

**CORK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ**

Autumn Examinations 2014

Module Title: Biological Chemistry 2

Module Code: CHEM6009

School: Science and Informatics.

Programme Title: Bachelor of Science in Applied Biosciences
 Bachelor of Science in Pharmaceutical Biotechnology
 Bachelor of Science in Nutrition and Health Science
 Bachelor of Science in Herbal Science

Programme Code: **SBIOS_7_Y1**
 SPHBI_8_Y1
 SNHSC_8_Y1
 SHERB_8_Y1

External Examiner(s): Dr. Carmel Roche

Internal Examiner(s): Dr. Rosamund Hourihane
 Dr. Mary Lehane

Instructions: Attempt **THREE** questions.
 Section A is compulsory.
 Attempt 8 out of 10 questions from Section A.
 Attempt one question each from sections B and C.
 Show all calculations and rough work on the answer book.

Duration: 2 Hours

Sitting: Autumn 2014

Requirements for this examination: Periodic Tables

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.

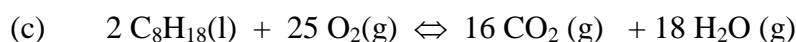
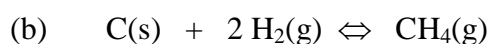
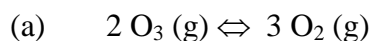
Section A

Attempt 8 of the following 10 parts

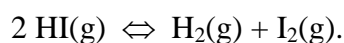
All parts carry equal marks.

Q1.

- (i) Write the expressions for K_c for the following reactions. In each case indicate whether the reaction is homogeneous or heterogeneous.



- (ii) Gaseous hydrogen iodide is placed in a closed container at 425°C , where it partially decomposes to hydrogen and iodine :



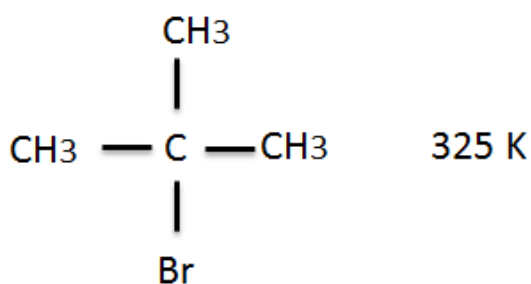
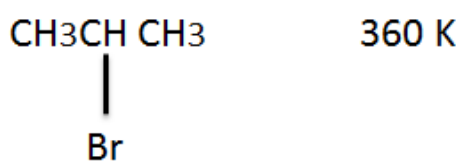
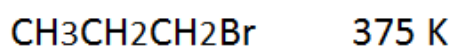
At equilibrium it is found that $[\text{HI}] = 3.53 \times 10^{-3} \text{ mol dm}^{-3}$,

$[\text{H}_2] = 4.79 \times 10^{-4} \text{ mol dm}^{-3}$, and $[\text{I}_2] = 4.79 \times 10^{-4} \text{ mol dm}^{-3}$.

What is the value of K_c at this temperature?

- (iii) Write the Henderson – Hasselbalch equation, explain in words each of the quantities contained within.
- (iv) Illustrate the pH profile, which results from a titration between a weak acid and strong base. Mark the endpoint on the profile.
- (v) Identify the acid, base, conjugate acid and conjugate base in the following equations:
- (a) $\text{CH}_3\text{COOH} + \text{NH}_3 \rightleftharpoons \text{NH}_4^+ + \text{CH}_3\text{COO}^-$
- (b) $\text{H}_2\text{PO}_4^- + \text{H}_2\text{O} \rightleftharpoons \text{OH}^- + \text{H}_3\text{PO}_4$

- (vi) Sketch the following compounds:
- Pentyl-cyclopentane
 - 1-Bromo-2,2,-dimethylpropane
 - 1-iodo-3- methyl heptane
- (vii) Cyclohexane is often represented in the literature as being a hexagonal shaped molecule; however it exists in 2 spatial conformations. Sketch these conformational isomers and comment on their relative stability.
- (viii) Account for the differences in boiling points of the following isomeric compounds (boiling points are given in Kelvin).



- (ix) List five ways in which Organic Compounds differ from Inorganic compounds.
- (x) Describe the meaning of the terms Electrophile and Nucleophile

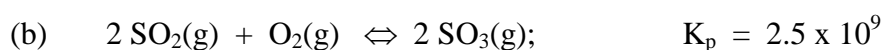
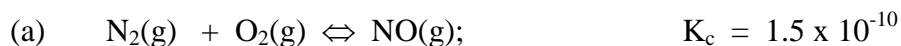
Section B

Attempt any one of the following questions

Q2.

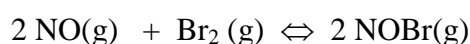
- (i) When the following reactions come to equilibrium, does the equilibrium lie on the left in favour of the reactants or on the right in favour of the products ?

Justify your answer.

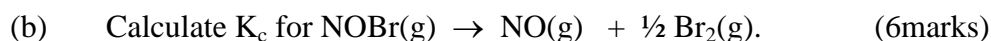


(4 marks)

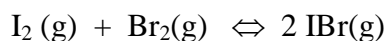
- (ii) The equilibrium constant for the reaction



is $K_c = 1.3 \times 10^{-2}$ at 1000 K.



- (iii) The equilibrium constant value, K_c , for the following reaction at 150 °C is 280.



If 0.500 mols of IBr (g) in a 2.00 L flask is allowed to reach equilibrium at this temperature, what are the equilibrium concentrations of IBr, I_2 and Br_2 ?

(12 marks)

- (iv) According to Le Chatelier's principle, how do the following changes affect the value of the equilibrium constant for a gas-phase exothermic reaction, justify your predictions.

(a) removal of a reactant

(b) decrease in the temperature. (8 marks)

Q3.

- (i) Distinguish between an Arrhenius and a Bronsted-Lowery acid, give an example in each case. (6 marks)
- (ii) Calculate the pH or $[H^+]$ ion, which ever is appropriate, for each of the following solutions
- (a) $0.2 \text{ mol dm}^{-3} \text{ HNO}_3$
 - (b) $4 \times 10^{-3} \text{ mol dm}^{-3} \text{ NaOH}$
 - (c) a solution prepared by dissolving 0.25g HBr in water and diluting to 250mL in a volumetric flask.
 - (d) 0.2 mol dm^{-3} solution of Hydrogen peroxide (H_2O_2)
 $K_a 1.8 \times 10^{-12}$
 - (e) a solution of pH = 5.56 (14 marks)
- (iii) Calculate the change in pH of the following buffer solution, Benzoic acid / Sodium benzoate, each with a concentration of 2.00 mol dm^{-3} , when 10 cm^3 $0.5 \text{ mol dm}^{-3} \text{ HCl}$ is added to the solution. (7 marks)
- (iv) Briefly explain the function of a buffer solution. (3 marks)

Section C

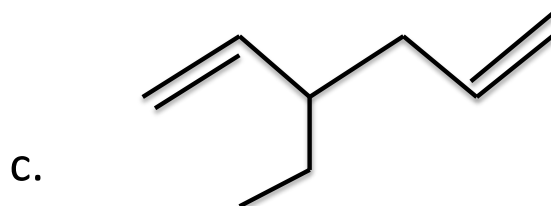
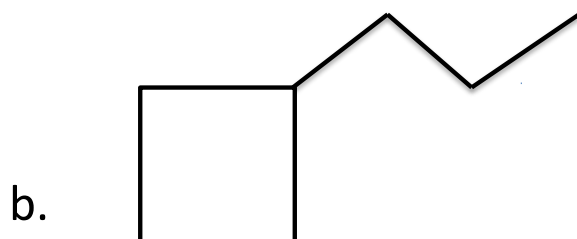
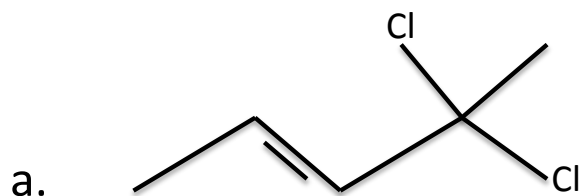
Attempt any one of the following questions

Q4.

- a) Distinguish between the empirical and molecular formulae of an organic compound. (3 marks)
- b) 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. (6 marks)

Q4. Continued...

c) Name the following compounds using the IUPAC rules of nomenclature.



(8 Marks)

d) Explain giving suitable examples the following terms:

- Addition reaction
- Substitution reaction
- Saturated and Unsaturated hydrocarbons
- Primary (1°), Secondary (2°) and Tertiary (3°) alcohols.

(8 marks)

e) List some of the unique properties of Carbon and explain how it can form such a diverse array of compounds.

(5 marks)

Q5.

- a) Explain and draw the mechanism of the reaction of Cl_2 with ethene.
(6 marks)
- b) Define Markovnikov's and anti-Markovnikov's addition to asymmetric alkenes and give an example of both reactions.
(8 marks)
- c) Discuss the structure of benzene and describe some of its unique properties.
(6 marks)
- d) Discuss why and how, in the petrochemical industry, most of the long chain alkanes are 'cracked'.
(5 marks)
- e) Write out four structural isomers of an alkane with the formula C_8H_{20}
(5marks)