyatakan di bawah adalah contoh proses yang dijalankan dalam unit. Definisikan proses yang berikut:

i) Batch process
Proses kelompok

[2 marks]
[*2 markah*]

ii) Semi-batch process
Proses separa kelompok

[2 marks]
[*2 markah*]

CLO2
C2

(b) 2500 kg/h of a mixture containing equal parts by mass of methanol and water is distilled. Product streams leave the top and bottom of the distillation column. The flow rate of the bottom stream is measured and found to contain 8.5wt% of methanol, and the overhead stream is analyzed and found to contain 96.0 wt% methanol.
2500 kg/jam suatu campuran mengandungi kuantiti yang sama mengikut jisim methanol dan air telah disulingkan. Hasil keluar pada aliran atas dan bawah turus penyulingan. Aliran bawah mengandungi 8.5wt% methanol dan aliran atas mengandungi 96.0% methanol mengikut jisim.

i) Draw a flowchart of the process with complete labelling
Lukis carta alir proses dengan label yang lengkap

[3 marks]
[*3 markah*

ii) Calculate all the unknown flow rates of the process
Kirakan semua kadar alir yang tidak diketahui dalam proses

[7 marks]
[*7 markah*]

CLO2
C3

(c) The feed to a continuous ammonia formation reactor is 100 mol/s nitrogen, 300mol/s hydrogen and 1.00 mol/s argon (inert gas). The fractional conversion of hydrogen in the reactor is 75%. Calculate the molar flow rate of each species as it exits the reactor by using the extent of reaction method.
Suapan ke dalam reaktor pembentukan ammonia berterusan adalah 100 mol/s gas nitrogen, 300 mol/s gas hydrogen dan 1.00 mol/s argon(gas lengai). 'Fractional Conversion' bagi gas hidrogen di dalam reaktor ialah 75%. Kirakan kadar alir molar bagi setiap spesis yang keluar dari reaktor menggunakan kaedah 'extent of reaction'.

$$N_2 + 3H_2 \rightarrow 2NH_3$$

[11 marks]
[*11 markah*]

QUESTION 3
SOALAN 3

CLO2
C1

(a) Define the following concentration
Takrifkan kepekatan berikut

i) The mass concentration
Kepekatan jisim

[2 marks]
[*2 markah*]

ii) The molar concentration
Kepekatan molar

[2 marks]
[*2 markah*]

CLO2
C2

b) A labelled flow chart of continuous steady state two unit distillation processes is shown below. Each stream contains two components A and B, in different proportion.
Carta alir suatu proses penyulingan dua unit berterusan yang telah lengkap dilabel ditunjukkan di bawah. Setiap aliran mengandungi dua komponen A dan B dalam pecahan kuantiti yang berlainan.

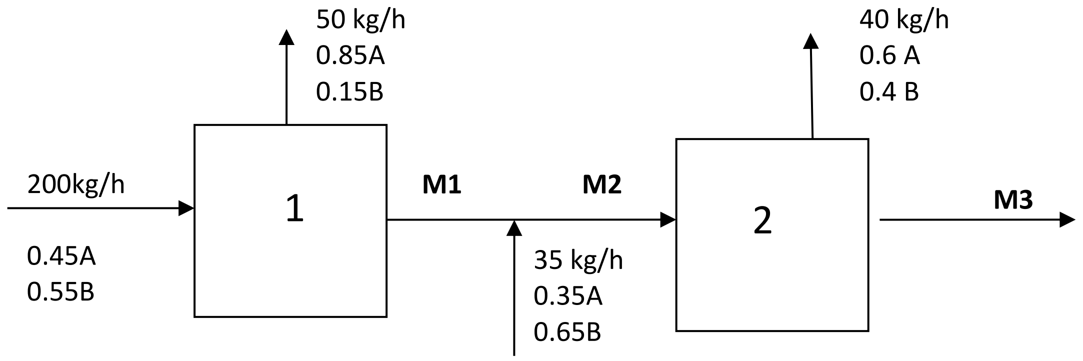

Diagram 3(b)/*Rajah 3(b)*

i). Calculate the flow rate M1,M2 and M3
Kirakan kadar alir M1, M2 dan M3

[6 marks]
[*6 markah*]

ii). Calculate all composition of stream M1, M2 and M3
Kirakan semua komposisi bagi aliran M1,M2 dan M3

[6 marks]
[*6 markah*]

CLO2
C3

c) Butane (C_4H_{10}) at 280 °C and 4.5 atm flows into a reactor at a rate of 3190 kg/h. Calculate the volumetric flow rate in m^3/s of this stream using conversion from standard conditions. The molecular weight of butane is 58.
Butana (C_4H_{10}) pada suhu 280 °C dan tekanan 4.5 atm mengalir ke dalam reaktor pada kadar 3190 kg/jam. Kirakan kadar alir isipadu dalam unit m^3/s. menggunakan penukaran daripada keadaan mutlak. Berat molekul butana ialah 58.
Standard condition/*keadaan piawai:*

Pressure, P_s *Tekanan, P_s*	Volume, V_s *Isipadu, V_s*	Number of mol, n_s *Bilangan mol, n_s*	Temperature, T_s *Suhu, T_s*
1 atm	22.415 m^3	1 mol	273 K

[9 marks]
[*9 markah*]

QUESTION 4
SOALAN 4

CLO1
C1

(a) (i) Define the kinetic energy.
Takrifkan Tenaga Kinetik

[2 marks]
[*2 markah*]

ii) Give the S.I unit of Kinetic Energy
Berikan unit S.I bagi tenaga kinetik.

[2 marks]
[*2 markah]*

CLO1 C2

(b) Calculate the mass flow rate required to raise the temperature of 35000 kJ/ h of nitrous oxide from 10°C to 100° C. The constant heat capacity of N_2O in this temperature range is given by the equation below:
Kirakan jisim yang diperlukan untuk menaikkan suhu bagi 35000 kJ nitrogen oksida daripada 10°C kepada 100° C. Nilai pemalar isipadu haba muatan N_2O untuk julat suhu tersebut diberi dalam persamaan di bawah.

$$C_p (kJ/mol.^{O}C) = 0.855 + 9.42 \times 10^{-4} T$$

Where T is in °C/ *Di mana T dalam °C*
[Molecular weight of N_2O is 44/ *Berat Molekul N_2O ialah 44*]

[11 marks]
[*11 markah*]

CLO1 C3

(c) The pressure gauge on a 45 m^3/h of nitrogen, at 27 °C reads 12 bar. Molecular weight of N_2 is 28 g/mol. Determine the mass in g/sec of nitrogen gas using direct solution of the ideal gas equation of state.
Tekanan bagi 45 m^3/jam nitrogen ialah 27 °C ialah 12 bar.Berat molekul nitrogen N_2 ialah 28 g/mol. Tentukan jisim dalam g/s bagi gas nitrogen dengan penyelesaian menggunakan persamaan ideal gas.

[10 marks]
[*10 markah*]

SOALAN TAMAT

Appendix 1

Table of Unit Conversions

Quantity	Equivalent Values
Mass	1 kg = 1000 g = 0.001 metric ton = 2.20462 Ib_m = 35.27392 oz 1 Ib_m = 16 oz = 5 X 10^{-4} ton = 453.593 g = 0.453593 kg
Length	1 m = 100 cm = 1000 mm = 10^6 microns (μm) = 10^{10} angstroms (A) = 39.37 in. = 3.2808 ft = 1.0936 yd = 0.0006214 mile
Volume	1 m^3 = 1000 liters = 10^6 cm^3 = 10^6 ml = 35.3145 ft^3 = 220.83 imperial gallons = 264.17 gal = 1056.68 qt 1 ft^3 = 1728 in^3 = 7.4805 gal = 0.028317 m^3 = 28.317 liters = 28 317 cm^3
Force	1 N = 1 kg.m/s^2 = 10^5 dynes = 10^5 g.cm/s^2 = 0.22481 Ib_f 1 Ib_f = 32.174 Ibm.ft/s^2 = 4.4482 N = 4.4482 X 10^4 dynes
Pressure	1 atm = 1.01325 x 10^5 N/m^2 (Pa) = 101.325 kPa = 1.01325 bars = 1.01325 x 10^6 dynes/cm^2 = 760 mm Hg at 0 °C (torr) = 10.333 m H_2O at 4 °C = 14.696lb_f/in^2 (psi) = 33.9 ft H_2O at 4 °C = 29.921 in Hg at 0 °C
Energy	1 J = 1 N.m = 10^7 ergs = 10^7 dyne.cm = 2.778 x 10^{-7} kW.h = 0.23901 cal = 0.7376 ft-lb_f = 9.486 x 10^{-4} Btu
Power	1 W = 1J/s = 0.23901 cal/s = 0.7376 ft.lb_f/s = 9.468 x 10^{-4} Btu/s = 1.341 x 10^{-3} hp

Appendix II

FORMULAS & EQUATIONS

CHAPTER 1

1. W = mg
2. g = 9.8066 m/s^2 = 980.66 cm/s^2 = 32.174 ft/s^2
3. Kinetic Energy = ½ mv^2
4. Potential Energy = mgh

CHAPTER 2

1. SG = ρ / ρ_{ref}
2. ρ_{ref} (H_2O, 4˚C) = 1.000 g/cm^3 = 1000 kg/m^3 = 62.43 lb_m/ft^3
3. ρ = m/V
4. Avogadro's Number = 6.02 X 10^{23}
5. $Mass\ Fraction, x = \frac{m}{m_{Total}}$ and $Mole\ Fraction, y = \frac{n}{n_{total}}$

CHAPTER 3

1. General Balance Equation for steady state process:

   input + generation = output + consumption

2. $$Frational\ excess = \frac{moles_{(fed)} - moles_{(reacted)}}{moles_{(reacted)}}$$

3. $$percentage\ excess = \frac{moles_{(fed)} - moles_{(reacted)}}{moles_{(reacted)}} \times 100\%$$

4. $$fractional\ conversion, f = \frac{moles_{(reacted)}}{moles_{(Fed)}}$$

5. $$\%\ fractional\ conversion = \frac{moles_{(reacted)}}{moles_{(Fed)}} \times 100\%$$

6. $$Yield = \frac{moles_{(desired\ product)}}{moles_{(LR)}} \times \frac{stoichiometry\ coefficient_{(LR)}}{stoichiometry\ coefficient_{(DP)}} \times 100\%$$

7 $$Selectivity = \frac{moles_{(desired\ product)}}{moles_{(undesired\ product)}}$$

8. Overall conversion $= \dfrac{\text{reactant input to the process - reactant output from process}}{\text{reactant input to process}}$

9. Single-pass conversion $= \dfrac{\text{reactant input to reactor - reactant output from reactor}}{\text{reactant input to reactor}}$

10. Percentage excess air $= \dfrac{(\text{moles air})_{fed} - (\text{moles air})_{theoretical}}{(\text{moles air})_{theoretical}} \times 100\ \%$

11. 100 mol air ⟶ 79 mol nitrogen

⟶ 21 mol oxygen

CHAPTER 4

1. Ideal gas law : PV = nRT : $\dfrac{PV}{P_sV_s} = \dfrac{nT}{n_sT_s}$: $\dfrac{P_1V_1}{P_2V_2} = \dfrac{T_1}{T_2}$
2. $P_{absolute} = P_{atmospheric} + P_{gauge}$
3. Gas constant, R = 8.314 m^3.Pa / mol .K = 0.08314 liter.bar / mol . K =0.08206 liter.atm/mol.K = 63.36 liter.mm Hg/mol.K = 0.7302 ft^3.atm/Ib-mole.˚R = 10.73 ft^3 .psia / Ib-mole . ˚R = 8.314 J/mol.K = 1.987 cal/mol.K = 1.987 Btu / Ib-mole. ˚R
4. T (K) = T (˚ C) + 273

   T (˚R) = T (˚F) + 460

   T(°F) = $T(°C)\dfrac{5}{9}$ + 32
5. Standard Condition for gases

system	T_s	P_s	V_s	n_s
SI	273 K	1 atm	0.02245 m^3	1 mol

6. V_s/n_s = 0.0224 m^3 (STP)/mol = 22.4 liters(STP)/mol = 359 ft^3(STP)/lb-mole

CHAPTER 5

1. First Law of Thermodynamics for closed system:

$$\Delta U + \Delta E_{kinetic} + \Delta E_{potential} = Q + W$$

2. Energy balance for closed system:

$$Q = \Delta U = m\,\Delta\hat{U}$$

3 Specific internal energy, $\Delta\hat{U} = \int_{T_1}^{T_2} Cv(T)\,dT$

4 Heat of reaction $\Delta H = \sum n\,\Delta H_{(products)} - \sum n \Delta H_{(reactants)}$