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 ^{12}C atom.

Particle	Actual mass / kg
electron	9.1×10^{-31}
neutron	1.6×10^{-27}
proton	1.7×10^{-27}

[3 marks]

(b) Element W has 40 electrons and 41 neutrons
(i) Find the atomic number of W [2 marks]
(ii) Find the mass number of W [2 marks]
(iii) Give the complete symbol of W [2 marks]

(c) Naturally occurring chlorine consists of two isotopes ^{35}Cl, ^{37}Cl and with relative abundances of 75% and 25% respectively. Calculate the relative atomic mass of chlorine. [3 marks]

(d) Write dot and cross diagrams for the following species
(i) PH_3 [2 marks]
(ii) NaCl [2 marks]
(iii) HBr [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) Weak base [2 marks]
(ii) Strong acid [2 marks]

(b) Identify and indicate the reducing and oxidizing agent in each of the following reactions
(i) $Ca + Br_2 \longrightarrow CaBr_2$ [2 marks]
(ii) $2H_2 + O_2 \longrightarrow 2H_2O$ [2 marks]

(c) Calculate pH for each of the following:

(i) 0.02 M H_2SO_4 [3 marks]

(ii) 0.02 M NaOH [3 marks]

(iii) 0.02 M $Ca(OH)_2$ [3 marks]

(iv) 0.02 M HNO_3 [3 marks]

3 (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.

- Electron (e^-)
- Hydride ion ($^1H^-$)
- Hydrogen atoms (H) [6 marks]

(c) Define the following terms:

(i) Isotopes [2 marks]

(ii) pH [2 marks]

(iii) Lewis base [2 marks]

(iv) Mass number [2 marks]

4 (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 chlorides 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, P_4O_6 and P_4O_{10}. [6 marks]

SECTION B: ANSWER ANY TWO QUESTIONS FROM THIS SECTION.

5. (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 propanoic acid (CH_3CH_2COOH) in a non-aqueous solvent like pentane, a value of 148 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) $Cl^- + H_3O^+ \rightleftharpoons H_2O + HCl$ [2x4 marks]

(d) Calculate the percentage by mass of the named element in the compounds listed below:
(i) Ca in CaI_2. [2 marks]
(ii) Al in Al_2O_3. [2 marks]

6. (a) (i) Write complete equations representing the first and second ionization energies of calcium, (Ca). [4 marks]
(ii) Give the electron configuration of the ion resulting from the first ionization energy of Ca. [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]
(iii) The difference between the 1st ionization energies of Na and K. [2 marks]

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

(b) Use the VSEPR theory to predict the shapes and bond angles in the following molecules:
(i) BeH_2 [2 marks]
(ii) BH_3 [2 marks]
(iii) H_2O [2 marks]
(iv) CH_4 [2 marks]

END OF PAPER

15 Periodic Table

Group												13	14	15	16	17	18
1	2																
											1 H hydrogen 1.0						2 He helium 4.0
3 Li lithium 6.9	4 Be beryllium 9.0											5 B boron 10.8	6 C carbon 12.0	7 N nitrogen 14.0	8 O oxygen 16.0	9 F fluorine 19.0	10 Ne neon 20.2
11 Na sodium 23.0	12 Mg magnesium 24.3	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27.0	14 Si silicon 28.1	15 P phosphorus 31.0	16 S sulfur 32.1	17 Cl chlorine 35.5	18 Ar argon 39.9
19 K potassium 39.1	20 Ca calcium 40.1	21 Sc scandium 45.0	22 Ti titanium 47.9	23 V vanadium 50.9	24 Cr chromium 52.0	25 Mn manganese 54.9	26 Fe iron 55.8	27 Co cobalt 58.9	28 Ni nickel 58.7	29 Cu copper 63.5	30 Zn zinc 65.4	31 Ga gallium 69.7	32 Ge germanium 72.6	33 As arsenic 74.9	34 Se selenium 79.0	35 Br bromine 79.9	36 Kr krypton 83.8
37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium –	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 116.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3
55 Cs caesium 132.9	56 Ba barium 137.3	57–71 lanthanoids	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1	79 Au gold 197.0	80 Hg mercury 200.6	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 209.0	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cr copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key: atomic number / atomic symbol / name / relative atomic mass

lanthanoids	57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.4	61 Pm promethium –	62 Sm samarium 150.4	63 Eu europium 152.0	64 Gd gadolinium 157.3	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.1	71 Lu lutetium 175.0
actinoids	89 Ac actinium –	90 Th thorium 232.0	91 Pa protactinium 231.0	92 U uranium 238.0	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –