UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	CHEMICAL PROCESS AND SUSTAINABILITY
COURSE CODE	:	BNQ 20603
PROGRAMME	:	2 BNN
EXAMINATION DATE	:	JUNE 2015 / JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

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

Q1   In real chemical industry, the hypothetical reaction which is no by products, no waste, no need for separation are not happen. Development of processes and technologies that result in more efficient chemical reactions are required to generate little waste and fewer environmental emissions than traditional chemical reactions.

    (a) Define the following term :
        (i) Green chemistry
        (ii) Sustainability

                                                          (4 marks)

    (b) Based on the traditional chemical reactions, propose **SEVEN (7)** factors that causes the implementation of green chemistry principles. Support your answer with a simple reactions pathway.

                                                           (9 marks)

    (c) Combine **SIX (6)** green chemistry that relate and apply in **Q1(b)**.

                                                           (6 marks)

    (d) Propose a main concept to provide a balance system in a sustainable development towards more sustainable products and production process.

                                                           (6 marks)

Q2   Green Principles is a chemistry to produce chemical products that do not harm either our health or the environment.

    (a) Describe **FOUR (4)** level in increasing greenness and sketch a diagram to support your answer.

                                                           (4 marks)

    (b) Compare the traditional route and green route processes in water cleaning process.

                                                            (4 marks)

    (c) Chemicals waste which are highly toxic, need appropriate control and maintain. Explain the LD_{50} and LC_{50} method.

                                                           (6 marks)

    (d) Propose **THREE (3)** industries which potentially use supercritical carbon dioxide as a green solvent.

                                                           (9 marks)

    (e) Analyze the green chemistry principles that relates to the **Q2(d)**.

                                                              (2 marks)

Q3   One of green chemistry approach – avoiding the use of organic solvents for the reaction media (*Principle 5*).

    (a) Discuss the importance of supercritical CO_2 as one of alternative solvent.

CONFIDENTIAL

(5 marks)

(b) Compare **FIVE (5)** characteristic of solvent-free system over organic solvent.

(10 marks)

(b) You are a technologist working in the development of a new industrial process. The lead chemist need your idea towards greener process. Propose the green solvent with an explanation for the following industry:
(i) Solvent to replace toluene in the paints and coatings industry.
(ii) Solvent to replace acetone in polyurethane industry.

(10 marks)

(c) Discuss the importance of supercritical CO_2 as one of alternative solvent.

(5 marks)

Q4 You as the technologist who are experts in nanomaterials need to convince your company about nanomaterials as one of the emerging materials which consider and concern on human, environmental and process safety.

(a) Explain **FOUR (4)** methods of producing nanoparticles.

(8 marks)

(b) List **THREE (3)** advantages and disadvantages of nanomaterials.

(6 marks)

(c) Give example **SIX (6)** area of nanomaterials application.

(6 marks)

(d) Identify **FIVE (5)** precautions taken in laboratory or manufacturer.

(5 marks)

Q5 Chemistry students in UTHM found rearrangement reactions is better than substitution reaction and the used of protection and deprotection should be avoidable.

(a) Select **TWO (2)** Green Chemistry Principles apply to the above statement .

(2 marks)

(b) Define the Green Chemistry Principles apply to the above statement .

(4 marks)

(c) List the following industry according to the order from low mass intensity industry to high mass intensity industry.

i) Bulk Chemicals
ii) Pharmaceuticals
iii) Oil Refining
iv) Fine Chemicals

(4 marks)

CONFIDENTIAL

(d) 21.9 g of p toluenesulfonyl chloride (0.115 mol) is reacted with 10.81g benzyl alcohol (0.10 mol) in solution (toluene (500 g) and triethylamine (15 g) to induce the reaction to give the sulfonate ester isolated in 90% yield (0.09 mol, 23.6 g). Given that the MW of p toluenesulfonyl chloride, benzyl alcohol and sulfonate ester are 190.65, 108.1 and 262.29 respectively. Calculate for the above reaction:

(i) The atom economy (AE) ,

(3 marks)

(ii) The reaction mass efficiency (RME),

(3 marks)

(iii) The mass intensity (MI),

(3 marks)

(iv) The mass productivity (MP).

(3 marks)

(v) The *E*-factor.

(3 marks)

- **END OF QUESTIONS -**