



MACHAKOS UNIVERSITY

UNIVERSITY EXAMINATIONS 2017/2018

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF EDUCATION (SCIENCE)

SCH 405: INDUSTRIAL CHEMISTRY

DATE: 14/12/2017

TIME: 2.00 – 4.00 PM

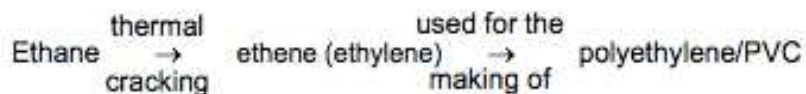
INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory**.
- Answer any **two** questions from section **B**.

SECTION A (30 MARKS) COMPULSARY

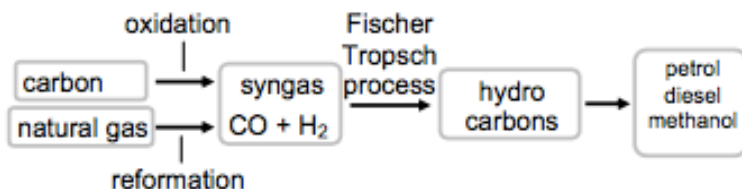
QUESTION ONE (30 MARKS)

- a) Distinguish between the following terms
- i) Batch processes and continuous processes. (2 marks)
 - ii) Specialty chemicals and fine chemicals. (2 marks)
- b) Two of the hydrocarbon fuels formed during fractional distillation of crude oil are ethane and propylene. These are used as raw materials in the polymer industry as represented in the scheme shown.



Two types of polyethylene are formed from the polymerization process, namely HDPE and LDPE.

- i) Write down the name given to ethene unit molecules that bond with one another to form long polymer chains. (1 mark)
 - ii) Write down an equation representing the cracking process of ethane and indicate the type of reaction. (3 marks)
 - iii) Indicate what the abbreviations HDPE and LDPE stand for, differences and two of their industrial uses. (6 marks)
- c) One of the most important uses of sodium hydroxide is in the making of soap. The following equation represents the soap making process:
- $$\text{Triglyceride} + \text{NaOH} \longrightarrow \text{Soap} + \text{Glycerol}$$
- i) Write down the common name of NaOH (1 mark)
 - ii) To which homologous series does triglyceride belong? (1 mark)
 - iii) Briefly account for the cleaning action of soap. (3 marks)
- d) Study the following diagram.



- i) List the raw materials in this process and name the main gas found in natural gas. (3 marks)
- ii) Briefly explain what happens during the oxidation of carbon and provide the equation to show how natural gas reforms to CO and H₂. (3 marks)
- e) Outline the procedure for material balance calculations without chemical reactions. (5 marks)

SECTION B: ATTEMPT ANY TWO QUESTIONS (20 MARKS EACH)

QUESTION TWO (20 MARKS)

- a) South Africa has well-developed chemical industries that consist of factories producing the following products: explosives, fertilizers, insecticides, petrochemical products, polymers, paper, glass, cotton products, soap and many other products. Due to the availability of coal in the country, the manufacture of petrol, oil and diesel has been made possible.
 - i) Explain why it is advantageous for South Africa to use coal. (4 marks)
 - ii) List four impacts that development of the chemical industry has had on man and the environment. (4 marks)
- b) A balance should be maintained between man's activities and the environment. Sustainable development must be pursued, including the development of new industries
 - (i) Define the term sustainable development. (1 mark)
 - (ii) Is the Kenyan Chemical Industry sustainable or not? Explain. (2 marks)
 - (iii) Briefly explain four factors to consider projecting a more favorable impression of the chemical industry of a country. (4 marks)
- c) Ammonia is used during the Ostwald process in the production of nitric acid.
 - (i) Write down the three steps (in the form of chemical equations) of the Ostwald process. (3 marks)
 - (ii) Briefly explain the use of the nitric acid, formed during this process. (2 marks)

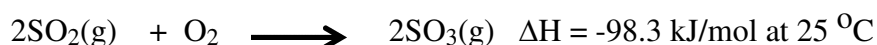
QUESTION THREE (20 MARKS)

- a) Distinguish between the following terms
 - i) Industrial Chemistry and Classical Chemistry. (2 marks)
 - ii) Unit Operations and Unit Processes. (2 marks)

- b) Three raw materials are mixed in a tank to make a final product in the ratio of 1:0.4:1.5 respectively. The first raw material contains A and B with 50% A. The second raw material contains C while the third raw material contains A and C with 75% A. Assuming a continuous process at steady state;
- Write the general mass balance equation. (1 mark)
 - Determine the flow and composition of the product. (6 marks)
- c) One of the reactions used to form sulfuric acid is the reaction of oxygen with sulfur dioxide under equilibrium conditions to form sulfur trioxide. Before the reaction, the concentration of sulfur dioxide was 0.06 mol L^{-1} and the concentration of oxygen was 0.05 mol L^{-1} . After equilibrium was reached, the concentration of sulfur trioxide was 0.04 mol L^{-1} .
- Calculate the equilibrium constant, K, for the reaction. Show relevant working. (2 marks)
 - Use a chemical equation to describe what happens when sulfuric acid is **added** to water in a laboratory. (1 mark)
 - Describe the use of sulfuric acid as an oxidizing agent, as a dehydrating agent and as a means of precipitating sulfates. Use chemical equations to illustrate your answer. (6 marks)

QUESTION FOUR (20 MARKS)

- List four major industrial or domestic uses of ammonia. (2 marks)
- Briefly discuss the environmental impact of ammonia. (3 marks)
- Describe briefly with the help of a diagram and equations, the Haber process for manufacture of ammonia. (7 marks)
- Briefly explain why it is necessary to remove sulphur compounds from the feedstock for the ammonia process. (2 marks)
- Consider the following reaction:



Explain the reason behind setting the conditions as follows:

- Temperature: $400 - 450^\circ\text{C}$. (2 marks)

b. Pressure: 2 atmospheres. (2 marks)

c. O_2 : SO_2 ratios: 1:1. (2 marks)

QUESTION FIVE (20 MARKS)

- a) Define the following terms
- i) Sintering. (1 mark)
 - ii) Smelting. (1 mark)
- b) Using equations, distinguish between calcination and roasting. (2 marks)
- c) Briefly describe the following processes;
- i) Removal of silica and alumina removed from iron ore. (5 marks)
 - ii) Extraction of alumina from bauxite. (5 marks)
- d) With respect to extractive metallurgy of copper, write equations for reactions that take place during matte smelting. (6 marks)