

CORK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ

Autumn Examinations 2010/11

Module Title: Physical and Organic Chemistry
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Module Code: **CHEM6003**

School: Science

Programme Title:

Bachelor of Science in Applied Biosciences & Biotechnology – Year 1

Bachelor of Science (Honours) in Herbal Science – Year 1

Bachelor of Science (Honours) in Nutritional Health Science – Year 1

Bachelor of Science (Honours) in Pharmaceutical Biotechnology – Year 1

Bachelor of Science (Honours) in Biomedical Science – Year

Bachelor of Science in Applied Physics and Instrumentation – Year 1

Programme Code: **SBIOS_7_Y1**
 SHERB_8_Y1
 SNHSC_8_Y1
 SPHBI_8_Y1
 SBISC_8_Y1
 SPHYS_7_Y1

External Examiner(s): Dr G. Keavney

Internal Examiner(s): Dr R. Hourihane, Dr M. Lehane, Ms C. Griffin

Instructions: **Attempt four Questions. Question ONE, SECTION A is compulsory. Attempt ONE question each from SECTIONS B and C, and ONE other question. Show all calculations on the examination script.**

Duration: 2 Hours

Sitting: Autumn 2011

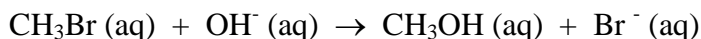
Requirements for this examination: Maths Tables

<p>Note to Candidates: Please check the Programme Title and the Module Title to ensure that you have received the correct examination paper. If in doubt please contact an Invigilator</p>

Section A

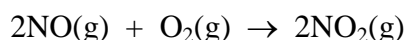
Q1. Attempt **Eight** of the following. All carry equal marks.

- (i) For the following reaction



The rate for this reaction is first order in CH_3Br and first order in OH^- . When $[\text{CH}_3\text{Br}]$ is $5 \times 10^{-3} \text{ M}$ and $[\text{OH}^-]$ is 0.05 M the reaction rate at 298 K is 0.0432 Ms^{-1} . What is the specific rate constant at this temperature?

- (ii) (a) What factors determine whether a collision between two molecules will lead to a chemical reaction?
(b) According to the collision model, why does the temperature affect the value of the rate constant?
- (iii) Illustrate the pH profile, (titration curve), obtained when a strong acid is titrated against a strong base. Show how the end-point is determined from the graph.
- (iv) Distinguish between a strong acid and a weak acid. Give appropriate examples.
- (v) Consider the following gas phase reaction



If the reaction is carried out in a constant volume container at constant temperature, will the measured heat change represent ΔH or ΔE ? Is there a difference, which is larger in this instance?

- (vi) Distinguish between conformational and structural isomers in organic compounds.
- (vii) Write the reaction mechanism for the reaction of but-1-ene with hydrogen bromide
- (viii) List some of the practical uses of the lower molecular weight alkanes.
- (ix) Explain why alcohols have higher boiling points than hydrocarbons of similar molecular masses.
- (x) Is 2-methylpropan-2-ol a primary, secondary or tertiary alcohol? Explain your answer.

(25 marks)

Section B

- Q2.** (a) Distinguish between the following terms elementary, unimolecular, and bimolecular reaction. Which term most accurately describes the process in (b) below? (6 marks)

- (b) The following data were collected from the first order gas phase isomerisation of CH_3NC at 215°C , Calculate the first order rate constant and the half - life for the reaction:

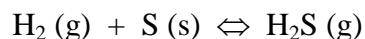
Time /s	Pressure CH_3NC / torr
0	502
2000	335
5000	180
8000	95.5
12000	41.7
15000	22.4

(13 marks)

- (c) (i) Most commercial catalysts are extremely finely divided solid materials. Why is particle size important?
- (ii) What role does adsorption play in the action of a heterogeneous catalyst?
- (iii) Do catalysts affect the overall enthalpy change for a reaction, the activation energy or both?

(6 marks)

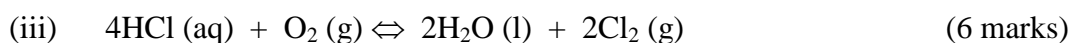
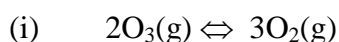
- Q3.** (a) A mixture of H_2 , S and H_2S is held in a 1L container at 90°C and reacts according to the following equation



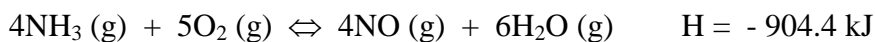
At equilibrium the mixture contains 0.46g of H_2S and 0.40g H_2 .

Write the equilibrium expression for this reaction and calculate a value for the equilibrium constant at this temperature. (6 marks)

- (b) Write the equilibrium expression for each of the following reactions. In each case indicate whether the reaction is homogeneous or heterogeneous:



- (c) Consider the following equilibrium reaction



Predict how each of the following changes affects the

- (i) equilibrium position
- (ii) yield of NO at equilibrium
- (iii) equilibrium constant

1. an increase in $[\text{NH}_3]$;
2. an increase in $[\text{H}_2\text{O}]$;
3. a decrease in the volume of the container in which the reaction occurs;
4. An increase in temperature.

(13 Marks)

Section C

- Q4. (a) The halogenation of alkanes is an example of a free radical substitution reaction. Explain what is meant by the underlying term. (6 Marks)
- (b) State Markownikoff's rule and provide an appropriate example that illustrates this rule. (4 Marks)
- (c) Explain the process of thermal and catalytic cracking as pertains to the refinement of crude oil extract. (5 Marks)
- (d) (i) Distinguish between the molecular, empirical and structural formulae of an organic compound.
- (ii) Aspartic acid contains 36.09% Carbon, 5.30% Hydrogen, 10.52% Nitrogen, and 48.08% Oxygen by weight. Using this information determine the empirical formula for aspartic acid. (10 Marks)
- Q5. (a) Draw the structures of the following organic compounds:
- 4-methyl-2-pentene
 - 3 methyl-4butyl-octane
 - 2 methyl propan-1-ol
 - Methoxyethane (methyl ethyl ether)
 - 2-bromo-1-chloro-3-methylcyclopentane
- (10 Marks)
- (b) Describe, giving relevant examples, geometrical isomerism in alkenes. (4 Marks)
- (c) Describe providing diagrams the type of hybridisation that facilitates the formation of carbon double bonds in the alkenes. (6 Marks)
- (d) Predict which of the molecules below will have the highest boiling point and justify your answer. (4 Marks)

