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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2015/2016**

COURSE NAME : CHEMICAL PROCESS AND
SUSTAINABILITY
COURSE CODE : DAK 32103
PROGRAMME : 2 DAK
EXAMINATION DATE : JUNE / JULY 2016
DURATION : 3 HOURS
INSTRUCTION : SECTION A : ANSWER ALL
QUESTIONS
SECTION B : ANSWER TWO (2)
QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

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SECTION A

Q1 Sustainability is emerging as a market driver with the potential to grow profits and present opportunities for value creation. Choose one of the green sustainable chemistry product and answer the following question:

(a) Briefly explain the process description for the production of the selected green product.

(7 marks)

(b) Demonstrate the green chemistry principle apply to the approached process.

(10 marks)

(c) Analyze the applications of the bio-based chemicals.

(8 marks)

Q2 (a) A number of metrics have been proposed over the past 5 to 10 years to make chemists aware of the need to change the methods used for chemical syntheses and chemical processes. Define the metric:

- (i) The atom economy (AE).
- (ii) E-Factor.
- (iii) Reaction mass efficiency (RME).
- (iv) Mass Intensity (MI).
- (v) Mass productivity (MP).

(5 marks)

(b) Benzyl alcohol (10.81 g, 0.10 mol, MW 108.1) is reacted with p toluenesulfonyl chloride (21.9 g, 0.115 mol, MW 190.65) in solution [toluene (500 g) and trimethylamine (15 g)] to induce the reaction to give sulfonate ester (MW262.29) isolated in 90% yield (0.09 mol, 23.6 g). Calculate:

(i) The atom economy (AE).

(4 marks)

(ii) The reaction mass efficiency (RME).

(4 marks)

(iii) The mass intensity (MI).

(4 marks)

(iv) The mass productivity (MP).

(4 marks)

(v) The E-factor.

(4 marks)

SECTION B

Q3 In real chemical industry, the hypothetical reaction which is no by-product, no waste and no need for separation are not happen. Development of process and technologies that resulting more efficient chemical reactions are required to generate little waste and lower environment emissions compare to traditional chemical reaction.

- (a) Define the following term:
(i) Green Chemistry.
(ii) Sustainability. (4 marks)
- (b) Based on the traditional chemical reaction, explained **FOUR (4)** factors that causes the implementation of green chemistry principle. (8 marks)
- (c) Support the answer in **Q1 (b)** with **TWO (2)** relevant tragedy which involve chemical accident. (6 marks)
- (d) Explained design approaches for safety chemical process towards sustainable product. (7 marks)

Q4 Catalytic reagents are known superior to stoichiometric reagents.

- (a) List the **SIX (6)** possible approaches for multiphase operation of catalysis to improve their usability and recycle. (6 marks)
- (b) Explain the role of multiphase operations in general aspects. (4 marks)
- (c) Demonstrate the **FOUR (4)** types of catalyst available in industry. (8 marks)
- (d) Outline the general characteristic of catalyst to enable sustainable chemical process. (7 marks)

Q5 (a) The ecological footprint (EF) is one of the most widely used indicators of sustainability.

(i) Define ecological footprint.

(1 marks)

(ii) Write the significance value of ecological footprint as sustainability indicators.

(8 marks)

(iii) Propose **TWO (2)** example of ecological footprint with the measurements unit.

(6 marks)

(b) Various metrics and methods in engineering design are used to evaluate and measure the different aspects of the environmental impact of industrial activities and services. Demonstrate the sustainability metrics characteristic in **FIVE (5)** broad categories.

(10 marks)

Q6 (a) A raw material or feedstock should be renewable rather than depleting whenever technically and economically practicable.

(i) Define renewable resources.

(1 marks)

(ii) Propose **FOUR (4)** example of renewable resources.

(4 marks)

(iii) Explain each renewable resources to support the answer in **Q6 (a) (ii)**.

(8 marks)

(b) The rationale for using biomass as a chemical feedstock is illustrate by several important advantages. Demonstrate **FOUR (4)** advantages of biomass feedstocks.

(8 marks)

(c) Briefly discuss **TWO (2)** available basic platforms of biofuels production from renewable biomass.

(4 marks)

-END OF QUESTIONS-