



# TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCES

DEPARTMENT OF PURE & APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY IN ANALYTICAL CHEMISTRY

ACH 4410: GREEN CHEMISTRY

SPECIAL SUPPLEMENTARY EXAMINATION

**SERIES: AUGUST 2017**

**TIME: 2 HOURS**

**DATE: 12 Sep 2017**

## Instructions to Candidates

You should have the following for this examination

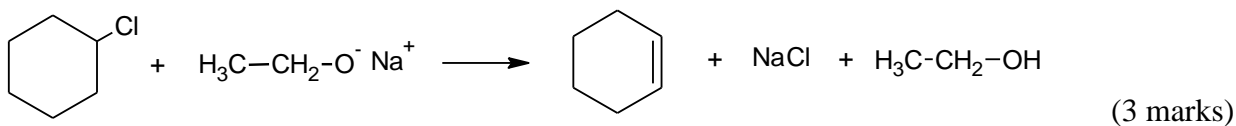
-Answer Booklet, examination pass and student ID

This paper consists of **FIVE** questions. Answer question ONE (Compulsory) and any other **TWO** questions.

**Do not write on the question paper.**

## Question ONE

- (a) Provide any **FOUR** merits of the use of water as a solvent in organic synthesis. (4 marks)
- (b) Highlight the effects of chlorinated hydrocarbon solvents, such as  $\text{CCl}_4$ , on the environment and human health. (4 marks)
- (c) (i) Define the principal of atom economy in organic synthesis. (1 mark)
- (ii) Determine the atom efficiency of the following reaction;



- d) Highlight the merits of the application of catalysis rather than stoichiometric reactions in organic synthesis. (4 marks)

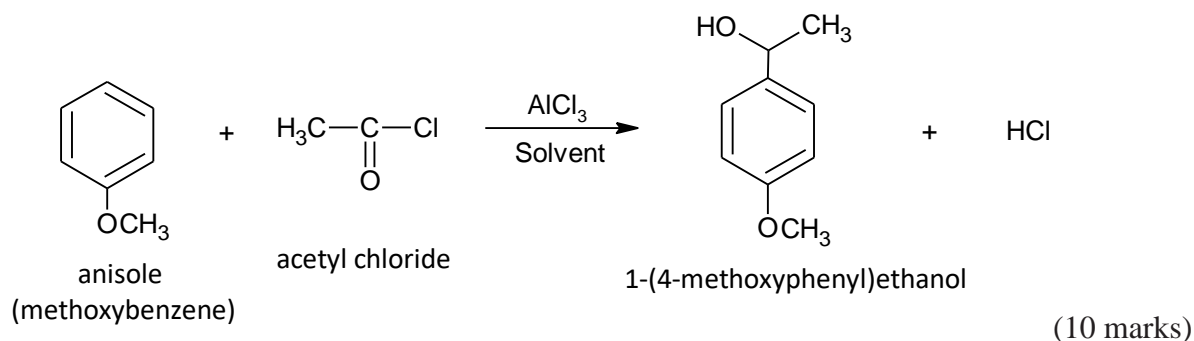
- (e) Provide any FOUR advantages of using polymer supported substrates and reagents in organic reactions. (4 marks)
- (f) Highlight any TWO advantages and TWO disadvantages of heterogeneous catalysts in organic synthesis. (4 marks)
- (g) State TWO basic principles of Green Chemistry that aim to reduce risk in the laboratory. (2 marks)
- (h) (i) Write a reaction equation showing the common method for industrial manufacture of methylene oxide. (2 marks)
- (ii) Give TWO uses of ethylene oxide. (2 marks)

### Question TWO

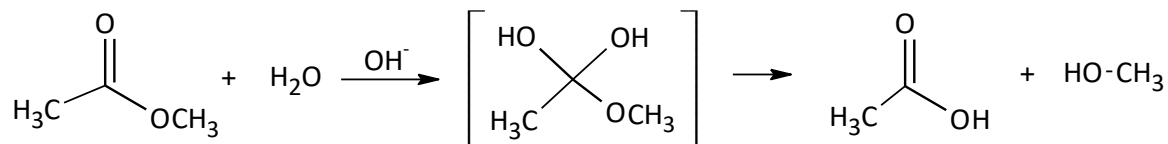
- (a) Briefly describe the characteristics that make the following solvents favourable for use in organic synthesis.
- (i) Polyethylene glycol (5 marks)
- (ii) Supercritical carbon dioxide. (5 marks)
- (b) Describe the nature and application of the following energy sources, indicating their suitability or unsuitability in green synthesis.
- (i) Electromagnetic radiation (4 marks)
- (ii) Fossil fuels. (6 marks)

### Question THREE

- (a) In the classical Friedel-Crafts acylation of anisole, using a homogenous catalyst, about 4.5 kg of waste effluent per kg of product is generated. Suggest different (green) reaction conditions that would reduce the quantity of waste produced and improve quality and quantity of yield.



- (b) Explain the stabilization of the intermediate state in the base catalyzed conversion of methyl acetate and water into ethanoic acid and methanol.



(10 marks)

#### Question FOUR

- (a) Outline the development of catalysis in the manufacture of ammonia by the Haber process. (12 marks)
- (b) Describe TWO uses of methanol in the manufacturing sector. (4 marks)
- (c) Give TWO advantages of the use of methanol as fuel for vehicles (4 marks)

#### Question FIVE

- (a) State two common methods of industrial preparation of maleic anhydride. (4 marks)
- (ii) Highlight uses of maleic anhydride in the chemical in industry (6 marks)
- (b) (i) Describe the base catalyzed transesterification of triglycerides with methanol using appropriate reaction equation(s) (8 marks)
- (ii) State ant TWO advantages of using biofuel as an alternative energy source. (2 marks)