MAR 2024

BINDURA UNIVERSITY OF SCIENCE EDUCATION
SCIENCE AND MATHEMATICS EDUCATION DEPARTMENT
DIPLOMA IN SCIENCE EDUCATION

DCH001/DC001: GENERAL CHEMISTRY

TIME: 2 HOURS

ANSWER QUESTION ONE AND TWO QUESTIONS FROM EACH OF SECTIONS A AND B. EACH QUESTION CARRIES 20 MARKS

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1 (a) Use the information in the following table to calculate the actual mass of the ^{4}He atom.

Particle	Actual mass /kg
electron	9.1×10^{-31}
neutron	1.64×10^{-27}
proton	1.73×10^{-27}

[3 marks]

(b) Element X has 49 electrons and 52 neutrons:
(i) Find the atomic number of X. [2 marks]
(ii) Find the mass number of X. [2 marks]
(iii) Give the complete symbol of X. [2 marks]

(c) Naturally occurring neon consists of three isotopes ^{20}Ne, ^{21}Ne and ^{22}Ne with relative abundances of 90.92%; 0.26% and 8.82% respectively. Calculate the relative atomic mass of neon. [3 marks]

(d) Write dot and cross diagrams for the following species:
(i) H_2O [2 marks]
(ii) NaCl [2 marks]
(iii) HCl [2 marks]
(iv) CO_2 [2 marks]

SECTION A: ANSWER ANY TWO QUESTIONS FROM THIS SECTION

2 (a) Giving appropriate examples define the following terms:
(i) Strong base. [2 marks]
(ii) Weak acid. [2 marks]

(b) Identify and indicate the reducing and oxidizing agent in each of the following reactions:
(i) $2K + Cl_2 \longrightarrow 2KCl$ [2 marks]
(ii) $2H_2 + O_2 \longrightarrow 2H_2O$ [2 marks]

(c) Calculate pH for each of the following:
(i) 0.01 M H_2SO_4 [3 marks]
(ii) 0.01 M NaOH [3 marks]
(iii) 0.01 M $Ca(OH)_2$ [3 marks]
(iv) 0.02 M HCl [3 marks]

3 (a) Explain the following observations:
(i) The boiling points of group VII elements increase down the group.

Element	Boiling point / ^0C
Cl_2	-35
Br_2	+59
I_2	+184

[3 marks]
(ii) Electrical conductivity of period 3 elements increases from Na to Al. [4 marks]
(iii) Aqueous solutions of ionic compounds conduct electricity whilst those of covalent substances do not. [3 marks]

(b) (i) Give the formulae of the chloides of the period three elements, Na to Si. [4 marks]
(ii) Write equations to show the reactions of the following oxides with water; SO_2, SO_3 and P_4O_{10}. [6 marks]

4 (a) Describe the charges and relative masses of the three sub-atomic particles, protons, neutrons and electrons. [6 marks]

(b) By means of a diagram describe how the paths of separate beams of the following particles are affected on passing through an electric field which is at right angles to their direction of travel.
- Proton ($^1H^+$)
- Hydride ion ($^1H^-$)
- Hydrogen atoms (H) [6 marks]

(c) Define the following terms:
(i) Isotopes. [2 marks]
(ii) pOH [2 marks]
(iii) Lewis acid. [2 marks]
(iv) Mass number. [2 marks]

SECTION B: ANSWER ANY TWO QUESTIONS FROM THIS SECTION.

5. (a) (i) Write complete equations representing the first, second and third ionization energies of magnesium, (Mg). [6 marks]
(ii) Give the electron configuration of the ion resulting from the second ionization energy of Mg. [2 marks]

(b) Using values from the Data Booklet plot a graph of the 1st ionization energy of the nine elements Na to K. [5 marks]

(c) Comment on the shape of the graph, in particular explaining the reasons for:

(i) The general trend from Na to Ar. [4 marks]
(ii) The discontinuities between Mg and Al. [3 marks]

6. (a) Use the species given in brackets to explain how the named types of bonds are formed:
(i) Covalent bond (H and Cl). [4 marks]
(ii) Metallic bond (Mg). [4 marks]
(iii) Ionic bond (Na and Cl). [4 marks]

(b) Use the Valency Shell Electron Pair Repulsion theory to predict the shapes and bond angles in the following molecules:
(i) $BeCl_2$ [2 marks]
(ii) BCl_3 [2 marks]
(iii) H_2S [2 marks]
(iv) CO_2 [2 marks]

7. (a) An organic acid has the following composition by mass: C, 40%; H, 6.7% and O, 53.3%.
Calculate the empirical formula of the acid [3 marks]

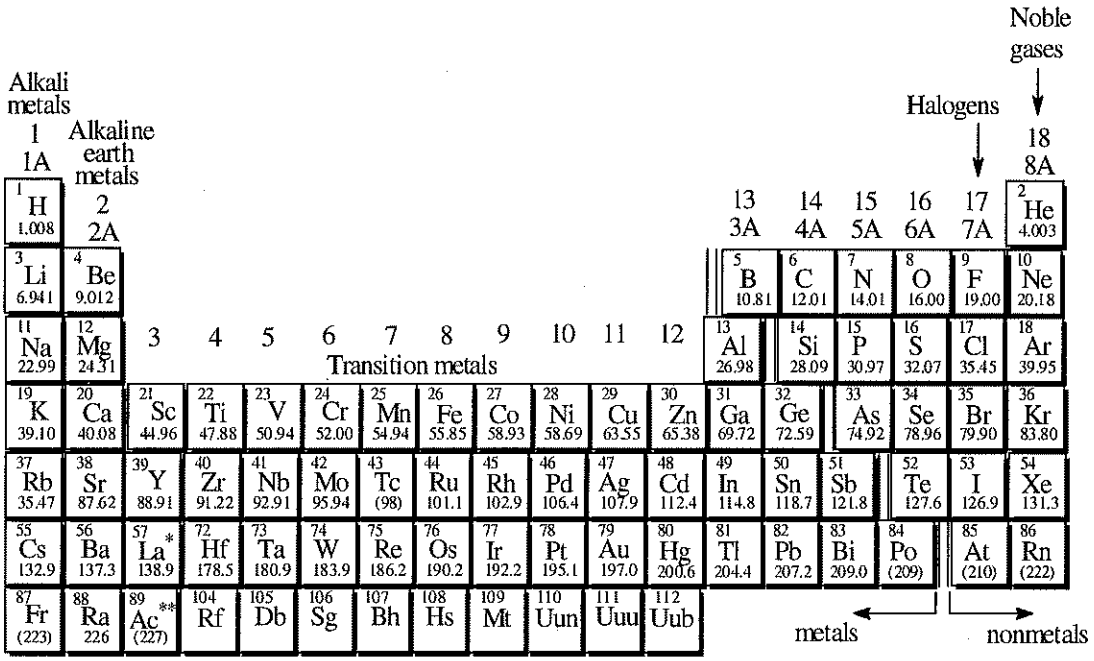
(b) When measurements are made of the M_r of ethanoic acid (CH_3COOH) in a non-aqueous solvent like pentane, a value of 120 is obtained.
(i) Suggest an explanation for this. [3 marks]
(ii) Draw a displayed formula of the species formed. [2 marks]

(c) Identify the conjugate acid-base pairs in the following reactions:
(i) $NH_4^+ + OH^- \rightleftharpoons NH_3 + H_2O$
(ii) $H_3O^+ + Cl^- \rightleftharpoons HCl + H_2O$ [2x4 marks]

(d) Calculate the percentage by mass of the indicated element in the compounds listed below:
(i) Br in $MgBr_2$. [2 marks]
(ii) Ca in Ca_3N_2. [2 marks]

END OF PAPER

PERIODIC TABLE OF ELEMENTS



*Lanthanides	Ce 140.1	Pr 140.9	Nd 144.2	Pm (145)	Sm 150.4	Eu 152.0	Gd 157.3	Tb 158.9	Dy 162.5	Ho 164.9	Er 167.3	Tm 168.9	Yb 173.0	Lu 175.0
**Actinides	Th 232.0	Pa (231)	U 238.0	Np (237)	Pu (244)	Am (243)	Cm (247)	Bk (247)	Cf (251)	Es (252)	Fm (257)	Md (258)	No (259)	Lr (260)