

UNIVERSITY OF RUHUNA

FACULTY OF FISHERIES AND MARINE SCIENCES & TECHNOLOGY



Academic Year 2022/2023

Bachelor of Science Honours in Marine and Freshwater Sciences Degree

Bachelor of Science Honours in Fisheries and Marine Sciences Degree

Level IV Semester I Examinations – April/May 2024

CHM 4121: Green Chemistry- Theory

Molecular weights: C= 12.0, H=1.0, S=32.0, O=16.0 g/mol

Part II (55 marks)

Answer one question only.

1) Answer all parts.

a)

I) Define the term “Green Chemistry”.

(05 marks)

II) “Safer solvents and auxiliaries” is the fifth principle of green chemistry. Briefly define the principle and state one industrial example for it.

(10 marks)

III) State 03 approaches to safer solvents in green chemistry.

(06 marks)

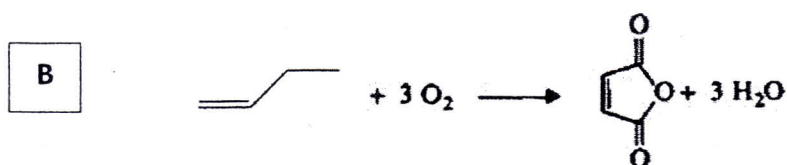
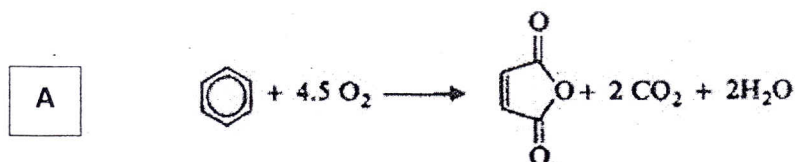
IV) What are the challenges faced in the search for green solvents?

(04 marks)

b) Maleic anhydride ($C_4H_2O_3$) is widely used in the manufacturing of paints and resins and it can be synthesized by the oxidation of benzene or but-1-ene as indicated below.

I) Calculate the atom economy of the two reactions, considering that no any other chemicals are used for the reaction.

(10 marks)



II) Percentage yield obtained from methods A and B are 75% and 65% respectively. As a green chemist, out of the above two methods (A) and (B), which one would you

recommend to an industry for the synthesis of maleic anhydride? Give reasons for your answer.

(15 marks)

- c) A \$2 million grant can be used to either prevent hazardous waste from entering the environment or to decrease worker exposure to hazardous chemicals.

Opinion A: It should be used to prevent environmental impact.

Opinion B: It should be used to increase occupational safety.

Which opinion do you agree with? Clearly state your opinion as A or B. Elaborate your answer using appropriate green chemistry principles with reasons.

(50 marks)

- 2) Answer all parts.

a)

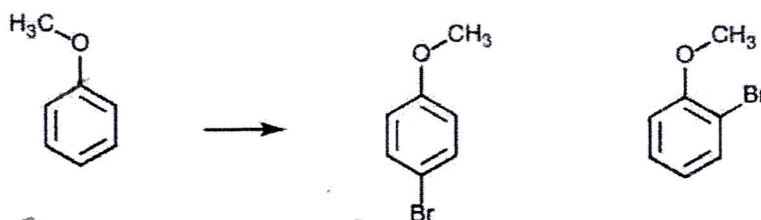
- I) State what is meant by the green chemistry principle "Reduce derivatives". Provide an industrial example for reducing derivatives.

(10 marks)

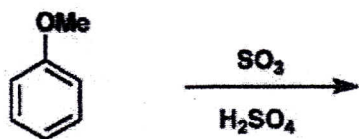
- II) State what is meant by blocking groups.

(05 marks)

- III) Consider the following reaction. According to the reaction, para product dominates (60%). Suggest a suitable mechanism if we need to have the ortho product only. (Hint: Use SO_3H as the blocking group.)



You can start the mechanism as follows. ($\text{Me}=\text{CH}_3$)

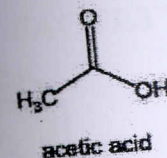


(15 marks)

- b) Esterification of 1-pentanol with acetic acid is as follows. This procedure involves the reaction of 37 g of 1-pentanol with 60 g of acetic acid to give pentyl acetate. A small amount of sulfuric acid is used as a catalyst to accelerate the reaction.

Then reaction mixture was poured into 250 g water. The organic layer was separated and washed with 100 g of water, 25 g of saturated NaHCO_3 solution, and 25 g of water

respectively. The pure ester. T



Calculate the

I) Atom eco

II) E-factor

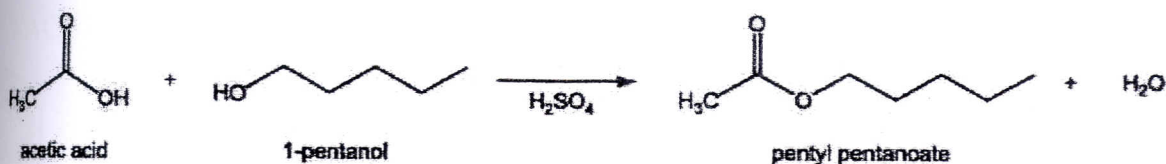
III) EMY

Note: Ignore benign reagent

c) Isocyanide contempor building m are innoc leaching. health ha of their p

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respectively. The crude ester was dried over anhydrous Na_2SO_4 (5 g) and distilled to collect the pure ester. The amount obtained as a product was 40 g.



Calculate the following matrices of the reaction.

I) Atom economy

(05 marks)

II) E-factor of

(10 marks)

III) EMY

(05 marks)

Note: Ignore the addition of sulfuric acid in your calculation and consider acetic acid as a benign reagent.

- c) Isocyanides play a pivotal role in the fabrication of numerous consumer goods integral to the contemporary standard of living enjoyed by many people, including paints, furniture, various building materials, and plastics. Advocates within the industry contend that these compounds are innocuous as they remain inert within final products, such as seat cushions, without leaching. However, divergent research suggests that isocyanides may engender substantial health hazards, underscoring the necessity for comprehensive examination and consideration of their potential risks.

Opinion A: Banning isocyanides is reasonable as their associated costs outweigh the accrued benefits.

Opinion B: The modern standard of living relies significantly on the utilization of isocyanides, where the advantages derived from their use outweigh the incurred costs.

As a green chemistry learning student elaborate your opinion(A or B) based on relevant facts and figures.

(50 marks)

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