CHE 1501; JUNE 2016

1 (a) Number of protons= 17 **(1)**

Number of neutrons= 36-17= 19 **(1)**

Number of electrons= 18 (**1)**

(b) Atoms of the same element with different number of neutrons **(2).** They are isotopes because one has 10 neutrons, the other has 11 **(1)**

(c) $Cu(OH)_2$ **(2)**

(d) group 7; halogens **(2)**

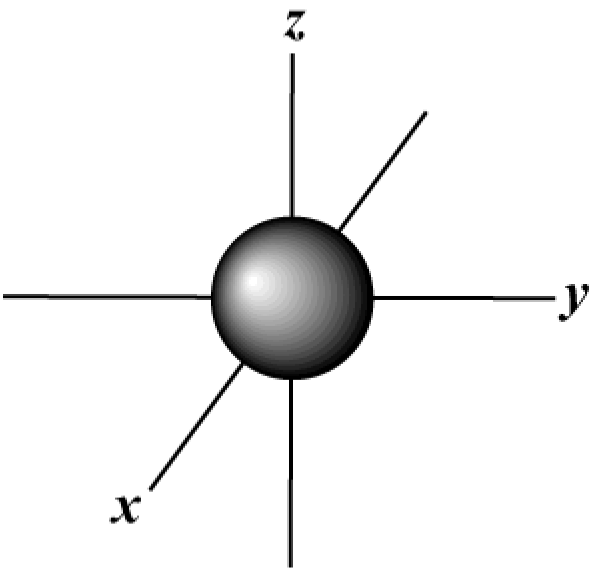
(e) n= 5 **(1)**

l= 4 **(1)**

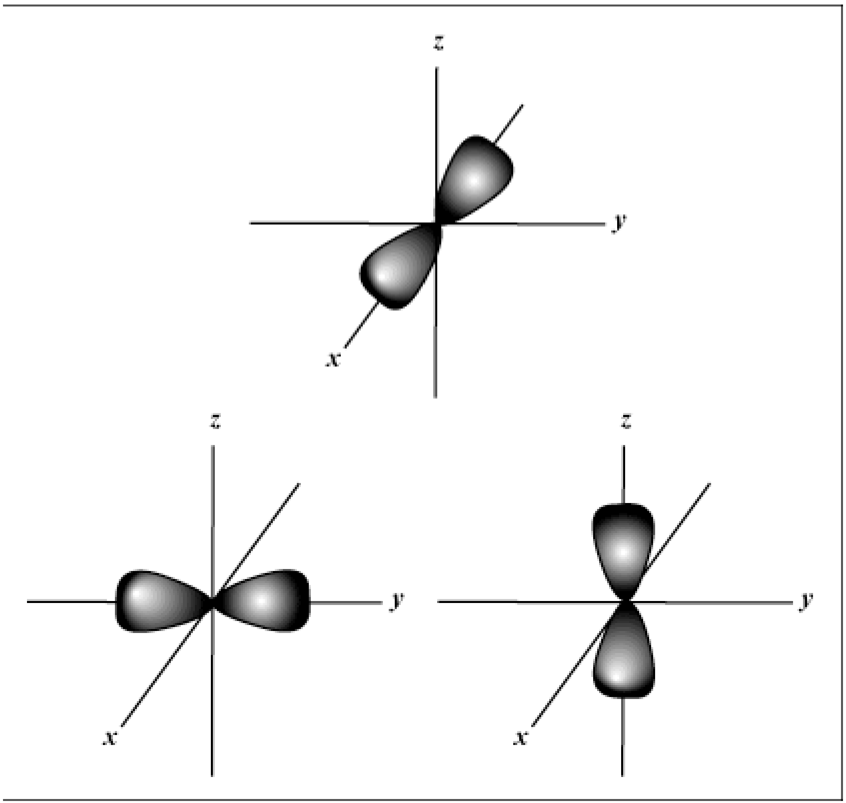
m_l= -4, -3, -2, -1, 0, +1, +2, +3,+4 **(1)**

$m_s = +\frac{1}{2}; \frac{-1}{2}$ **(1)**

(f)

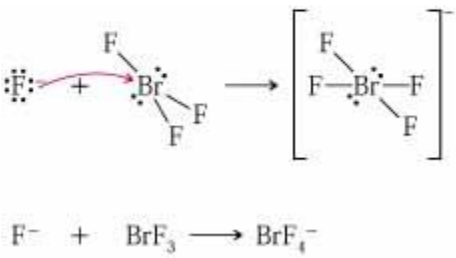


S orbital **(1)**

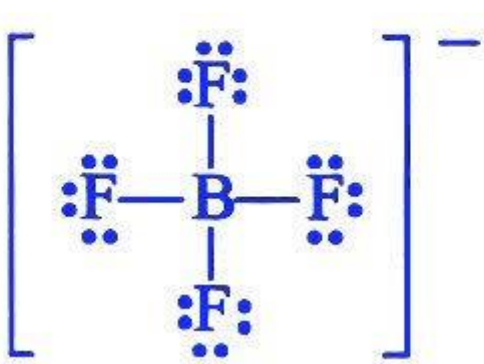


p- orbital **(2)**

(g)



(2)



(2)

BrF_4^- is square planar because the central atom has 2 lone pairs of electrons around it. On the other hand, BF_4^- has only four bond pairs of electrons around it, and no lone pairs, hence the tetrahedral structure. **(2)**

No. of valence electrons in BrF_4^-= 36 **(1)**

No. of valence electrons in BF_4^-= 32 **(1)**

2. NaI- ionic **(1)**

H —— Br- polar covalent **(2)**

Cl-Cl- non polar covalent **(1)**

(b) molecular geometry- AX_3E- trigonal pyramidal , one lone pair **(2)**

(c) Ca - +2 (**1**)

(ii) Ni- +1 (**1**)

(iii) O- -1 **(1)**

(d) reducing agent **(2)**

(e) acid **(2)**

(f) Ti is being reduced; Mg is being oxidized **(2)**

$TiCl_4$ (g) + 2Mg (l) → Ti (l) + $2MgCl_2$ (l) **(3)**

(g) a decomposition reaction in which Ag_2O is being broken down into simpler subtsances **(1)**

3.

	C	H

% by mass	92.3	7.7
No. of moles	92.3/ 12.001 =7.69	7.7/1.008 =7.64
Simplest whole number ratio	1	1

(5)

Empirical formula- CH **(1)**

Molecular formula= n(empirical formula)= 104

= n (13)= 104

N= 8 **(1)**

Molecular formula = C_8H_8 **(1)**

b) % yield= $\frac{\text{experimental yield}}{\text{theoretical yield}}$ **(2)**

(c)

N(KF) = $\frac{116.2}{39.10+19.00}$= 2.24 mol **(2)**

Molarity= $\frac{2.24}{3}$= 0.747 mol/L **(2)**

(d) 3Mg + Fe_2O3 → 3MgO + 2Fe

Mole ratio= 3:1

0.252mol of Fe_2O_3 react with 0.756mol of Mg **(1)**

Fe_2O_3 is the limiting reagent **(1)**

$n(MgO) = 0.756$mol produced

Theoretical mass= $0.756 \times (16.00+24.31) = 30.47$g **(2)**

(c) increasing pressure, decreasing temperature, increasing concentration of nitrogen, and use of a catalysts **(4)**

4**.** (a) the rate of rusting is controlled by the cathodic process of reduction which takes place as follows:

$2H_3O^+ + 2e^- \rightarrow H_2 + 2H_2O$ ………………(1)

$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$…………………………………(2)

$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$……………………(3)

The fast process takes place in the presence of H^+ ions and oxygen **(2)**

At the anode, the following reaction takes place:

$Fe \rightarrow Fe^{2+} + 2e^-$ **(1)**

Net Reaction; $2Fe + 2H_2O + O_2 \rightarrow 2Fe(OH)_2$ **(1)**

In excess oxygen the following reaction takes place

$4Fe(OH)_2 + O_2 \rightarrow 2Fe_2O_3.H_2O + 2H_2O$ **(1)**

Rusting takes place faster in salt solution because it is a good conductor of electricity, and this results in the cathode and anode reactions taking place faster **(2)**

(b) $K = \frac{[C].[D]^3}{[B][A]^2} = \frac{4\,(2)^3}{4.(1)^2} = 8\text{ M}$ **(3)**

(c) $NH_3 + H_2O \rightarrow NH_4^+ + OH^-$ **(2)**

The process facilitates the formation of OH^- ions (2)

(d) Arrhenius theory because it states that a base dissolves in water to increase the concentration of OH^- ions. Whereas, a Bronsted theory simply describes a base as a proton acceptor (2)

(e) $HCO_2H \leftrightarrow H^+ + HCO_2^-$ (1)

$$K_a = \frac{[HCO2-][H+]}{[HCO2H]} \quad (1)$$

$$3.5\times 10^{-8} = \frac{[HCO2-][H+]}{0.0025} \quad (1)$$

At equilibrium $[HCO_2^-] = [H^+]$ (1)

$$3.5\times 10^{-8} = \frac{[H+]^2}{0.0025} \quad (1)$$

$[H^+] = 9.35\times 10^{-6}$ (1)

pH= $-\log(9.35\times 10^{-6})$ (1)

= 5.03 (1)

Tank X= 6 mol CH_4, 1 mol O_2, and 3 mol SO_2

Tank Y= 1 mol CH_4, 3 mol O_2, 4mol SO_2

Tank Z= 4 mol CH_4, 2mol O_2,

(i) Tank 2 has the least number of moles of gas, hence it has the highest pressure (2)

(ii) $P_x(SO_2) = \frac{3}{11} = 0.27$; $P_y(SO_2) = \frac{4}{8} = 0.5$; $P_z(SO_2) = \frac{1}{7} = 0.14$ Tank Y has the highest partial pressure of SO_2 **(2)**

(iii)

	CH_4 mass	O_2 mass	SO_2 mass
X	112	32	192
Y	16	96	256
Z	64	64	64

Tank Z **(3)**

(iv) Tank X= 336; Tank Y= 368; Tank Z= 192 therefore Tank Y **(3)**