

**CORK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ**

Autumn 2010/11

Module Title: General and Inorganic Chemistry CA

Module Code: **CHEM6002**

School: Science

Course: **Bachelor of Science in Applied Biosciences & Biotechnology**
Bachelor of Science (Honours) in Herbal Science
BSc (Hons) Nutrition & Health Science
BSc (Hons) in Biomedical Science
BSc in Applied Physics & Instrumentation
BSc (Honours) in Instrument Engineering
BSc in Analytical & Pharmaceutical Chemistry
BSc (Hons) in Analytical Chemistry with Quality Assurance
BSc (Hons) in Environmental Science & Sustainable Technology

Programme Code: **SBISC-8-Y1**
 SBIOS-7-Y1
 SHERB-8-Y1
 SNHSC-8-Y1
 SPHBI-8-Y1
 SPHYS-7-Y1
 SINEN-8-Y1
 SCHEM-7-Y1
 SCHQA-8-Y1
 SESST-8-Y1

External Examiner(s): **Dr. G. Keavney.**

Internal Examiner(s): **Dr. R. Hourihane, Dr. L. Goold, Dr. B. Doyle,**
 Mr. D. Spicer, Dr. M. Lehane

Instructions: **Attempt both Sections A and B.**

Duration: 2 Hours

Sitting: Autumn 2011

Requirements for this examination

<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 any **10** of the following. All carry equal marks

- (i) Distinguish between Boyles Law and Charles Law. A diagram may aid your description.
- (ii) A fixed quantity of gas at 21°C exhibits a pressure of 752torr and occupies a volume of 5.12L. **(1atm = 760torr)**
Calculate the volume the gas will occupy if the pressure is increased to 1.88atm, while the temperature is held constant.
- (iii) Identify the four quantum numbers by name, symbol and possible values.
- (iv) State what is meant by each of the following atomic properties
(i) Atomic Radius, (ii) Ionisation Energy, and (iii) Electron Affinity.
Identify and explain briefly the trends of each property across a period and down a group in the periodic table?
- (v) Define the term electronegativity and explain how values may be used to determine bond polarity. Hence indicate which of the following bonds are polar, and why?
- P ----- Cl; Cl ----- Cl.
- (vi) Distinguish between ionic and covalent compounds under the following headings
- phase at room temperature,
 - boiling point and melting point and
 - solubility in water.
- (vii) Write the electronic configuration for the following elements
Magnesium, $^{12}_{24}\text{Mg}$
Chromium, $^{24}_{52}\text{Cr}$
- (viii) Distinguish between the terms atomic number and mass number. Give the values for the elements listed in (vii) above.
- (ix) What is meant by the Pauli exclusion principle? Illustrate with an example.

- (x) Identify three types of radioactive decay, by name, symbol, charge and mass.
- (xi) Complete and balance the following nuclear equations
- (a) $^{122}_{53}\text{I} \rightarrow ^{122}_{54}\text{Xe} + ?$
- (b) $^{14}_7\text{N} + ^4_2\text{He} \rightarrow ? + ^1_1\text{H}$
- (xii) Name the five basic molecular shapes which covalent molecules can adopt. Which of these would you predict for H_2O ?
- (xiii) Explain what is understood by the term 'metallic bonding'.
Concisely explain why metals are able to conduct electricity in their solid state.
- (xiv) Explain what is understood by the term 'semiconductor' in chemistry.
Outline how the introduction of a very small number of foreign atoms, e.g. phosphorus atoms into silicon, can change an element from being an insulator to a conductor. (40 marks)

Section B

Attempt any **two** of the following three questions

- Q2.** (i) Predict the chemical formula of the ionic compounds formed between the following pairs of elements and justify your predictions
- barium and fluorine
 - cesium and chlorine
 - Lithium and nitrogen (6 marks)
- (ii) Energy is required to remove two electrons from Ca to form Ca^{2+} and is released when we add two electrons to O to form O^{2-} . Why, then is CaO stable relative to the free elements. (8 marks)
- (iii) Which of the following elements are unlikely to form a covalent bond. Justify your answer. S, H, K, Ar, Si. (8 marks)
- (vi) Draw the Lewis Structure for the formation of PF_3 from P and F atoms. (8 marks)

- Q3.** (i) State whether the following statements are true or false
- (a) In terms of the total attractive forces for a given substance, dipole – dipole attractions when present are always larger than dispersion forces.
- (b) All other factors being the same, dispersion forces between linear molecules are greater than the dispersion forces between molecules whose shapes are nearly spherical. (6 marks)
- (ii) (a) What atoms must a molecule contain to participate in Hydrogen bonding with other molecules of the same kind.
- (b) Which of the following molecules can form Hydrogen bonds
 CH_3F ; CH_3OH CH_3Br (6 marks)
- (iii) A wooden artifact from a Chinese temple has a ^{14}C activity of 38.0 counts per minute as compared with an activity of 58.2 counts per minute for a standard of zero age. If the half-life of ^{14}C is 5712 yrs, determine the age of the artifact. (12 marks)
- (iv) Write a balanced equation for the following reactions
- (a) $^{238}_{92}\text{U} (\alpha, \text{n}) ^{241}_{94}\text{Pu}$
- (b) $^{14}_7\text{N}(\alpha, \text{p}) ^{17}_8\text{O}$ (6 marks)

Q4. Useful information

Avogadro's Number (N_A) = 6.023×10^{23} atoms mol^{-1}

- (i) Define the term 'mole of a chemical substance' (5 marks)
- (ii) The fermentation of glucose results in the formation of ethanol and carbon dioxide according to the equation:-



If 45.0g of glucose were used in an experiment and 10.0g of ethanol were formed, calculate the following:-

- (a) the number of moles of glucose used
- (b) the total number of atoms in 45.0 g of glucose.
- (c) the number of moles of ethanol that would theoretically be produced in the reaction.
- (d) the % yield of ethanol (20 marks)
- (iii) What volume (cm^3) of a 0.1 mol.dm^{-3} of Na_2CO_3 is required so that when it is diluted to 250 cm^3 with water, a $0.0125 \text{ mol.dm}^{-3}$ results. (5 marks)