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:

Isotope	*Mass (amu)*	*Abundance*
^{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 X 10^{-34}J.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 $C_6H_8O_6$. 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 per chlorate for fuel. A possible equation for the reaction is as follows:

$$3Al_s + 3NH_4ClO_{4(s)} \rightarrow Al_2O_{3(s)} + AlCl_{3(s)} + 3NO_{(g)} + 6H_2O_{(g)}$$

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 ^oC to 35.0 ^oC 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

$$CH_3OH_{(g)} \Leftrightarrow CO_{(g)} + 2H_{2(g)}$$

at 275^oC, K_p is 1.14 X 10^3 atm^2 calculate the value of K and determine the values of K and Kp for the reverse reaction at 275^oC (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:

$2SO_{2(g)} + O_{2(g)} \Leftrightarrow 2SO_3$

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 X 10^{-3}M. What is the ionization constant for this weak base, the reaction is (3 marks) :

$C_7H_7NH_2 + H_2O \Leftrightarrow C_7H_7NH_3^+ + OH^-$

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)

$CH_3CH_2C \equiv CCH_2CH_3 + H_2 \xrightarrow{catalyst}$

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)

$Benzene + HNO_3 \xrightarrow{H_2SO_4}$

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 X 10^{-6}

(ii) [OH^-] = 7.3 X 10^{-4}

C. Calculate the pH and the pOH of these solutions (4 marks)

(i) 0.0025 M NaOH

(ii) 0.10 M HClO (Ka = 3.5 X 10^{-8})

END OF EXAMINATION

The Periodic Table

Group								
I	II							
								$^{1}_{1}$H Hydrogen
$^{7}_{3}$Li Lithium	$^{9}_{4}$Be Beryllium							
$^{23}_{11}$Na Sodium	$^{24}_{12}$Mg Magnesium							
$^{39}_{19}$K Potassium	$^{40}_{20}$Ca Calcium	$^{45}_{21}$Sc Scandium	$^{48}_{22}$Ti Titanium	$^{51}_{23}$V Vanadium	$^{52}_{24}$Cr Chromium	$^{55}_{25}$Mn Manganese	$^{56}_{26}$Fe Iron	$^{59}_{27}$Co Cobalt
$^{85}_{37}$Rb Rubidium	$^{88}_{38}$Sr Strontium	$^{89}_{39}$Y Yttrium	$^{91}_{40}$Zr Zirconium	$^{93}_{41}$Nb Niobium	$^{96}_{42}$Mo Molybdenum	$^{99}_{43}$Tc Technetium	$^{101}_{44}$Ru Ruthenium	$^{103}_{45}$Rh Rhodium
$^{133}_{55}$Cs Caesium	$^{137}_{56}$Ba Barium	$^{139}_{57}$La Lanthanum	$^{178}_{72}$Hf Hafnium	$^{181}_{73}$Ta Tantalum	$^{184}_{74}$W Tungsten	$^{186}_{75}$Re Rhenium	$^{190}_{76}$Os Osmium	$^{192}_{77}$Ir Iridium
$^{223}_{87}$Fr Francium	$^{226}_{88}$Ra Radium	$^{227}_{89}$Ac Actinium						
			Lanthanides	$^{140}_{58}$Ce Cerium	$^{141}_{59}$Pr Praseodymium	$^{144}_{60}$Nd Neodymium	$^{147}_{61}$Pm Promethium	$^{150}_{62}$Sm Samarium
			Actinides	$^{232}_{90}$Th Thorium	$^{231}_{91}$Pa Protactinium	$^{238}_{92}$U Uranium	$^{237}_{93}$Np Neptunium	$^{244}_{94}$Pu Plutonium

Planck's constant, $h = 6.62 \times 10^{-34}$ J.s.
Speed of light, $c = 2.97 \times 10^{8} ms^{-1}$.
Avogadro's constant, $N_A = 6.02 \times 10^{23}$.
Raydberg constant, $R = 1.096776 \times 10^{7} m^{-1}$.
Electron charge, $e = (-) 1.602192 \times 10^{-19} C$.
Faraday constant, $F = 9.64867 \times 10^{4} C$.
Universal gas constant, $\mathbf{R} = 8.314 JK^{-1}$ $mole^{-1}$.
1 atm. = 760mmHg = $1.0132 \times 10^{5} Nm^{-2}$ = $1.0132 \times 10^{5} Pa$
Mass of an electron = $m_e = 9.10955 \times 10^{-28} g$

Of the Elements.

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

Key:
X = Relative Atomic Mass.
Y = Proton (Atomic) number.
A = Atomic Symbol.

= Shaded box shows none metal.

= Unshaded box shows metal.

1 mole of any gas at room temperature and pressure (r.t.p.) occupies 24 000cm^3.
1 mole of any gas at standard temperature and pressure (s.t.p.) occupies 22 400cm^3.