

**CORK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ**

Semester 2 Examinations 2013

Module Title: Biological Chemistry 2
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Module Code: CHEM6009

School: Science and Informatics

**Programme Title: Bachelor of Science in Applied Biosciences
 Bachelor of Science (Hons) in Biomedical Science
 Bachelor of Science in Herbal Science
 Bachelor of Science in Nutrition and Health Science
 Bachelor of Science in Pharmaceutical Biotechnology**

**Programme Code: SBIOS -7 –Y1
 SBISC_8_Y1
 SHERB_8_Y1
 SNHSC_8_Y1
 SPHBI_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 12 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: Summer 2013

Requirements for this examination:

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.
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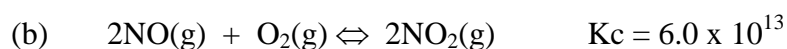
Section A

Attempt 8 of the following 12 parts

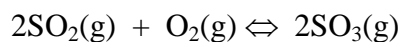
All parts carry equal marks.

Q1.

- (i) When the following reactions reach equilibrium does the equilibrium mixture contain mostly reactants or mostly products, justify your answer



- (ii) Calculate the equilibrium constant for the following reaction at 800K from the following data

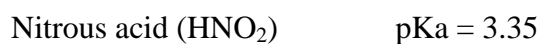


$$[\text{SO}_2] = 3.0 \times 10^{-3} \text{ mol dm}^{-3}, \quad [\text{O}_2] = 3.5 \times 10^{-3} \text{ mol dm}^{-3},$$

$$[\text{SO}_3] = 5.0 \times 10^{-2} \text{ mol dm}^{-3}$$

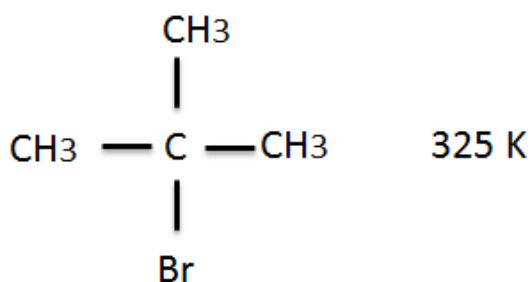
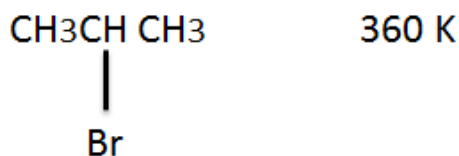
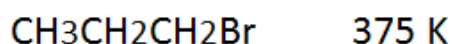
What is the equilibrium constant for the reverse reaction?

- (iii) State Le Chatelier's principle. Explain what is meant by a stress?
- (iv) Distinguish between a strong and a weak acid, give examples of both.
- (v) Determine the K_a values for the following weak acids



Write an equation describing their dissociation.

- (vi) Define what is meant by a buffer solution? Identify four classification of buffer solution, give the pH range over which each operate.
- (vii) Sketch the following compounds:
- Pentyl-cyclopentane
 - 1-Bromo-2,2,-dimethylpropane
 - 1-iodo-3-pentanone
- (viii) Distinguish with examples the difference between cis (Z) and trans (E) isomers in alkene structures.
- (ix) Draw 4 possible structural isomers for a compound with a molecular formula of C_8H_{18} .
- (x) Account for the differences in boiling points of the following isomeric compounds (boiling points are given in Kelvin).



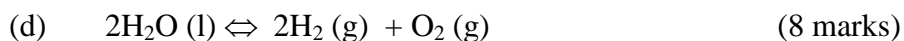
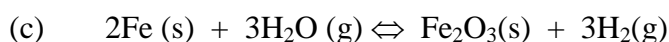
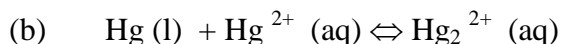
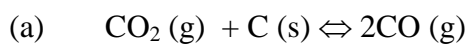
- (xi) Describe and sketch examples of primary (1°), secondary (2°), and tertiary (3°) alcohols.
- (xii) Write the chemical equation for the synthesis of an alkane.

Section B

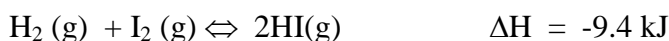
Attempt one of the following questions

Q2.

(i) Write the equilibrium expression, K_c , for the following equilibrium reactions



(ii) For the following equilibrium reaction,



will the equilibrium concentration of HI increase or decrease when

(a) I_2 is added

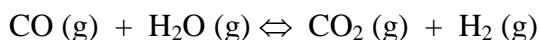
(b) H_2 is added

(c) A catalyst is added

(d) The temperature is increased.

How will the equilibrium constant, K_c , be affected in each case? (10 marks)

(iii) The H_2/CO ratio in mixtures of carbon monoxide and hydrogen (*called synthesis gas*) is increased by the water gas shift reaction below

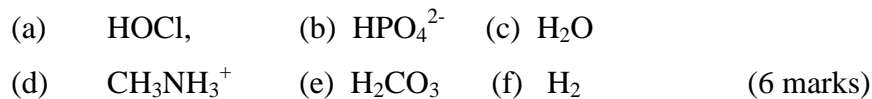


Equilibrium constant for this reaction $K_c = 4.24$ at 800 K.

Calculate the equilibrium concentrations of all species at 800K; if only CO and H_2O are present initially each at a concentration of $0.150 \text{ mol dm}^{-3}$. (12 marks)

Q3.

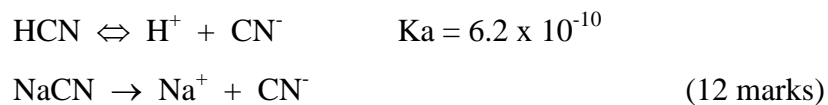
- (i) Give the formula for the conjugate base of each of the following Bronsted-Lowery acids



- (ii) Calculate the pH or $[\text{H}^+]$ ion where appropriate for each of the following

- (a) $0.2 \text{ mol dm}^{-3} \text{ HClO}_4$
(b) $4 \times 10^{-3} \text{ mol dm}^{-3} \text{ Ba(OH)}_2$
(c) a solution prepared by dissolving 0.93g HCl in 0.4L of H_2O
(d) 0.1 mol dm^{-3} solution of phenol, $\text{C}_6\text{H}_5\text{OH}$, $K_a = 1.3 \times 10^{-10}$
(e) a solution of $\text{pH} = 10.82$ (12 marks)

- (iii) Calculate the pH of 0.500L of $0.2 \text{ mol dm}^{-3} \text{ HCN}$, $0.12 \text{ mol dm}^{-3} \text{ NaCN}$ buffer solution before and after addition of 0.005 mol NaOH and 0.02 mol HCl.



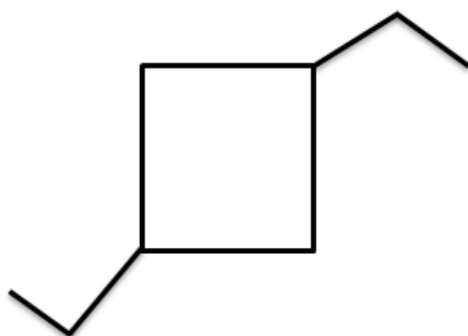
Section C

Attempt one of the following questions

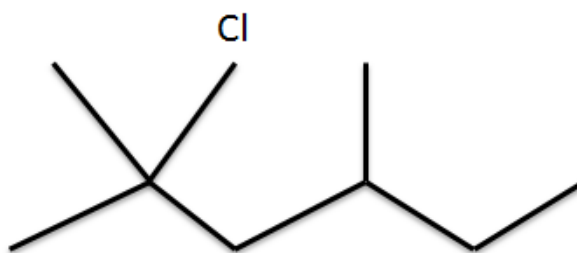
Q4.

- a) Name the following compounds using the IUPAC rules of nomenclature.

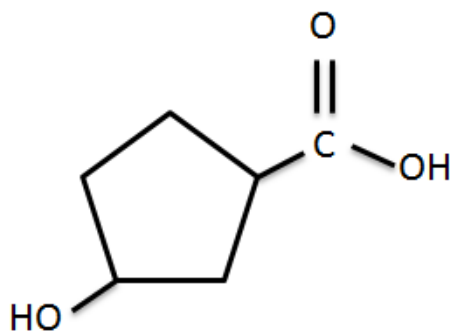
A.



B.



C.



(10 marks)

- b) Caffeine has an elemental analysis of 49.48% carbon, 5.190% hydrogen, 16.47% oxygen, and 28.85% nitrogen. It has a molar mass of 194.19 g/mol. What is the molecular formula of caffeine? (6 marks)

c) Explain giving suitable examples the following terms:

- a. Electrophile
- b. Nucleophile
- c. Addition reaction
- d. Conformers of cyclohexane
- e. Saturated and Unsaturated hydrocarbons

(10 marks)

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

(4 marks)

Q5.

- a) Discuss and draw the mechanism of the reaction of Br₂ with ethene. (6 marks)
- b) Define Markovnikov's and anti- Markovnikov's addition to alkenes and give an example of both reactions. (8 marks)
- c) 'Benzene is a six carbon ring compound that has a unique arrangement of its π electrons this confers special properties to benzene which are different from other ring compounds.'
- Discuss the structure of benzene and some of its unique properties. (10 marks)
- d) Predict the most likely position of electrophilic attack in the following substituted benzene rings. (6 marks)

