MACHAKOS UNIVERSITY

University Examinations 2021/2022

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND YEAR SUPPLEMENTARY/SPECIAL EXAMINATION FOR

BACHELOR OF SCIENCE IN ANALYTICAL CHEMISTRY

SAN 206: GREEN CHEMISTRY

DATE: 16/03/2022 **TIME: 8:30-10:30 AM**

INSTRUCTIONS

- 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 COMPULSORY (30 MARKS)

(a) The solution to the environmental problems caused by use of the non-renewable energy sources is replacing them with renewable energy sources. Describe how solar energy is a renewable energy source and how it can be harnessed to provide clean energy source. (10 marks)

(b) Hydrogen gas is now regarded as the renewable energy that can drive modern economies.

(i) Describe how H_2 can be generated from the electrolysis of water with the help of a diagram and appropriate chemical equations. (10 marks)

(ii) Describe with the help of a diagram how the H_2 Fuel cell can generate clean and non-polluting energy to be utilized in the various sectors of the modern economies. (10 marks)

QUESTION TWO (20 MARKS)

(a) Traditionally a chemical reaction or synthesis process is considered to go to completion by measuring its yield. However, Green Chemistry advocates for atom economy. Show clearly how the two approaches measure the completion of a reaction. (5 marks)

(b) Consider the following reaction, which goes to completion in which the desired product is $HCl_{(g)}$.

$2NaCl_{(s)} + H_2SO_{4\,(aq)} \longrightarrow 2HCl_{(g)} + Na_2SO_{4(s)}$. Yield calculation for the above reaction gives 100%.

(i) Explain why the percent atom economy approach gives a lower figure of less than 100%. (5 marks)

(ii) Work out by calculations the percent atom economy for the above reaction. (5 marks)

(iii) The value obtained in 2(a) ii is NOT 100%. Suggest an alternative synthesis process which can yield a percent atom economy of 100%. (5 marks)

Useful information: Atomic masses Na = 23, Cl= 35.5, H= 1, S= 32, O = 16.

QUESTION THREE (20 MARKS)

(a) Green Chemistry is relatively a new field branch of Chemistry which has come about due to environmental pollution which has led to climate change manifested in global warming among other global challenges.

(I) Explain briefly how the following branches of chemistry, Physical chemistry, Analytical chemistry,Inorganic chemistry, Organic chemistry, Synthetic chemistry and Environmental Chemistry have clearly brought out environmental pollution issues which Green Chemistry intends to resolve. (2 marks)

(b) Environmental chemistry is intimately interconnected with Green Chemistry. Clearly with the help of examples, show how Green Chemistry complements Environmental Chemistry. (6 marks)

(c) With the help of examples of some of the principles which Green Chemistry embraces, show clearly how green chemistry can address the current environmental problems which are currently being addressed through the command-and-control regulation system, which has not completely succeeded to curb global environmental pollution. (7 marks)

(d) Environmental chemistry only looks at the hydrosphere, atmosphere, biosphere and the lithosphere as segments of the environment. However, Green chemistry has added the 5th component, the anthrosphere. Explain why is this component necessary as part of the components of the environment. (5 marks)

QUESTION FOUR (20 MARKS)

(a) A chemical reaction occurs when chemical bonds are broken and formed, and atoms are exchanged to produce chemically different species. The statement above is qualified by the following reaction,

$O_2 + hv \longrightarrow 2O$

$O_2 + O \longrightarrow O_3$

The final product is ozone, which forms part of the stratosphere.

(i). What is the role of hv in this reaction? (3 marks)

(ii). In which compound are bonds broken and in which are they formed above? (3 marks)

(iii). What role does this compound (O_3) play in our lives? (4 marks)

(b) Through Environmental Chemistry, it has been shown the chemical O_3 is being depleted by substances used in refrigerators.

(i). What is the name of this chemical used in refrigerators which is depleting O_3 in the stratosphere? (4 marks)

(ii). As a result, this chemical is now replaced in the refrigerators we currently use in our homes. What does this show us is the relationship between Environmental chemistry and green chemistry? (6 marks)

QUESTION FIVE (20 MARKS)

Describe how Green Chemistry controls Environmental pollution by use of the following green alternatives to conventional methods.

(a). Ionic liquids (5 marks)

(b). Supercritical CO_2 and supercritical H_2O (5 marks)

(c). Solvent free reactions (5 marks)

(d). Microwave assisted solvent free organic synthesis (5 marks)