

**STRUCTURED QUESTIONS: 100 MARKS****SOALAN STRUKTUR: 100 MARKAH****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

- (a) State the S.I unit of the velocity.

*Nyatakan unit S.I untuk halaju.*

[2 marks]

[2 markah]

CLO1

- (b) (i) Butane can be used as a replacement for CFCs in refrigerators. The specific gravity of butane is 0.6. Approximate the volume in gallon(gal) needed to contain 550.0 g of butane.

*Butana boleh digunakan untuk menggantikan CFCs dalam peti sejuk. Specifik graviti butana ialah 0.6. Anggarkan isipadu dalam unit gallon(gal) yang mengandungi 550.0 gram butana.*

[ 5 marks]

[5 markah]

- (ii). A density of copper is 8.96 g/mL. The initial level of water in the graduated cylinder rises from 325 mL to 815 mL after a piece of copper is submerged. Approximate the mass of copper in kg.

*Ketumpatan kuprum ialah 8.96 g/mL. Paras awal air di dalam silinder penyukat naik dari 325mL kepada 815mL selepas sekeping kuprum direndam. Anggarkan jisim kuprum dalam unit kg.*

[5 marks]

[5 markah]

CLO1

(c) Liquid methanol is flowing through a pipe at a rate of  $75 \text{ m}^3/\text{hr}$ . Molecular weight of methanol is  $32.0 \text{ g/mol}$  and the specific gravity of methanol is  $0.791$ .  
*Cecair metanol mengalir dalam pipe dengan kadar  $75 \text{ m}^3/\text{hr}$ . Berat molekul methanol ialah  $32.0 \text{ g/mol}$  dan specific gravity methanol ialah  $0.791$ .*

i) Calculate the density of methanol.

*Kirakan ketumpatan methanol.*

[4 marks]

[4 markah]

ii) Calculate the mass flow rate of this stream in  $\text{kg/min}$ .

*Kirakan kada ralis jisim bagi aliran ini dalam  $\text{kg/min}$ .*

[4 marks]

[4 markah]

iii) Calculate the molar flow rate in  $\text{mol/s}$ .

*Kirakan kadar alir molar dalam  $\text{mol/s}$ .*

[ 5 marks]

[5 markah]

## QUESTION 2

### SOALAN 2

CLO2

(a) State **TWO (2)** differences between complete combustion and incomplete combustion by giving an appropriate example.

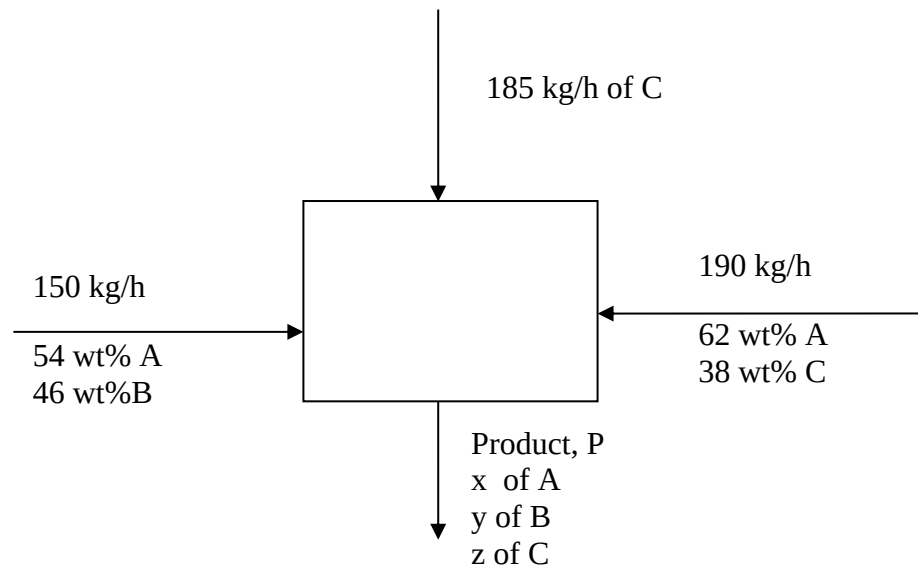
*Nyatakan **DUA (2)** perbezaan antara pembakaran lengkap dan pembakaran tidak lengkap dengan memberikan satu contoh yang sesuai.*

[4 marks]

[4 markah]

CLO2

- (b) The diagram 2(b) describes a mixing tank of three streams.  
*Rajah 2(b) menerangkan suatu tangki campuran bagi tiga aliran.*



**Diagram 2(b)/Rajah 2(b)**

- (i) Calculate the mass of product, P.  
*Kirakan jisim produk P.*

[ 4 marks]

[4 markah]

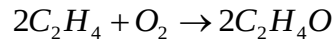
- (ii). Calculate the composition (%) of each component A, B and C in the product stream.  
*Kirakan komposisi (%) setiap komponen A, B dan C di dalam aliran produk.*

[ 5 marks]

[5 markah]

CLO2

- (c) Ethylene oxide is produced by the catalytic oxidation of ethylene. The feed to a reactor contains 200 kmol  $C_2H_4$  and 200 kmol  $O_2$ . The fractional conversion of limiting reactant is 85%. The reaction is stated as below;  
*Etilena oksida terhasil daripada pengoksidaan bermangkin. Suapan ke reaktor mengandungi 200 kmol  $C_2H_4$  dan 200 kmol  $O_2$ . 'Fractional conversion' bahan tindak balas terhad ialah 85%. Tindak balas seperti di bawah.*



- (i). Calculate the percentage (%) of the excess reactant.

*Kirakan peratus (%) bahan yang berlebihan.*

[ 5 marks]

[5 markah]

- (ii). Calculate the mole of all products in the output stream.

*Kirakan bilangan mol semua produk dalam aliran keluar.*

[ 7 marks]

[7 markah]

### QUESTION 3

#### SOALAN 3

CLO1

- (a) Define the following terms.

*Takrifkan istilah.*

- (i) Partial pressure

*Tekanan separa*

[2 marks]

[2 markah]

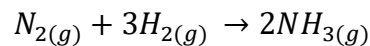
CLO1

- (ii) Ideal Gas Equation of State  
*Persamaan Asas Ideal Gas*

[2 marks]

[2 markah]

- (b) Ammonia (NH<sub>3</sub>) gas can be synthesized from the complete reaction of 8.5 kg of hydrogen, H<sub>2</sub> (g) and nitrogen, N<sub>2</sub>(g) at pressure 3.5 atm(abs) and 75°C .  
 Molecular weight of H<sub>2</sub> is 2.0 g/mol. Assume ammonia is an ideal gas.  
*Gas ammonia (NH<sub>3</sub>) boleh disintesis daripada tindak balas lengkap 8.5 kg gas hidrogen, H<sub>2</sub> (g) dan gas nitrogen, N<sub>2</sub>(g) pada tekanan 3.5 atm(abs) dan suhu 75°C. Berat molekul H<sub>2</sub> ialah 2.0 g/mol. Anggapkan ammonia ialah gas ideal.*



- (i) Approximate the mole of hydrogen and ammonia.  
*Anggarkan bilangan mol hidrogen dan ammonia.*

[ 4 marks]

[4 markah]

- (ii) Approximate the volume in m<sup>3</sup> of ammonia, NH<sub>3</sub> .  
*Anggarkan isipadu dalam m<sup>3</sup> ammonia NH<sub>3</sub>..*

[ 4 marks]

[4 markah]

CLO1

- (c) (i) Calculate the value of gas constant, R in (liter.atm/mol.K) occupied by 115 liters, 355 g of butane gas at 23°C and 18.7 psi(abs) assuming ideal gas behaviour.  
 Molecular weight of butane is 58 g/mol.  
*Kirakan nilai pemalar gas R dalam (liter.atm/mol.K) yang mengandungi 115 liters dan 355 g gas butana pada 23 °C and 18.7 psi (abs) dengan menganggap gas bersifat ideal. Berat molekul butana ialah 58 g/mol.*

[ 6 marks]

[6 markah]

CLO1

- (ii) Hexane ( $C_6H_{14}$ ) at  $300^\circ C$  and 4 atm (gauge) flows into a reactor at a rate of 220kg/hr. Calculate the volumetric flow rate of this stream in  $m^3/hr$  by using conversion of standard condition. Molecular weight Hexane ( $C_6H_{14}$ ) is 86.0 g/mol.

*Heksana ( $C_6H_{14}$ ) pada  $300^\circ C$  dan 4 atm(gauge) mengalir ke dalam reaktor pada kadar 220kg/jam. Kirakan kadar alir isipadu dalam in  $m^3/jam$  menggunakan 'conversion of standard condition' Berat molekul Heksana ( $C_6H_{14}$ ) ialah 86.0 g/mol.*

[ 7 marks]

[7 markah]

**QUESTION 4****SOALAN 4**

CLO2

- (a) Define the following terms:

*Difinasikan istilah berikut:*

- i) Hess's Law  
*Hukum Hess*

[ 2 markah]

[ 2 markah]

- ii) Heat of Reaction  
*Tenaga tindak balas*

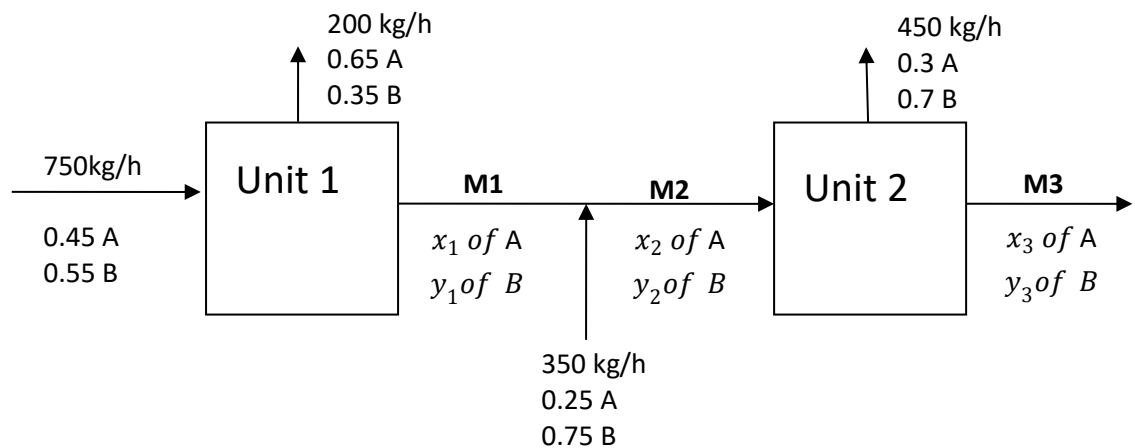
[ 2 markah]

[ 2 markah]

CLO2

- (b) In a distillation train a mixture contains 45% of component A and 55% of component B is to be fractionated into essentially pure components as shown in the **Diagram 4(b)**.

*Dalam penyulingan berperingkat suatu campuran yang mengandung 45% komponen A dan 55 % komponen B akan disulingkan kepada komponen tulen seperti di dalam **Rajah 4(b)** di bawah.*



**Diagram 4(b)/Rajah 4(b)**

CLO2

- (i) Approximate the flow rates of M1, M2 and M3.  
*Anggarkan kadar alir M1, M2 dan M3.*

[4 marks]

[4 markah]

- (ii) Approximate the composition (%) of component A and B in all the unknown flow rates.  
*Anggarkan komposisi (%) komponen A dan B dalam semua kadar alir yang tidak diketahui.*

[4 marks]

[4 markah]

CLO2

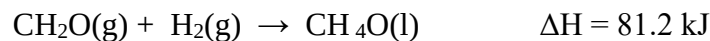
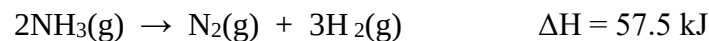
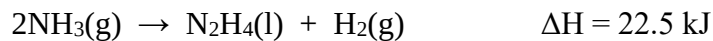
- (c) (i) Calculate the heat of reaction,  $\Delta H(\text{kJ})$  at 298K for the following reaction using the listed standard enthalpy of reaction data using Hess's law.

*Kirakan haba tindak balas,  $\Delta H(\text{kJ})$  at 298K bagi tindak balas di bawah dengan menggunakan Hukum Hess.*



The standard enthalpy of the following reactions have been determined experimentally:

*Haba tentu bagi tindak balas di bawah telah diperolehi dari ujikaji.*



[ 4 marks]

[4 markah]

CLO2

- (ii) The heat removal rate is required to cool the nitrous oxide from 25°C to 120°C is 58000 kJ/h. The constant heat capacity of  $\text{N}_2\text{O}$  in this temperature range is given by the equation below. Where T is in °C. Calculate the specific internal energy,  $\Delta \tilde{U}$  of the  $\text{N}_2\text{O}$ .

*Kadar haba tersingkir diperlukan untuk menurunkan nitrogen oksida daripada 25°C kepada 120° C ialah 58000 kJ/h. Nilai pemalar isipadu haba muatan  $\text{N}_2\text{O}$  untuk julat suhu tersebut diberi dalam persamaan di bawah.. Di mana T dalam °C. Kirakan tenaga dalaman tentu,  $\Delta \tilde{U}$  bagi  $\text{N}_2\text{O}$ .*

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

[ 5 marks]

[5 markah]



CLO2

- (iii) Calculate the mass flow rate required in g/s to raise the  $N_2O$  based on C(ii).  
Molecular weight of  $N_2O$  is 44.0 g/mol .  
*Kirakan kadar alir jism dalam g/s yang diperlukan untuk memanaskan  $N_2O$  berdasarkan C(ii). Berat molekul  $N_2O$  ialah 44.0 g/mol.*

[4 Marks]

[4 Markah]

**SOALAN TAMAT**