



# 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

END OF SEMESTER EXAMINATION

**SERIES:** APRIL 2016

**TIME:** 2 HOURS

**DATE:** 12 May 2016

## PAPER I

### Instructions to Candidates

You should have the following for this examination

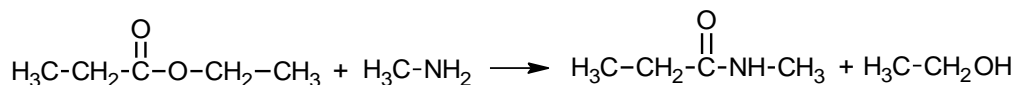
-Answer Booklet, examination pass and student ID

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

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

### Question ONE

- (a) Benzene and toluene are excellent solvents that have been widely used in chemical manufacturing. Explain potential impacts of these solvents on the environment, including human health. (8 marks)
- (b) (i) Define the principal of atom economy in organic synthesis. (1 mark)
- (ii) Determine the atom economy of the following substitution reaction to form N-methyl propamide;



(3 marks)

- (iii) State the atom efficiency of the reaction if the alcohol by-product can be quantitatively recovered and marketed. (1 mark)

- (c) Highlight the merits, indicating the issues addressed, of reducing intermediate derivatives in organic synthesis. (4 marks)
- (d) Give any FOUR advantages of applying biocatalysis in organic synthesis. (4 marks)
- (e) Highlight the advantages and disadvantages of heterogeneous catalysts in organic synthesis. (6 marks)
- (f) State THREE basic principles of Green Chemistry that aim to reduce risk in the laboratory. (3 marks)

### Question TWO

- (a) (i) Describe the characteristics of supercritical CO<sub>2</sub>. (8 marks)
- (ii) Provide TWO examples of applications of supercritical CO<sub>2</sub> in chemical processes. (4 marks)
- (b) (i) State the desired characteristics of energy sources in chemical synthesis. (4 marks)
- (ii) Highlight the merits of the application of microwaves in organic synthesis. (4 marks)

### Question THREE

- (a) State the issues addressed by the application of catalysis, rather than the use of stoichiometric reagents in organic synthesis. (4 marks)
- (b) Explain the effect of solvation with water in the S<sub>N</sub>2 substitution reaction between bromomethane and ammonia, if
- (i) reaction is in aqueous medium (8 marks)
- (ii) water is present in catalytic amounts. (6 marks)
- (c) Write a reaction equation for the catalytic industrial preparation of methanol. (2 marks)

### Question FOUR

- (a) The Haber process has remained the standard for the industrial preparation of ammonia.
- (i) Outline the merits of the process that meet green principles. (6 marks)
- (ii) Highlight weaknesses of the Fe-based catalyst and approaches to improving catalyst performance. (10 marks)

- (b) (i) Write a reaction equation showing the a common method for industrial manufacture of methylene oxide. (2 marks)
- (ii) Give TWO uses of ethylene oxide. (2 marks)

**Question FIVE**

- (a) Describe the transesterification of triglycerides with methanol using appropriate reaction equation(s) (6 marks)
- (ii) State the advantages of using biofuels as alternative energy sources. (4 marks)
- (b) Describe the general structure and functioning of a hydrogen fuel cell. (10 marks)