



MACHAKOS UNIVERSITY

University Examinations 2018/2019

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: 29/4/2019

TIME: 8.30-10.30 AM

INSTRUCTIONS TO CANDIDATES

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

SECTION A

QUESTION ONE (30 MARKS) (COMPULSORY)

- a) A chemical industrial process may be likened to the chemical reaction taking place at the laboratory level in a reaction vessel where reactants undergo a chemical process to be converted into products. Define the following terms with examples as applied at the level of an industrial chemical process;
- Unit process (2 marks)
 - Unit operation (1 mark)
 - Reactor (3 marks)
 - Splitter (2 marks)
 - Mixer (2 marks)
 - Separator (2 marks)
 - Material balance (2 marks)
- b) In material balance equation; Accumulation = In-Out + generation- consumption; Define the following terms as used in the equation;
- Nonreactive species (2 marks)
 - Generation (1 mark)
 - Accumulation (1 mark)
 - When is the reaction steady state? (2 marks)

- v. Input streams (2 marks)
- vi. Output streams (2 marks)
- c) The industrial chemical processes may be distinguished into batch, semi batch and continuous process. Clearly distinguish these three processes. (3 marks)
- d) Explain what yield of a chemical process is and state the factors which determine the Yield (3 marks)

QUESTION TWO (20 MARKS)

- a) Refining of the crude oil into many useful products is one of the chemical processes done at industrial level (Oil Refinery).
 - i. State clearly the three unit processes which together accomplish the refining of crude oil (petroleum) into different products. (3 marks)
 - ii. Describe what each of the process units in (i) above achieves. (3 marks)
 - iii. Describe fully the composition of crude oil. (3 marks)
 - iv. Describe how the quality of gasoline, which is one of the products from refining of crude oil is achieved for use in the internal combustion engine. (3 marks)
- b) i Explain the importance of crude oil to the national economy of a country (3 marks)
- ii Briefly explain the environmental problems encountered in the use of petroleum products for combustion in internal combustion engines (3 marks)
- iii What are the alternatives of petroleum products as a source of energy in cleaner production technology? (2 marks)

QUESTION THREE (20 MARKS)

- a) Manufacturing of phosphate fertilizers from the phosphate rock is another example of a chemical industrial process. The fertilizer plant is normally regarded as a fertilizers' complex plant.
 - i. Write the chemical formula of the phosphate rock. (1 mark)
 - ii. Why is phosphate fertilizers' plant considered to be a complex? (2 marks)
 - iii. Name with brief mention of what the various manufacturing plants in the phosphate fertilizers complex plant do. (3 marks)
- b) Three different types of phosphate fertilizers are produced from the phosphate fertilizers' complex.
 - i. Name the three types of fertilizers. (3 marks)
 - ii. Briefly describe how the three types of phosphate fertilizers are produced. (3 marks)

- iii. What is beneficiation which is one of the steps in the production of phosphate fertilizers? (2 marks)
- iv. Write a balanced chemical equation between phosphate rock and sulphuric acid to form phosphoric acid (2 marks)
- v. Write a balanced chemical equation between phosphoric acid and phosphate rock in the formation of the triple super phosphate fertilizer. (2 marks)
- c) Describe briefly the type of waste generated from phosphate fertilizer manufacturing and how it is controlled. (2 marks)

QUESTION FOUR (20 MARKS)

- a) The fossil fuels are non-renewable sources of energy and are known to contribute to climate change as opposed to renewable energy sources.
 - i. In what ways does the use of fossil fuels through heating and powering our homes and fuel our cars contribute to climate change? (4 marks)
 - ii. What are the likely manifestations of global warming which is a signal of climate change as predicted by scientists? (4 marks)
 - iii. Why are renewable energy sources also known as green energy sources? (1 mark)
- b) i Give three examples of renewable energy sources. (3 marks)
- ii Briefly describe geothermal energy as one of the green energy sources. (4 marks)
- c) Explain why full utilization of renewable energy resources is likely to make countries prosper more than reliance on fossil fuels. (4 marks)

QUESTION FIVE (20 MARKS)

- a) The industrial production of sulphuric acid is carried out in Contact process.
 - i. State and describe briefly the different sources of elemental sulphur which is the starting raw material in the contact process. (4 marks)
 - ii. Outline the main steps in the production of sulphuric acid in the Contact process starting with sulphur and ending with the final product. (4 marks)
- b) From the chemical equation in the formation of one of the intermediates of sulphuric acid manufacturing in Contact process;

$$\text{SO}_2 + \frac{1}{2}\text{O}_2 = \text{SO}_3; \Delta H = -99 \text{ kJ mol}^{-1}.$$
 - i. This is an equilibrium reaction. What is the name of the catalyst on which this reaction occurs? (2 marks)
 - ii. From the thermodynamic and stoichiometric considerations of the above reaction, state **four** ways by which the formation of SO_3 can be maximized. (6 marks)
- c) Cement is an important material in the construction industry. Outline steps in the manufacture of cement stating the raw materials required. (4 marks)