



KEMENTERIAN PENDIDIKAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI

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

JABATAN KEJURUTERAAN PETROKIMIA

PEPERIKSAAN AKHIR

SESI II : 2025/2026

DGP30373 : MASS AND ENERGY BALANCE

TARIKH : 04 MEI 2026

MASA : 8.30 PAGI - 10.30 PAGI (2 JAM)

Kertas soalan ini mengandungi **SEPULUH (10)** halaman bercetak.

Struktur (4 soalan)

Dokumen sokongan yang disertakan : Formula

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

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**

CLO1

- (a) Define the specific gravity, SG.
Definisikan graviti tentu, SG.

[2 marks]

CLO1

[2 markah]

- (b) The specific gravity of xylene is 0.88. Approximate:
Graviti tentu xilena ialah 0.88. Anggarkan:

- i) the mass in kg of 35 liters of xylene.
jisim dalam kg 35 liter xilena.

[5 marks]

[5 markah]

- ii) the volumetric flow rate in L/min corresponding to a mass flow rate of 85lb_m/min xylene.
kadar aliran volumetrik dalam L/min sepadan dengan kadar aliran jisim 85lb_m/min xilena.

[5 marks]

[5 markah]

CLO1

- (c) 850g of liquid contains 45% butane (C_4H_{10}), 30% pentane (C_5H_{12}), and the balance is hexane (C_6H_{14}). Molecular weight of butane (C_4H_{10}), pentane (C_5H_{12}) and hexane (C_6H_{14}) are 58.0g/mol, 72.0 g/mol and 86.0 g/mol respectively.

Calculate:

850g cecair mengandungi 45% butana (C_4H_{10}), 30% pentana (C_5H_{12}), dan selebihnya adalah heksana (C_6H_{14}). Berat molekul butana (C_4H_{10}), pentana (C_5H_{12}), dan heksana (C_6H_{14}) masing-masing ialah 58.0 g/mol, 72.0 g/mol and 86.0 g/mol. Kirakan:

- i) the number of moles of butane, pentane and hexane.

bilangan mol bagi butana, pentana dan heksana.

[4 marks]

[4 markah]

- ii) the mole fraction composition of the liquid.

pecahan mol komposisi cecair tersebut.

[4 marks]

[4 markah]

- iii) the average molecular weight of the gas mixture.

purata berat molekul bagi campuran gas tersebut.

[5 marks]

[5 markah]

QUESTION 2

SOALAN 2

- CLO1 (a) Material balances are obeying the law of conservation of mass where the mass can neither be created nor destroyed.
Keseimbangan bahan adalah mematuhi undang – undang pemuliharaan jisim dimana jisim tidak boleh dicipta atau dimusnahkan.
- i) State the general balance equation of theory material balance.
Nyatakan persamaan keseimbangan umum bagi teori baki bahan.
 [2 marks]
 [2 markah]
- ii) Define the steady-state condition.
Definisikan keadaan mantap.
 [2 marks]
 [2 markah]
- CLO1 (b) 2000 kg/h liquid mixture containing 70% ethanol and the balance of water. A stream of this mixture is fed to a separator vessel and operates under steady-state conditions. Product streams emerge at the distillate and residue streams. 85% of the water-fed recovery in the residue stream and the distillate streams contain 75% ethanol.
2000kg/j campuran cecair yang mengandungi 70% etanol dan keseimbangan air. Aliran campuran ini masuk ke dalam pemisah vesel dan beroperasi di bawah keadaan-mantap. Aliran produk muncul di aliran sulingan dan sisa. 85% daripada pemulihan yang diberi air dalam aliran sisa dan aliran sulingan mengandungi 75% etanol.
- i) Draw a flowchart of the process with complete labeling
Lukiskan carta alir proses dengan penglabelan lengkap
 [4 marks]
 [4 markah]

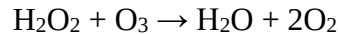
CLO1

- ii) Calculate all the unknown variables in the process flowchart
Kirakan semua pemboleh ubah tidak diketahui dalam carta alir proses

[5 marks]

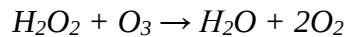
[5 markah]

- (c) Consider the reaction below: -



The molar composition of feed streams consists of 40% H_2O_2 and the balance of O_3 is fed an oxidation reactor. This reactor is operating under a stable steady state with the fractional conversion of H_2O_2 is 0.68. Take 200mol feed as basic calculation. With the process flow diagram, calculate:

Pertimbangkan reaksi dibawah:-



Komposisi molar aliran suapan terdiri daripada 40% H_2O_2 dan baki O_3 masuk ke dalam reaktor pengoksidaan. Reaktor ini beroperasi keadaan stabil dengan penukaran pecahan H_2O_2 ialah 0.68. Ambil suapan 200mol sebagai asas pengiraan. Dengan gambarajah aliran proses, kirakan:

- i) the extent of reaction.
takat tindak balas

[6 marks]

[6 markah]

- ii) the molar products of each species as it exits the reactor.
produk molar bagi setiap spesies semasa ia keluar dari reaktor

[6 marks]

[6 markah]

QUESTION 3

SOALAN 3

- | | |
|------|---|
| CLO1 | <p>(a) Define the following:
<i>Definisikan perkara berikut:</i></p> <p>i) Ideal gas
<i>Gas ideal</i></p> <p style="text-align: right;">[2 marks]
[2 markah]</p> <p>ii) Gas constant, R
<i>Pemalar gas, R</i></p> <p style="text-align: right;">[2 marks]
[2 markah]</p> |
| CLO1 | <p>(b) 200L of nitrous oxide gas is being stored in a pressure vessel at absolute 250bar and temperature of 20°C. The nitrous oxide is fed into a heated chamber, where the temperature is raised up to 80°C, and pressure is reduced to 5bar. By assuming the ideal gas system. Approximate:
<i>200L gas nitrous oksida disimpan dalam vesel tekanan pada 250 bar mutlak dan suhu 20°C. Nitrous oksida dimasukkan ke dalam ruang yang dipanaskan, dimana suhu meningkat kepada 80°C dan tekanan dikurangkan kepada 5bar. Dengan mengandaikan sistem gas ideal. Anggarkan:</i></p> <p>i) the mol of gas in pressure vessel.
<i>bilangan mol gas dalam vesel tekanan.</i></p> <p style="text-align: right;">[4 marks]
[4 markah]</p> <p>ii) the volume (L) occupied in heated chamber.
<i>isipadu (L) yang memenuhi dalam ruang pemanas.</i></p> |

[4 marks]

[4 markah]

CLO1

- (c) At 100°C and 10 atm, a stream of steam with flowrate of 10m³/h is mixed with a stream of air that contains 21% oxygen, and the rest is nitrogen at flowrate 150 mol/h. The gases mixture is then kept inside the container at 12 atm absolute pressure. By assuming the ideal gas system. Calculate:

Pada 100°C dan 10 atm, aliran wap dengan kadaran aliran pada 10 m³/j dicampur dengan aliran udara yang mengandungi 21% oksigen dan selebihnya nitrogen pada kadar aliran 150mol/j. Gas campuran kemudian disimpan di dalam bekas pada tekanan mutlak 12 atm. Dengan mengandaikan sistem gas ideal. Kirakan:

- i) the molar flow rate of each species in the container.
kadar aliran molar bagi setiap spesies dalam bekas.

[6 marks]

[6 markah]

- ii) the partial pressure of each species
tekanan separa bagi setiap spesies

[7 marks]

[7 markah]

QUESTION 4

SOALAN 4

CLO1

(a) Define the following:

Definisikan perkara berikut:

i) Kinetic energy

Tenaga kinetik

[2 marks]

[2 markah]

ii) Internal energy

Tenaga dalam

[2 marks]

[2 markah]

CLO1

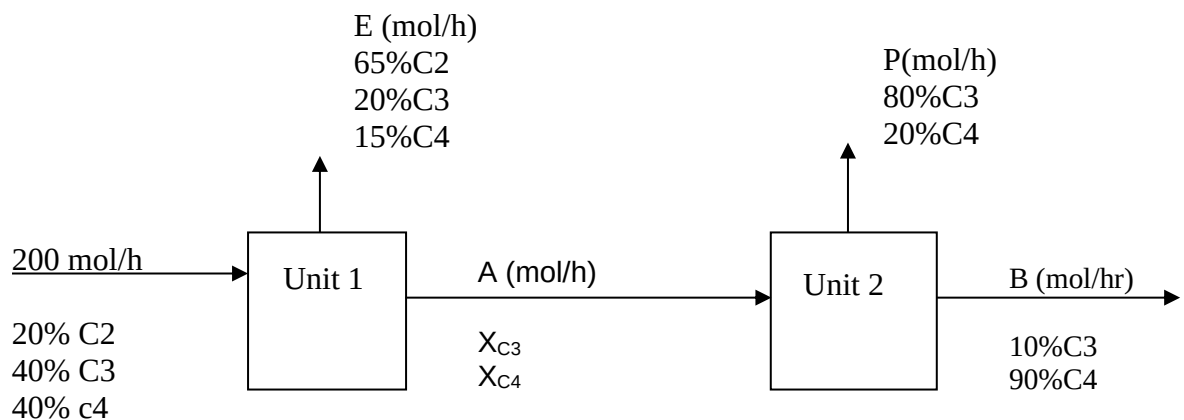
(b) In a distillation system, light hydrocarbons which consists of 20% ethane (C₂), 40% propane(C₃) and 40% butane (C₄) is to be fractionated into essentially pure components as shown in the diagram below. Approximate:*Dalam sistem penyulingan, hidrokarbon ringan yang mengandungi 20% etana (C₂), 40% propana (C₃) dan 40% butana (C₄) hendaklah dipecahkan menjadi komponen-komponen yang tulen seperti yang ditunjukkan dalam rajah di bawah. Anggarkan:*

Figure 4(b)/Rajah 4(b)

- i) the flow rate A, E and composition of stream A.

kadar aliran A, E dan komposisi aliran A

[4 marks]

[4 markah]

- ii) the flowrate B and P.

kadar alir B dan P

[4 marks]

[4 markah]

CLO1

- (c) In the following process, water is being evaporated to be used in a large-scale steam-methane reforming plant. The steam exiting the evaporator will be mixed with a methane stream. The water stream is required to be heated from 150 to 300°C. Given the polynomial heat capacity formula for steam is:

Dalam proses berikut, air akan disejatkan untuk diguna dalam loji pembaharuan metana stim berskala besar. Wap yang keluar dari penyejat akan dicampur dengan aliran metana. Aliran air perlu dipanaskan dari 150 hingga 300°C. Diberikan formula kapasiti haba polynomial untuk stim adalah:-

$$C_v \text{ (kJ/mol.}^\circ\text{C)} = 33.46 \times 10^{-3} + 0.688 \times 10^{-5}T$$

- i) Calculate the $\Delta \tilde{U}$ (kJ/mol) of steam.

Kirakan $\Delta \tilde{U}$ (kJ/mol) bagi wap

[4 marks]

[4 markah]

- ii) If the molar flowrate is 200mol/h, calculate the heat, Q (kJ/min).

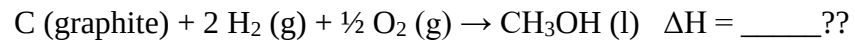
Jika kadar aliran molar ialah 200mol/j, kirakan haba Q (kJ/min)

[5 marks]

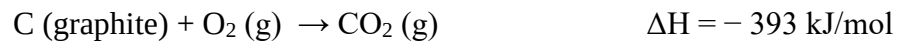
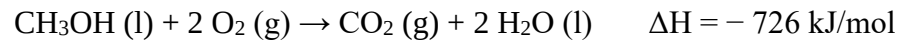
[5 markah]

- iii) Calculate the heat reaction of methanol reforming according to the heat formation given below:

Kirakan tindak balas haba pembaharuan metanol mengikut pembentukan haba yang diberikan di bawah:



Given/Diberi:



[4 marks]

[4 markah]

SOALAN TAMAT