

CORK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ

Autumn 2014

Module Title: Biological Chemistry 1 CA

Module Code: CHEM6011

School: Science

Programme Title: Bachelor of Science in Applied Biosciences
Bachelor of Science in Herbal Science
BSc Hons Nutrition & Health Science

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. C. Roche.**

Internal Examiner(s): Dr. L. Goold, Dr. R. Hourihane, Dr. M. Sheahan.

Instructions: Attempt **both** Sections A and B.
Show all calculations in the answer book.

Duration: 2 Hours

Sitting: Autumn 2014

Requirements for this examination: Periodic Table, Standard Enthalpy Tables
Electronegativity Table

Useful Constants $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$, $0.0821 \text{ L atm mol}^{-1} \text{ K}^{-1}$

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

Q1. Attempt any eight of the following. *All parts carry 5 marks*

- (i) Write the ground state electronic configuration for ${}^7\text{N}$ and ${}^{24}\text{Cr}$. Illustrate the detail of the configuration/orbital occupancy of the valance shell in both cases.
- (ii) What is an atomic orbital? Name two types of atomic orbitals. What characteristics may be used to distinguish between different orbitals?
- (iii) List all sub atomic particles. Give the mass, charge and location within the atom of each.
- (iv) In each of the following pairs of ions, name and give the chemical formula for the ionic compound formed:
 - (a) Zn^{2+} and Cl^-
 - (b) Fe^{3+} and O^{2-}
 - (c) Mg^{2+} and OH^-
- (v) Describe through the application of valence shape electron pair repulsion theory, (VSEPR), the shape of the NH_3 molecule.
- (vi) Balance the following chemical equations
 - (a) $\text{ZnS (s)} + \text{O}_2 \text{ (g)} \rightarrow \text{ZnO (s)} + \text{SO}_2 \text{ (g)}$
 - (b) $\text{MgCl}_2 \text{ (s)} + \text{AgNO}_3 \text{ (s)} \rightarrow \text{Mg(NO}_3)_2 \text{ (s)} + \text{AgCl (s)}$
- (vii) Calculate the molarity of a solution of sodium carbonate (Na_2CO_3), which was prepared by dissolving 21.2g of Na_2CO_3 in water and diluting to a total volume of 500cm^3 .
- (viii) Calculate the number of moles of butane (C_4H_{10}), in 30g of butane. What is the percentage carbon in butane?
- (ix) What mass of solid potassium chloride (KCl), is required to prepare 250cm^3 of a 0.1mol dm^{-3} solution?
- (x) What volume of the solution described in (ix) above is required to prepare 100cm^3 of a 0.005mol dm^{-3} solution?

Section B

Attempt any **TWO** questions

Q2.

- (a) Locate the element Gallium, (Ga), in the periodic table attached to this paper
- (i) State and define the atomic number and relative atomic mass of Ga. (4 marks)
- (ii) Gallium has two naturally occurring isotopes with mass numbers 69 and 71. Calculate the number of neutrons in the 69 isotope. (2 marks)
- (iii) The approximate isotopic abundance of the 69, (68.926amu), and 71, (70.926amu), isotopes are 60% and 40% respectively. Define the underlined term and calculate the average relative atomic mass of a Ga atom. (10 marks)
- (b) State what is meant by each of the following atomic properties.
- (i) Atomic Radius
 - (ii) Ionisation Energy
 - (iii) Electron Affinity
 - (iv) Electronegativity

Identify and explain briefly the trends in any three of the listed properties, across a period and down a group in the periodic table (14 marks)

Q3.

- (a) State the First Law of Thermodynamics in words and by equation. (6 marks)
- (b) When 50cm³ of 1.0 moldm⁻³ HCl is added to 50mL of 1.0 moldm⁻³ NaOH in a calorimeter, the temperature of the aqueous solution increases from 25 to 33.9 °C. Assuming that the calorimeter absorbs only a negligible quantity of heat and that the specific heat capacity and density of the final solution is the same as that of pure water, calculate enthalpy of neutralisation, $\Delta H_{\text{neutralisation}}$ (in kJmol⁻¹) for the reaction:
- $$\text{HCl}(aq) + \text{NaOH}(aq) \rightarrow \text{NaCl}(aq) + \text{H}_2\text{O}(l)$$
- Specific Heat Capacity H₂O = 4.18 J g⁻¹K⁻¹ Density H₂O = 1 g cm⁻³ (8 marks)
- (c) Using the table of standard enthalpy of formation data attached, and the combustion equation illustrated below, calculate the enthalpy of combustion of benzene, C₆H₆(l)
- $$\text{C}_6\text{H}_6(l) + 7.5 \text{O}_2(g) \rightarrow 6\text{CO}_2(g) + 3\text{H}_2\text{O}(l) \quad (8 \text{ marks})$$
- (d) Define the underlined terms in parts (b) and (c) above. (8 marks)

Q4.

- (a) Which groups from the periodic table typically form (i) ionic (ii) covalent bonds? Hence, or otherwise, describe the bonding in LiCl (s) and Cl₂ (g). (10 marks)
- (b) List three differences between ionic and covalent compounds. (6 marks)
- (c) What are intermolecular forces, IMF? Identify three types listing them in order of increasing strength? (8 marks)
- (d) Discuss briefly the effect(s) IMF's have on (i) solubility (ii) boiling point of liquid molecules. (6 marks)