

**CORK INSTITUTE OF TECHNOLOGY  
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ**

**Semester 2 Examinations 2009/10**

<b>Module Title:     Physical and Organic Chemistry</b>
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**Module Code:**        CHEM6003

**School:**                Science

**Programme Title:**    Bachelor of Science in Applied Biosciences  
                              Bachelor of Science in Herbal Science  
                              BSc Hons in Nutrition & Health Science  
                              BSc Hons in Biomedical Science  
                              BSc Hons in Pharmaceutical Biotechnology  
                              BSc in Applied Physics & Instrumentation

**Programme Code:**    SBISC-8-Y1  
                              SBIOS-7-Y1  
                              SHERB-8-Y1  
                              SNHSC-8-Y1  
                              SPHBI-8-Y1  
                              SPHYS-7-Y1

**External Examiner(s):**    Dr. G. Keaveney  
**Internal Examiner(s):**    Dr. R. Hourihane  
                                      Dr. D. O'Driscoll

**Instructions:**    Attempt four Questions. Question ONE is SECTION A 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 2010

**Requirements for this examination:**        Maths Tables

<p><b>Note to Candidates:</b> 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>
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## Section A

**Q1. Attempt 8 of the following 10 parts. All carry equal marks.**

- (i) Distinguish between empirical and molecular formulas of an organic molecule.
- (ii) Explain the meaning and give an example of the following terms:
  - (a) nucleophile
  - (b) electrophile.
- (iii) Explain, giving examples, the difference between saturated and unsaturated hydrocarbons.
- (iv) Write a balanced equation for the combustion of propane.
- (v) Identify the conditions necessary for the halogenation of alkanes.
- (vi) Why do alkenes undergo addition reactions as apposed to substitution reactions?
- (vii) Define what is meant by path function in thermodynamics.
- (viii) Define what is meant by specific heat capacity and give the units. Give one example of a substance that has good specific heat capacity and one example of a substance that has poor specific heat capacity.
- (ix) Define what is meant by a rate law. How can you tell the order of the reaction from the rate law?
- (x) Identify the acid, base, conjugate acid and conjugate base in the following acid base reactions:
  - (a)  $\text{HBrO (aq)} + \text{H}_2\text{O (l)} \leftrightarrow \text{H}_3\text{O}^+ \text{ (aq)} + \text{BrO}^-$
  - (b)  $\text{HSO}_4^- \text{ (aq)} + \text{HCO}_3^- \text{ (aq)} \leftrightarrow \text{SO}_4^{2-} \text{ (aq)} + \text{H}_2\text{CO}_3 \text{ (aq)}$  (25 marks)

## Section B

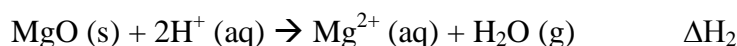
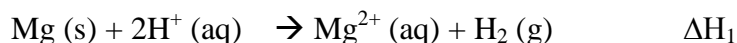
- Q2.** (i) From the following equation solve for entropy from the table of standard entropies of formation given:



State whether there is a decrease or increase in entropy from the above reaction.

(5 marks)

- (ii) Determine, (without using numerical data), the standard enthalpy of formation for Magnesium Oxide, (MgO), from the following reactions and enthalpy ( $\Delta H$ ) changes:



- (iii) Nitrosyl bromide decomposes at  $10^\circ\text{C}$  according to the reaction below:



The following kinetic data were obtained:

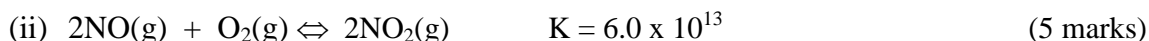
Time/min	0	10	20	30	40
[NOBr] /M	0.0400	0.0303	0.0244	0.0204	0.0175

- (a) Using the data supplied determine the order of the reaction.  
 (b) Evaluate a value for the specific rate constant. (10 marks)

- Q3.** (a) Explain what is meant by the term chemical equilibrium.

How do you know a chemical reaction has reached equilibrium? (5 marks)

- (b) When the following reactions come to equilibrium does the equilibrium mixture contain mostly reactants or mostly products?



- (c) Calculate the equilibrium concentrations of  $\text{N}_2$ ,  $\text{O}_2$  and  $\text{NO}$  present, when a mixture that was initially  $0.100 \text{ mol dm}^{-3}$  in  $\text{N}_2$  and  $0.090 \text{ mol dm}^{-3}$  in  $\text{O}_2$ , comes to equilibrium at  $600^\circ\text{C}$ . The following equation illustrates the reaction:



## Section C

- Q4.** (i) Justify, why lower molecular weight alcohols are soluble in water, while alkanes of similar weight are completely insoluble. ( 5 marks)
- (ii) Draw the structural formulas for the alkenes, (major and minor), formed by the acid catalysed dehydration of 3-methyl -2- butanol. Hydration / dehydration is a reversible process, how might the dehydration reaction process be maximised? (10 marks)
- (iii) Alcohols can undergo oxidation reactions yielding a variety of products depending on the starting alcohol. Name the possible products, identifying the appropriate reaction conditions required to yield each product type. (10 marks)
- Q5.** (i) Taking propene as a starting material name and draw the product formed as well as identify the reaction conditions necessary for successful completion of each of the following processes:
- Addition of hydrogen
- Addition of halogens
- Addition of hydrogen halides. (9 marks)
- (ii) Identify two laboratory methods of preparation of alkenes. Write an equation for each process identified. (5 marks)
- (iii) An organic compound was subjected to an elemental analysis and gave the following data: carbon 61.9% and hydrogen 10.3%. Its molecular mass was determined to be 116. From the above data determine the empirical and molecular formula for the compound. (6 marks)
- (iv) Explain why even though cycloalkanes and alkenes have the same general formula, they differ significantly in their chemical reactivity. (5 marks)