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**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER II  
SESSION 2013/2014**

**COURSE NAME** : CHEMICAL PROCESS AND  
SUSTAINABILITY  
**COURSE CODE** : BNQ 20603  
**PROGRAMME** : 2 BNN  
**TEST DATE** : JUNE 2014  
**DURATION** : 3 HOURS  
**INSTRUCTION** : ANSWER FOUR (4)  
QUESTIONS ONLY

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

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- Q1** Catalytic reagents are known superior to stoichiometric reagents.
- (a) Explain the **THREE (3)** general characteristics of catalyst. (9 marks)
- (b) Catalyst makes the chemical process more efficient in terms of energy consumption. Sketch a diagram to assist your answer. (8 marks)
- (c) State **TWO (2)** types of biocatalyst and for each biocatalyst list : (8 marks)
- (i) **ONE (1)** advantage
  - (ii) **TWO (2)** disadvantages
- Q2** Chemical industries contribute to disposal of industrial such as DDT and pollute the environment. The chemicals do not readily degrade and persist in environment (air,water,soil).
- (a) Analyze and discuss which of the Green Chemistry Principles apply to the above statement and give further definition of the principle. (10 marks)
- (b) One of the method of onsite waste treatment is biotreatment plants. Explain the purpose of biotreatment plant and the concept of biodegradation. (8 marks)
- (c) Chemicals waste which are highly toxic, need appropriate control and maintain. Explain the Ames method for measuring the potential harmful effects of chemicals. (7 marks)

**Q3** You are a technologist working in the development of a new industrial process of Polylactic acid (PLA) plastic. The lead chemist in the project mentions that solvent that will be used for the process is acetone.

(a) Give **FOUR (4)** characteristics of acetone. (8 marks)

(b) Explain **FOUR (4)** characteristics of suitable alternative solvent to replace the acetone? (8 marks)

(c) Plan the projects to be more environmentally friendly by:  
(i) Suggesting the alternative solvents that will replace acetone.  
(ii) Predict **TWO (2)** advantages of the alternative solvents. (9 marks)

**Q4** Lactic acid, ethanol and acetic acid are bio-based chemicals produced from renewable resources. Choose only two of these bio-chemicals and answer the following question:

(a) Analyze and discuss which of the Green Chemistry Principles apply to the above statement. (10 marks)

(b) State **ONE (1)** type of bioprocess methods to produce each of the chosen bio-chemicals. (5 marks)

(c) Outline **TWO (2)** examples of :  
(i) Derivatives produced from the process (5 marks)  
(ii) Applications of the bio-based chemicals (5 marks)

**Q5** Benzyl alcohol (10.81 g, 0.10 mol, FW 108.1) is reacted with p toluenesulfonyl chloride (21.9 g, 0.115 mol, FW 190.65) in solution [toluene (500 g) and triethylamine (15 g)] to induce the reaction to give the sulfonate ester (FW 262.29) isolated in 90% yield (0.09 mol, 23.6 g). Calculate for the above reaction:

(a) The atom economy (AE) ,

(5 marks)

(b) The reaction mass efficiency (RME),

(5 marks)

(c) The mass intensity (MI),

(5 marks)

(d) The mass productivity (MP).

(5 marks)

(e) The *E*-factor.

(5 marks)

- END OF QUESTION -