

THE COPPERBELT UNIVERSITY
SCHOOL OF NATURAL RESOURCES

2010 DEFFERED EXAMINATIONS

CH110/FO 130 - CHEMISTRY 1

3 HOURS

INSTRUCTIONS TO CANDIDATES:

1. This paper has **SEVEN** questions.
2. Answer any **five** questions.
4. All answers must be written in **ink**. **Do not** use **red** or **green** ink. Pencil can only be used for diagrams.
5. All questions carry equal marks. Marks allocated for each sub-question are indicated in the brackets, [].

QUESTION ONE

- A. Define and explain the difference between a law and a theory (2 marks)
- B. Many atomic dimensions are expressed in angstroms. What is the angstrom equal to in terms of the SI units' nanometer (nm) and picometer (pm)? (2 marks)
- C. What is the difference between homogeneous and heterogeneous matter (2 marks)
- D. The element magnesium has three stable isotopes with the following masses and abundances:

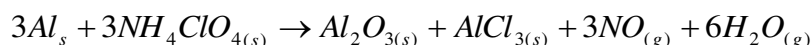
<i>Isotope</i>	<i>Mass (amu)</i>	<i>Abundance</i>
^{24}Mg	23.9850	78.99%
^{25}Mg	24.9858	10.00%
^{26}Mg	25.9826	11.01%

Calculate the relative atomic mass of magnesium (2 marks)

- E. Calculate the energy required to excite the Na electron from level $n = 1$ to $n = 2$. Calculate the frequency of light absorbed by Na atom in its ground state to reach this excited state. $h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$. (4 marks)
- F. A compound contains only Nitrogen and Oxygen and is 69.6% O by mass, the molar mass of the compound is 92 g/mol. Determine the empirical formula and molecular formula of the compound (4 marks)
- G. State the postulates of Dalton's atomic theory (4 marks)

QUESTION TWO

- A. State the uncertainty principle and name the prominent scientist associated with it (2 marks)
- B. A solution of NaOH is analyzed by titration using a standard HCl solution of 0.5M concentration and phenolphthalein indicator. A 10 ml sample of the alkali required an average of 8 mls of the standard acid. Calculate the molarity of the NaOH. (2 marks)
- C. Ascorbic Acid or vitamin C has the formula $\text{C}_6\text{H}_8\text{O}_6$. What is the molar mass of Ascorbic Acid? If a tablet contains 200 mg of vitamin C how many moles and how many molecules of vitamin C does it contain? (4 marks)
- D. The reusable booster rocket of the US space shuttle employs a mixture of aluminium and ammonium perchlorate for fuel. A possible equation for the reaction is as follows:



What mass of NH_4ClO_4 should be used in the fuel mixture for 1.0Kg of Al (2 marks).

- E. List the four quantum numbers and explain what each identifies and what values each may assume (10 marks)

QUESTION THREE

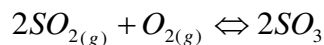
- A. A mixture of 0.770 g of $N_2O_{(g)}$ and 0.770 g of $N_{2(g)}$ exerts a pressure of 0.500 atm. What is the partial pressure of each gas? (2 marks)
- B. List the postulates of the kinetic theory of gases (4 marks)
- C. Assign the oxidation state for chlorine in the following anions OCl^- and ClO_4^- (2 marks)
- D. Balance the following equation occurring in acidic media (4 marks)
- $$S_2O_3^{2-} + IO_3^- + Cl^- \rightarrow SO_4^{2-} + ICl_2^-$$
- E. Balance the following equation occurring in alkaline solution (4 marks)
- $$SbH_3 + H_2O \rightarrow Sb(OH)_4^- + H_2$$
- F. Define the terms oxidation and reduction by the electronic concept (2 marks)
- G. Write the balanced ionic equation for the reaction that occur between ZnS and HCl (2 marks)

QUESTION FOUR

- A. Distinguish between crystalline and amorphous solids (2 marks)
- B. Distinguish between the four main classes of crystalline solids (4 marks)
- C. List the four main types of unit cells found in solids (2 marks)
- D. Atmospheric pressure at the top of Nkombwa hill is approximately 480 mmHg. Convert this value to atmospheres and to Pascal's (2 marks)
- E. Oxygen gas is commonly sold in 49.0 L steel containers at a pressure of 150 atm. What volume in liters would the gas occupy at a pressure of 1.02 atm if the temperature remained unchanged? If the temperature was raised from 20.0 °C to 35.0 °C at constant P = 130 atm (5 marks)
- F. What are the basic assumptions of the kinetic – molecular theory (5 marks)

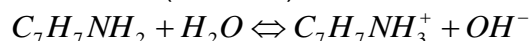
QUESTION FIVE

- A. For the equilibrium
- $$CH_3OH_{(g)} \rightleftharpoons CO_{(g)} + 2H_{2(g)}$$
- at 275°C, K_p is $1.14 \times 10^3 \text{ atm}^2$ calculate the value of K and determine the values of K and K_p for the reverse reaction at 275°C (6 marks)
- B. A mixture of 0.0080 mol $SO_{2(g)}$ and 0.0056 mol of $O_{2(g)}$ is placed in a one-liter container at 1000 K. When equilibrium is established, 0.0040 mol $SO_{3(g)}$ is present:



What are the equilibrium concentrations of $SO_{2(g)}$ and $O_{2(g)}$ and determine the value of K for the equilibrium at 1000 K (6 marks)

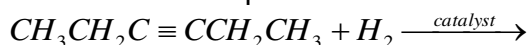
- C. In a 0.25 M solution of benzyl amine, $C_7H_7NH_2$ the concentration of OH^- is $2.4 \times 10^{-3}M$. What is the ionization constant for this weak base, the reaction is (3 marks) :



- D. What are the limitations of the Bronstead-Lowry concept (2 marks)
E. Calculate the pH of a buffered solution containing 0.25 M acetic acid and 0.10 M sodium acetate (3 marks)

QUESTION SIX

- A. Draw and name the structural isomers of Heptane (9 marks)
B. Draw and name the products of the following reaction (4 marks)



- C. Name the following compound (2 marks)
 $CH_3CH_2C \equiv CCH_2CH_2CH = CHCH(CH_3)CH_3$
D. Draw and name the products of the following reaction (3 marks)
 $\text{Benzene} + HNO_3 \xrightarrow{H_2SO_4}$
E. Draw the structure of cis-2,3-Dichloro-2-pentene (2 marks)

QUESTION SEVEN

- A. A common laboratory reagent is 1.0 M NaOH. Calculate the $[H^+]$, $[OH^-]$, pH and the pOH of this solution (8 marks)
B. Calculate the $[H^+]$ and the pH of these solutions (8 marks)
(i) $[OH^-] = 4.5 \times 10^{-6}$
(ii) $[OH^-] = 7.3 \times 10^{-4}$
C. Calculate the pH and the pOH of these solutions (4 marks)
(i) 0.0025 M NaOH
(ii) 0.10 M HClO ($K_a = 3.5 \times 10^{-8}$)

END OF EXAMINATION

The Periodic Table

Group									
I	II							<div><div>¹₁H</div>Hydrogen</div>	
<div><div>⁷₃Li</div>Lithium</div>	<div><div>⁹₄Be</div>Beryllium</div>								
<div><div>²³₁₁Na</div>Sodium</div>	<div><div>²⁴₁₂Mg</div>Magnesium</div>								
<div><div>³⁹₁₉K</div>Potassium</div>	<div><div>⁴⁰₂₀Ca</div>Calcium</div>	<div><div>⁴⁵₂₁Sc</div>Scandium</div>	<div><div>⁴⁸₂₂Ti</div>Titanium</div>	<div><div>⁵¹₂₃V</div>Vanadium</div>	<div><div>⁵²₂₄Cr</div>Chromium</div>	<div><div>⁵⁵₂₅Mn</div>Manganese</div>	<div><div>⁵⁶₂₆Fe</div>Iron</div>	<div><div>⁵⁹₂₇Co</div>Cobalt</div>	
<div><div>⁸⁵₃₇Rb</div>Rubidium</div>	<div><div>⁸⁸₃₈Sr</div>Strontium</div>	<div><div>⁸⁹₃₉Y</div>Yttrium</div>	<div><div>⁹¹₄₀Zr</div>Zirconium</div>	<div><div>⁹³₄₁Nb</div>Niobium</div>	<div><div>⁹⁶₄₂Mo</div>Molybdenum</div>	<div><div>⁹⁹₄₃Tc</div>Technetium</div>	<div><div>¹⁰¹₄₄Ru</div>Ruthenium</div>	<div><div>¹⁰³₄₅Rh</div>Rhodium</div>	
<div><div>¹³³₅₅Cs</div>Caesium</div>	<div><div>¹³⁷₅₆Ba</div>Barium</div>	<div><div>¹³⁹₅₇La</div>Lanthanum</div>	<div><div>¹⁷⁸₇₂Hf</div>Hafnium</div>	<div><div>¹⁸¹₇₃Ta</div>Tantalum</div>	<div><div>¹⁸⁴₇₄W</div>Tungsten</div>	<div><div>¹⁸⁶₇₅Re</div>Rhenium</div>	<div><div>¹⁹⁰₇₆Os</div>Osmium</div>	<div><div>¹⁹²₇₇Ir</div>Iridium</div>	
<div><div>²²³₈₇Fr</div>Francium</div>	<div><div>²²⁶₈₈Ra</div>Radium</div>	<div><div>²²⁷₈₉Ac</div>Actinium</div>							
			Lanthanides	<div><div>¹⁴⁰₅₈Ce</div>Cerium</div>	<div><div>¹⁴¹₅₉Pr</div>Praseodymium</div>	<div><div>¹⁴⁴₆₀Nd</div>Neodymium</div>	<div><div>¹⁴⁷₆₁Pm</div>Promethium</div>	<div><div>¹⁵⁰₆₂Sm</div>Samarium</div>	
			Actinides	<div><div>²³²₉₀Th</div>Thorium</div>	<div><div>²³¹₉₁Pa</div>Protactinium</div>	<div><div>²³⁸₉₂U</div>Uranium</div>	<div><div>²³⁷₉₃Np</div>Neptunium</div>	<div><div>²⁴⁴₉₄Pu</div>Plutonium</div>	

Planck's constant, $h = 6.62 \times 10^{-34} \text{ J.s.}$

Speed of light, $c = 2.97 \times 10^8 \text{ ms}^{-1}.$

Avogadro's constant, $N_A = 6.02 \times 10^{23}.$

Raydberg constant, $R = 1.096776 \times 10^7 \text{ m}^{-1}.$

Electron charge, $e = (-) 1.602192 \times 10^{-19} \text{ C.}$

Faraday constant, $F = 9.64867 \times 10^4 \text{ C.}$

Universal gas constant, $R = 8.314 \text{ JK}^{-1} \text{ mole}^{-1}.$

1 atm. = 760mmHg = $1.0132 \times 10^5 \text{ Nm}^{-2} = 1.0132 \times 10^5 \text{ Pa}$

Mass of an electron = $m_e = 9.10955 \times 10^{-28} \text{ g}$

Of the Elements.

Group.								
							III	IV
							V	VI
							VII	O
							$\begin{matrix} 4 \\ 2 \end{matrix}$ He Helium	
			$\begin{matrix} 11 \\ 5 \end{matrix}$ B Boron	$\begin{matrix} 12 \\ 6 \end{matrix}$ C Carbon	$\begin{matrix} 14 \\ 7 \end{matrix}$ N Nitrogen	$\begin{matrix} 16 \\ 8 \end{matrix}$ O Oxygen	$\begin{matrix} 19 \\ 9 \end{matrix}$ F Fluorine	$\begin{matrix} 20 \\ 10 \end{matrix}$ Ne Neon
			$\begin{matrix} 27 \\ 13 \end{matrix}$ Al Aluminium	$\begin{matrix} 28 \\ 14 \end{matrix}$ Si Silicon	$\begin{matrix} 31 \\ 15 \end{matrix}$ P Phosphorus	$\begin{matrix} 32 \\ 16 \end{matrix}$ S Sulphur	$\begin{matrix} 35.5 \\ 17 \end{matrix}$ Cl Chlorine	$\begin{matrix} 40 \\ 18 \end{matrix}$ Ar Argon
$\begin{matrix} 59 \\ 28 \end{matrix}$ Ni Nickel	$\begin{matrix} 64 \\ 29 \end{matrix}$ Cu Copper	$\begin{matrix} 65 \\ 30 \end{matrix}$ Zn Zinc	$\begin{matrix} 70 \\ 31 \end{matrix}$ Ga Gallium	$\begin{matrix} 73 \\ 32 \end{matrix}$ Ge Germanium	$\begin{matrix} 75 \\ 33 \end{matrix}$ As Arsenic	$\begin{matrix} 79 \\ 34 \end{matrix}$ Se Selenium	$\begin{matrix} 80 \\ 35 \end{matrix}$ Br Bromine	$\begin{matrix} 84 \\ 36 \end{matrix}$ Kr Krypton
$\begin{matrix} 106 \\ 46 \end{matrix}$ Pd Palladium	$\begin{matrix} 108 \\ 47 \end{matrix}$ Ag Silver	$\begin{matrix} 112 \\ 48 \end{matrix}$ Cd Cadmium	$\begin{matrix} 115 \\ 49 \end{matrix}$ In Indium	$\begin{matrix} 119 \\ 50 \end{matrix}$ Sn Tin	$\begin{matrix} 122 \\ 51 \end{matrix}$ Sb Antimony	$\begin{matrix} 128 \\ 52 \end{matrix}$ Te Tellurium	$\begin{matrix} 127 \\ 53 \end{matrix}$ I Iodine	$\begin{matrix} 131 \\ 54 \end{matrix}$ Xe Xenon
$\begin{matrix} 195 \\ 78 \end{matrix}$ Pt Platinum	$\begin{matrix} 197 \\ 79 \end{matrix}$ Au Gold	$\begin{matrix} 201 \\ 80 \end{matrix}$ Hg Mercury	$\begin{matrix} 204 \\ 81 \end{matrix}$ Tl Thallium	$\begin{matrix} 207 \\ 82 \end{matrix}$ Pb Lead	$\begin{matrix} 209 \\ 83 \end{matrix}$ Bi Bismuth	$\begin{matrix} 210 \\ 84 \end{matrix}$ Po Polonium	$\begin{matrix} 210 \\ 85 \end{matrix}$ At Astatine	$\begin{matrix} 222 \\ 86 \end{matrix}$ Rn Radon
Key →								$\begin{matrix} X \\ Y \end{matrix}$ A Name
$\begin{matrix} 152 \\ 63 \end{matrix}$ Eu Europium	$\begin{matrix} 157 \\ 64 \end{matrix}$ Gd Gadolinium	$\begin{matrix} 159 \\ 65 \end{matrix}$ Tb Terbium	$\begin{matrix} 162.5 \\ 65 \end{matrix}$ Dy Dysprosium	$\begin{matrix} 165 \\ 67 \end{matrix}$ Ho Holmium	$\begin{matrix} 167 \\ 68 \end{matrix}$ Er Erbium	$\begin{matrix} 169 \\ 69 \end{matrix}$ Tm Thulium	$\begin{matrix} 173 \\ 70 \end{matrix}$ Yb Ytterbium	$\begin{matrix} 175 \\ 71 \end{matrix}$ Lu Lutetium
$\begin{matrix} 243 \\ 95 \end{matrix}$ Am Americium	$\begin{matrix} 247 \\ 96 \end{matrix}$ Cm Curium	$\begin{matrix} 247 \\ 97 \end{matrix}$ Bk Berkelium	$\begin{matrix} 251 \\ 98 \end{matrix}$ Cf Californium	$\begin{matrix} 254 \\ 99 \end{matrix}$ Es Einsteinium	$\begin{matrix} 257 \\ 100 \end{matrix}$ Fm Fermium	$\begin{matrix} 256 \\ 101 \end{matrix}$ Md Mendelevium	$\begin{matrix} 254 \\ 102 \end{matrix}$ No Nobelium	$\begin{matrix} 257 \\ 103 \end{matrix}$ Lr Lawrencium

Key:

X = Relative Atomic Mass.

Y = Proton (Atomic) number.

A = Atomic Symbol.



= Shaded box shows non metal.



= Unshaded box shows metal.

1 mole of any gas at room temperature and pressure (r.t.p.) occupies 24 000cm³.

1 mole of any gas at standard temperature and pressure (s.t.p.) occupies 22 400cm³.