MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES
THIRD YEAR SECOND SEMESTER EXAMINATION FOR
BACHELOR OF SCIENCE (APPLIED PHYSICS AND TECHNOLOGY)
BACHELOR OF EDUCATION (SCIENCE)
SAN: 306 /SCH: 405 INDUSTRIAL UNIT OPERATIONS INDUSTRIAL CHEMISTRY

DATE: **TIME:**

INSTRUCTIONS:

ANSWER YOUR QUESTIONS IN ANSWER BOOKLET PROVIDED.
ANSWER QUESTION ONE [COMPULSORY] AND ANY OTHER TWO QUESTIONS.

QUESTION ONE (20 MARKS)

a) Define a chemical reaction? (1 mark)

b) Give a balanced chemical equation for each of the following reaction: (5 marks)

i. Synthesis
ii. Decomposition
iii. Substitution
iv. Precipitation
v. Redox

c) Formulate the reaction equation for (3 marks)

i. ammonia synthesis
ii. sulphuric acid manufacture
iii. nylon polymer production

d) Explain the effect of decreasing pressure in the above reactions listed in (Q1-C) (3 marks)

e) Using a relevant example define a consecutive reaction. (2 marks)

f) Explain if distillation is a unit process of a unit operation. (2 marks)

g) Draw and label the following reactors listing one application where applicable (4 marks)

i. Batch reactor

ii. Continuous reactor

h) List three examples of unit operations applied in each of the following phenomenon (9 marks)

i. Mass transfer

ii. Movement of fluids

iii. Movement of solids

QUESTION THREE (20 MARKS)

a) Write balanced chemical equations for the manufacture of the following

i. DAP (1 mark)

ii. Urea (1 mark)

iii. Gypsum process of ammonium sulphate manufacture (1 mark)

iv. Define a polymer and draw the four-architect structures of polymer (5 marks)

b) Distinguish between unit operations and unit process. (2 marks)

c) List four types of continuous reactors (4 marks)

d) Explain the type of a reactor (Design) that would be best used production of:

i. Aspirin synthesis,

ii. Deionized water,

iii. Nylon polymer (6 marks)

QUESTION THREE (20 MARKS)

a) Explain the following as applied to materials analysis

i. Residual stresses and state why its undesirable. (2 marks)

ii. Elastic deformation. (2 marks)

iii. Linear elastic range. (2 marks)

iv. Plastic region. (2 marks)

v. Ultimate Tensile strength (UTS). (2 marks)

b) List five important physical properties of materials: (5 marks)

c) Define toughness of a material. How the defined material respond to stress and strain? (5 marks)

QUESTION FOUR (20 MARKS)

a) Explain with flow diagrams the physical processes in the following productions

(i) Sugar Manufacture (4 marks)

(ii) Pharmaceutical Manufacture (3 marks)

(iii) Salt Manufacture (3 marks)

b) What is Heat Transfer. List four modes of heat transfer (5 marks)

c) Draw a well labelled diagram of a microreactor used to produce phenol from benzene. (5 marks)

QUESTION FIVE (20 MARKS)

a) The Haber Process reaction is reversible and the production of ammonia is exothermic. State the following reaction conditions:

i. Proportion of nitrogen to hydrogen; (2 marks)

ii. Temperature; (1 mark)

iii. Catalyst; (1 mark)

iv. How is the ammonia removed from the equilibrium mixture. (2 marks)

b) The Haber Process combines nitrogen from the air with hydrogen derived mainly from natural gas (methane) into ammonia. Write an equation for the synthesis of exothermic ammonia. Explain the effect of increasing pressure in this reaction (4 marks)

c) List one example of ammonia product used in each of the following manufacture:

i. Fertilizer,

ii. Chemicals,

iii. Explosives,

iv. plastics,

v. Refrigeration

vi. Pharmaceuticals (6 marks)

d) There are a number of ways that the choice of conditions in ammonia synthesis affects the process:

- their effect on the position of equilibrium;
- their effect on the rate of the reaction;
- their effect on the economics of the process.

By considering each of these (where relevant), explain the choice of the conditions used in Haber process of ammonia synthesis with respect to optimum temperature.

(3 marks)