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) Natural gas is a naturally occurring mixture of light hydrocarbons accompanied by some non-hydrocarbon compounds. State **THREE (3)** physical properties of natural gas.
*Gas asli adalah campuran hidrokarbon ringan yang wujud secara semula jadi yang disertai oleh beberapa sebatian bukan hidrokarbon. Nyatakan **TIGA (3)** sifat fizik gas asli.*

[3 marks]
[3 *markah*]

CLO1 b) Acid gas treatment is a process used to remove harmful acidic gases such as hydrogen sulphide from natural gas or industrial emissions to make it safer for the environment. There are three main methods to reduce or remove hydrogen sulphide from natural gas which are chemical absorption, physical absorption and physical adsorption. Explain the following processes of acid gas treatment:
Rawatan gas asid ialah proses yang digunakan untuk membuang gas berasid berbahaya seperti hidrogen sulfida daripada gas asli atau pelepasan industri untuk menjadikannya lebih selamat untuk alam sekitar. Terdapat tiga kaedah utama untuk mengurangkan atau mengeluarkan hidrogen sulfida daripada gas asli iaitu penyerapan kimia, penyerapan fizikal dan penjerapan fizikal. Terangkan proses rawatan gas asid berikut:

i. physical absorption process.
proses penyerapan fizikal.

[5 marks]
[5 *markah*]

ii. physical adsorption process.
proses penjerapan fizikal.

[5 marks]
[5 *markah*]

CLO1

c) Madam Ruhil is working as a chemical engineer in one of the leading petroleum and petrochemical companies in Kerteh, Terengganu. By using the American Petroleum Institute (API) standards, she has been given a task to calculate and compare various petrochemicals products on Specific Gravity (SG) based on the data from Table 1(c) below.

Puan Ruhil bekerja sebagai jurutera kimia di salah sebuah syarikat petroleum dan petrokimia terkemuka di Kerteh, Terengganu. Dengan menggunakan piawaian Institut Petroleum Amerika (API), beliau telah diberi tugas untuk mengira dan membandingkan pelbagai produk petrokimia pada Graviti Tertentu (SG) berdasarkan data daripada Jadual 1(c) di bawah.

Table 1(c): Petrochemicals and their Specific Gravity (SG) respectively.
Jadual 1(c): Petrokimia dan Graviti Tertentu (SG) masing-masing.

Petrochemicals / *Petrokimia*	SG, 15.6°C
n-butene / *n-butena*	0.595
n-Octane / *n-Oktana*	0.707
Kerosene / *Minyak tanah*	0.80
Diesel fuel / B*ahan api diesel*	0.875
Neohexane / *Neoheksana*	Unknown / *Tidak diketahui*

i. calculate the API Gravity for n-butene and kerosene.
kirakan Graviti API untuk n-butena dan minyak tanah.

[4 marks]
[4 *markah*]

ii. write the types of n-butene and kerosene based on API Gravity.
tuliskan jenis n-butena dan minyak tanah berdasarkan Graviti API.

[4 marks]
[4 *markah*]

iii. calculate the unknown value of Specific Gravity (SG) for neohexane if the value API Gravity is 86.52° API.
kirakan nilai Graviti Tertentu (SG) yang tidak diketahui untuk neoheksana jika nilai Graviti API ialah 86.52° API.

[4 marks]
[4 *markah*]

QUESTION 2

SOALAN 2

CLO1 a) Paraffinic hydrocarbon is a class of hydrocarbons composed primarily of straight or branched chains of carbon atoms with a single bond. List **THREE (3)** physical characteristics of paraffinic hydrocarbons.

*Hidrokarbon paraffin adalah kelas hidrokarbon yang terdiri terutamanya daripada rantai atom karbon lurus atau bercabang dengan ikatan tunggal. Senaraikan **TIGA (3)** ciri-ciri fizikal hidrokarbon paraffin.*

[3 marks]

[3 *markah*]

CLO1 b) Bromination test can be conducted in the chemical laboratory by adding the bromine water to differentiate between butane and butene. When bromine water is added to butene, the unsaturated double bond reacts with bromine, causing the bromine to decolourise. In contrast, butane being a saturated hydrocarbon does not react with bromine water, and the orange colour of bromine persists. Other than bromination test, both butane and butene liquid can undergo complete and incomplete combustion reactions. Express:

Ujian brominasi boleh dijalankan di makmal kimia dengan menambahkan air bromin untuk membezakan antara butana dan butena. Apabila air bromin ditambah kepada butena, ikatan berganda tak tepu bertindak balas dengan bromin, menyebabkan bromin menjadi hilang warna. Sebaliknya, butana sebagai hidrokarbon tepu tidak bertindak balas dengan air bromin, dan warna oren bromin kekal. Selain daripada ujian brominasi, cecair butana dan butena boleh mengalami tindak balas pembakaran yang lengkap dan tidak lengkap. Ekspresikan:

i. the bromination reaction of butane and butene liquid.
tindak balas brominasi cecair butana dan butena.

[5 marks]
[5 *markah*]

ii. the sootiness of butane and butene liquid based on the percentage by mass of carbon.
jelaga butana dan butena berdasarkan kepada peratusan jisim karbon.

[5 marks]
[5 *markah*]

CLO1

c) Paraffinic hydrocarbon is stable and used primarily in fuels and lubricants, while olefinic hydrocarbon is more reactive and is the key building blocks in the chemical and polymer industries. Draw the molecular structure for each of the following paraffinic and olefinic hydrocarbons:
Hidrokarbon paraffinik adalah stabil dan digunakan terutamanya dalam bahan api dan pelincir, manakala hidrokarbon olefinik lebih reaktif dan merupakan bahan binaan utama dalam industri kimia dan polimer. Lukiskan struktur molekul berikut bagi setiap paraffinik dan olefinik hidrokarbon:

i. 2,3,5-trimethyl-4-propylheptane. .
2,3,5-trimetil-4-propilheptana.

[4 marks]
[4 *markah*]

ii. 1-chloro-2,4-dimethylcyclopentane.
1-kloro-2,4-dimetillcyclopentana.

[4 marks]
[4 *markah*]

iii. 4,7-dimethyl-octa-2,5-diene.
4,7-dimetil-octa-2,5-diena.

[4 marks]
[4 *markah*]

QUESTION 3

SOALAN 3

CLO1 a) In 1865, the structure of benzene was introduced by August Kekulé who suggested the hexagonal ring structure. Identify **THREE (3)** physical characteristics of benzene.

*Pada tahun 1865, struktur benzena telah diperkenalkan oleh August Kekulé yang mencadangkan struktur cincin heksagon. Kenal pasti **TIGA (3)** ciri fizikal benzena.*

[3 marks]

[3 *markah*]

CLO1 b) Benzene is produced primarily from petrochemical processes including the cracking of petroleum and coal distillation. It also can undergo several reactions with reagents such as chlorine gas, nitric acid and oxygen gas. Express:

Benzena dihasilkan terutamanya daripada proses petrokimia termasuk pemecahan petroleum dan penyulingan arang batu. Ia juga boleh mengalami beberapa tindak balas dengan reagen seperti gas klorin, asid nitrik dan gas oksigen. Ekspresikan:

i. the balanced chemical equation and operating temperature of oxidation of benzene.

persamaan kimia seimbang dan suhu operasi pengoksidaan benzena.

[5 marks]

[5 *markah*]

ii. **TWO (2)** applications and the catalyst of oxidation of benzene.

***DUA (2)** aplikasi dan pemangkin pengoksidaan benzena.*

[5 marks]

[5 *markah*]

CLO1

c) Aromatic compounds are those that contain an aromatic ring which is a type of ring structure that is planar, cyclic, and highly stabilized due to the delocalization of electrons in the ring. Draw the molecular structure for each of the following benzene and its derivatives:

Sebatian aromatik adalah yang mengandungi cincin aromatik iaitu sejenis struktur cincin yang planar, kitaran, dan sangat stabil akibat penyahlokalisasian elektron dalam cincin. Lukiskan struktur molekul berikut bagi setiap benzena dan terbitannya:

i. 2,3,4-trichlorophenol.
2,3,4-triklorofenol.

[4 marks]
[4 *markah*]

ii. 3,5-dinitrobenzoic acid.
3,5-asid dinitrobenzoik.

[4 marks]
[4 *markah*]

iii. 1,3,5-trimethylbenzene.
1,3,5-trimetilbenzena.

[4 marks]
[4 *markah*]

QUESTION 4

SOALAN 4

CLO1 a) Non-hydrocarbon intermediate compounds are involved in various types of chemical processes such as organic synthesis, combustion, and catalytic reactions. Name **THREE (3)** non-hydrocarbon intermediate compounds except for sulphur.
*Sebatian perantaraan bukan hidrokarbon terlibat dalam pelbagai jenis proses kimia seperti sintesis organik, pembakaran, dan tindak balas pemangkin. Namakan **TIGA (3)** sebatian perantaraan bukan hidrokarbon kecuali sulfur.*

[3 marks]
[3 *markah*]

CLO1 b) Direct reaction of methane can be applied with reagents such as carbon disulfide, chloromethane, hydrogen cyanide, and synthesis gas mixture. Explain the following processes in terms of catalyst, chemical reaction, operating temperature and percentage yield:
Tindak balas langsung metana boleh dilakukan dengan reagen seperti karbon disulfida, klorometana, hidrogen sianida, dan campuran gas sintesis. Terangkan proses berikut daripada segi pemangkin, tindak balas kimia, suhu operasi dan hasil peratusan:

i. Degussa Process.
Proses Degussa.

[5 marks]
[5 *markah*]

ii. Methane sulphurisation.
Sulphurisasi metana.

[5 marks]
[5 *markah*]

CLO1

c) The Malaysia polypropylene market keep growing from the year 2022 to 2030 by increasing the revenue by 47.79% according to Horizon annual report. Due to this positive demand, MTBE (M) Sdn Bhd is seeking a potential candidate to be employed as the new process engineer for the polypropylene plant in Gebeng, Pahang. Miss Sunatrah is interested in that post as a process engineer and discovered propylene is used mainly in the preparation of alkylates for gasoline and in the production of polypropylene, acrylonitrile, propylene oxide and several other industrial chemicals. In preparation for being interviewed as a process engineer, write:

Pasaran polipropilena Malaysia terus berkembang dari tahun 2022 hingga 2030 dengan meningkatkan hasil sebanyak 47.79% menurut laporan tahunan Horizon. Disebabkan permintaan positif ini, MTBE (M) Sdn Bhd sedang mencari calon berpotensi untuk diambil bekerja sebagai jurutera proses baharu bagi kilang polipropilena di Gebeng, Pahang. Cik Sunatrah berminat dengan jawatan itu sebagai jurutera proses dan mendapati propilena digunakan terutamanya dalam penyediaan alkilat untuk petrol dan dalam pengeluaran polipropilena, akrilonitril, propilena oksida dan beberapa bahan kimia industri lain. Sebagai persediaan untuk ditemuduga sebagai jurutera proses, tuliskan:

i. the balanced chemical equation of chlorination and hydration of propylene.
persamaan kimia seimbang pengklorinan dan penghidratan propilena.

[4 marks]
[4 *markah*]

ii. **TWO (2)** catalyst for the hydration of propylene.
DUA (2) *pemangkin untuk penghidratan propilena.*

[4 marks]
[4 *markah*]

iii. **ONE (1)** application of isopropanol and ally chloride from the reaction of propylene.
SATU (1) *aplikasi isopropanol dan alil klorida daripada tindak balas propilena.*

[4 marks]
[4 *markah*]

SOALAN TAMAT