Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2023/2024

COURSE NAME	:	FOUNDATION OF CHEMICAL ENGINEERING TECHNOLOGY
COURSE CODE	:	DAK 13303
PROGRAMME CODE	:	DAK
EXAMINATION DATE	:	JANUARY/FEBRUARY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ Closed book 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **SEVEN** (7) PAGES

Q1 Chemical Engineering technology including biotechnology and bioprocess engineering has a broad demand from manufacturing process materials and products to promote new products that lead to the sustainability of life including the health of humans and the environment.

(a) A new student, Nabil Halabiya, is interested in furthering his studies at Universiti Tun Hussein Onn Malaysia (UTHM) in Chemical Engineering Technology. Based on Nabil Halabiya condition,

(i) Identify two (2) disciplines of course associated with chemical engineering technology.

(2 marks)

(ii) Describe the role of chemical engineer technologists that has a vital impact in enhancing the sustainability of life in each area with an example.

(4 marks)

(iii) Propose two (2) potential challenges for the current generation of chemical engineering technology and justify your answers.

(4 marks)

(b) Natural resources have been used as an alternative way of recovering and developing bioproducts such as renewable energy and materials.

(i) Define the mean of natural resources and bioproducts.

(2 marks)

(ii) Explain three (3) categories of bioproducts in detail with examples.

(6 marks)

(iii) Based on your example in **Q1(b)(ii),** illustrate a simplified renewable bioenergy process flow diagram with appropriate indications.

(4 marks)

(iv) Express three (3) opinions on the demands in the development and production of bioproducts in Malaysia.

(3 marks)

Q2 Ashyiq owns an indoor balloon kiosk at a local theme park in Perak. He uses helium gas to fill his balloons from a 7000L helium gas tank at 100kPa and 0.005 m^3 per minute.

(a) Based on the given situation,

(i) Calculate the moles of helium gas that were used after one hour at room temperature (25°C).

(9 marks)

(ii) According to **Q2(a)(i)**, calculate the mass of helium used after 1 hour.

(4 marks)

(iii) According to **Q2(a)(ii)**, calculate the mass flow rate of the helium gas used after 3 hours.

(2 marks)

(iv) According to **Q2(a)(iii)**, convert the units to pounds per minute.

(3 marks)

(b) To save on helium costs, Ashyiq decides to inflate his balloons using a mixture of nitrogen and helium gas. The information on the mixture of both gasses is tabulated in **Table Q2 (b)**. Calculate the total pressure of the gas mixture.

(7 marks)

Q3 Toluene and hydrogen are used as feedstocks to produce benzene. The toluene and hydrogen are sent to a reactor, and the effluent is sent to a gas separator where the non-condensable gases are discharged from the system. The bottom of the separator provides a liquid feed to a still where the lighter benzene gas is collected as the distillate and the bottom toluene draw is recycled back into the reactor. The process flow diagram is shown in **Figure Q3**.

(a) Identify nine (9) elements that should be included in a process flow diagram (PFD).

(9 marks)

(b) Draw the block flow diagram of the benzene-making process (BFD).

(9 marks)

(c) Identify seven (7) functions of a piping and instrumentation diagram (P & ID).

(7 marks)

Q4 Chemical process safety is important to ensure the prevention of accidents in chemical process plants. Hazard and operability study (HAZOP) is one of the hazard analysis methods in hazard identification and evaluation procedures to avoid/ reduce any potential incidents and loss events in process plants.

(a) BASFin Resin and Coating Sdn Bhd have chemical plants that mainly produce polyamides, impregnated resin, and inorganic chemicals (potassium sulfite and sodium hypochlorite) exposed to the high possibility of hazards and need application of HAZOP study.

(i) State two (2) aims of the HAZOP study.

(2 marks)

(ii) Draw four (4) basic components of the flow diagram of a risk analysis process based on the HAZOP study.

(4 marks)

(iii) Differentiate three (3) classifications of hazardous substances.

(3 marks)

(iv) Sketch a diagram and justify the relationship of fire and flame characteristics based on the concept of fire tetrahedron (**Figure Q4**) for combustion reactions.

(4 marks)

(v) Elaborate on the estimation of risk controls and impacts of hazardous substances on the human.

(6 marks)

(b) Nabiha is responsible for abiding by the standard of work with the code of professional ethics as a chemical engineer/technologist in BASFin Resin and Coating Sdn Bhd. Express your opinion based on the rules of practice of ethics in these circumstances,

(i) In a certain period, one of the workers had released chemical waste directly to the nearest drainage without approval.

(3 marks)

(ii) Nabiha had conducted incorrect calculations in her project plan and shared the pieces of information about the project with her friend who was a competitor.

(3 marks)

- END OF QUESTIONS -

APPENDIX A

Table Q2 (b) Properties of Helium and Nitrogen Gas

Properties	Helium	Nitrogen
Mole	3 mole	2 mole
Volume	0.005 m^3	0.005 m^3
Temperature	25 °C	
Molecular weight	$2\frac{g}{mol}$	$28\frac{g}{mol}$

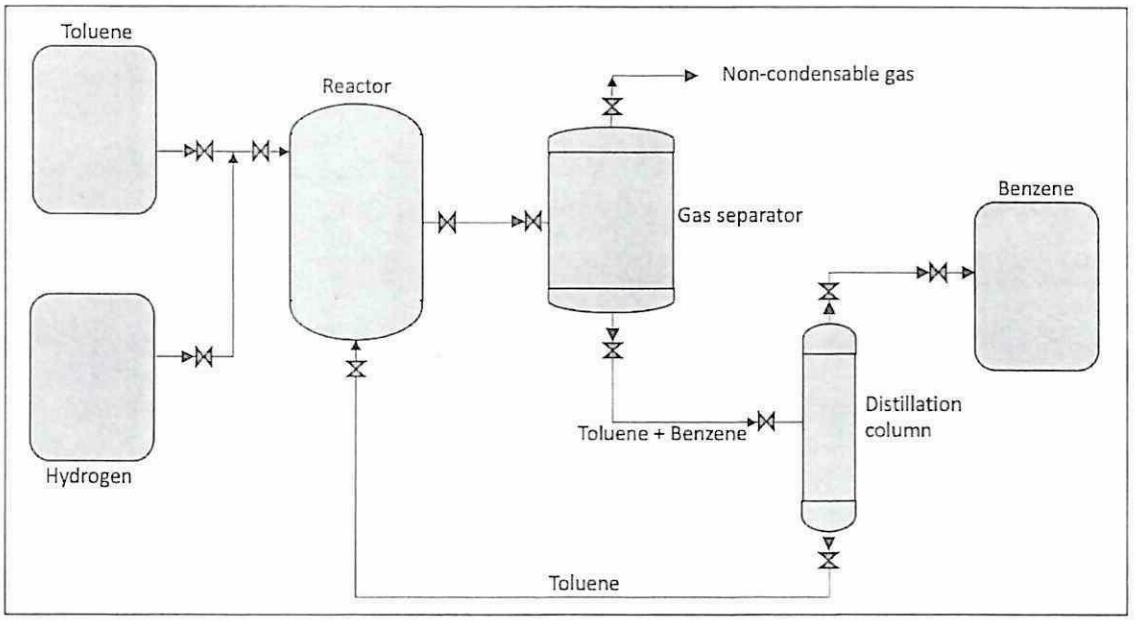

Figure Q3 Process Flow Diagram of Benzene Production

APPENDIX B

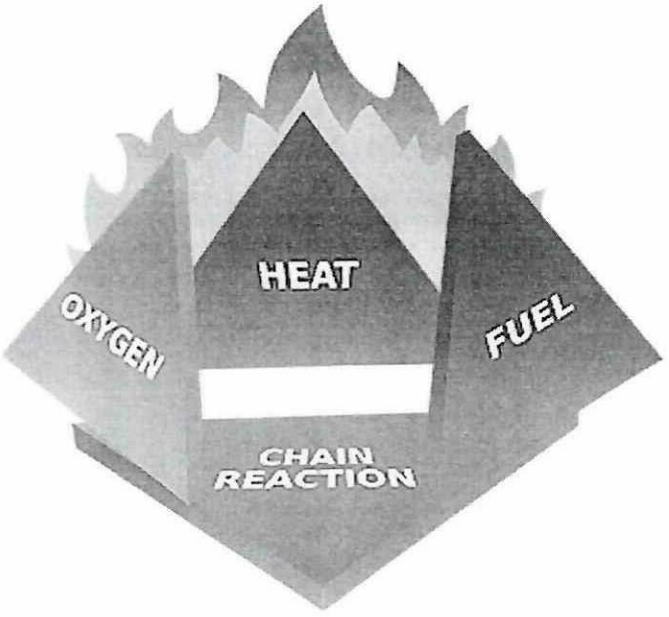

Figure Q4 Fire Tetrahedron of Hazardous Substances: Flammability

FORMULA

$SG = \frac{\rho substance}{\rho reference}$	$\rho = \frac{m}{v}$
$\dot{m} = \rho.Q$	$Q = v.A$
$P_1V_1 = P_2V_2$	$\frac{V_1}{P_1} = \frac{V_2}{P_2}$
$P_{total} = \sum P_{partial}$	$PV = nRT$
$\frac{V_1}{n_1} = \frac{V_2}{n_2}$	$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
$R = \frac{0.0821\ L \cdot atm}{mol \cdot K}$	

APPENDIX C

CONVERSION OF UNITS

Mass	1 kg	= 1000 g = 0.001 metric ton = 2.20462 lb_m = 35.27392 oz
	1 lb_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 ($\overset{0}{A}$)
		= 39.37 in = 3.2808 ft = 1.0936 yd = 0.0006214 mile
	1 ft	= 12 in = 1/3 yd = 0.3048 m = 30.48 cm
Volume	1 m^3	= 1000 liters = 10^3 m^3 = 10^6 cm^3 = 10^6 ml
		= 35.3145 ft^3 = 220.83 imperial gallons = 264.17 gal
		= 1056.68 qt
	1ft^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 lb_f
	1 lb_f	= 32.174 lb_m.ft/s^2 = 4.4482 N = 4.4482 x 10^5 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
		= 14.696 lb_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	= 1 J/s = 0.23901 cal/s = 0.7376 ft.lb_f/s = 9.486 x 10^{-4} Btu/s
		= 1.341 x 10^{-3} hp