1

A) What do the following have in common and briefly explain why? O^{2-}, Ne, Mg^{2+}

They all have the same electronic configuration.
O and Mg have different electronic configurations than Ne when they are not ions. O (Z=8) $1s^2\ 2s^2 2p^4$ but the anion O^{-2} has two more electrons so its electronic configurations is O^{-2} (Z=8) $1s^2\ 2s^2 2p^6$. Ne (Z=10) $1s^2\ 2s^2 2p^6$. And Mg (Z=12) $1s^2\ 2s^2 2p^6 3s^2$ but the cation Mg^{+2} (Z=12) $1s^2\ 2s^2 2p^6$ because it has two electrons less than the neutral atom.

B) Briefly explain why atomic radius decreases along a period in the periodic table?

As we move along a period, the atomic number (Z) increases. Due to this, the more protons the element has, the greater the attraction of the nucleus to the peripheral electrons and the smaller the radius.

2

A) Which of the following must be the same before and after a chemical reaction (answer each true or false)?

I. The sum of the masses of all substances involved. True
II. The number of molecules of all substances involved. False
III. The number of atoms of each type involved. True

B) Silver nitrate and sodium sulphide solutions are mixed, and a black precipitate forms. Write a balanced equation for the reaction.

$2AgNO_3 + Na_2S \rightarrow Ag_2S + 2NaNO_3$

C) You have 252 g of magnesium sulphate. How many moles is that?

$$252g\ MgSO4 \frac{1\ moles\ MgSO4}{120{,}4g\ MgSO4} = \mathbf{2{,}1\ moles\ MgSO4}$$

3

A) What is the formula for

a. calcium carbonate: **$CaCO_3$**
b. iron(II) carbonate: **$FeCO_3$**
c. iron(III) sulphate: **$Fe_2(SO_4)_3$**
d. ammonium phosphate: **$(NH_4)_3PO_4$**
e. aluminium nitrate: **$Al(NO_3)_3$**
f. Potassium dihydrogen phosphate: **KH_2PO_4**

B) How much sulphuric acid (0.102 M) is required to completely neutralise 15.08 mL of 0.098 M sodium hydroxide solution?

H_2SO_4 0.102M
NaOH 0.01508 L 0.098M

M= n (moles)/v(Litre) → n(moles)= M (moles/litre) * v (litre)
nNaOH= 0.01508L *0.098M= $1.478x10^{-3}$ moles NaOH

We need the same number of H_2SO_4 moles to completely neutralise the NaOH solution.

M=n (moles)/v(Litre) → v(Litre)= n(moles)/ M (moles/litre)
V (litres) H_2SO_4= $1.478x10^{-3}$ moles / 0.102 M = **0.0145 L H_2SO_4**

4

A) The formula for acetone is C_3H_6O. How many grams of acetone contain 6.4 g of oxygen?

$$6.4\text{g O} \times \frac{1\ mole\ O}{16\ g\ O} = 0.4\ moles\ O$$

If the formula for acetone is C_3H_6O, this means that in 1 mole of C_3H_6O, there is 1 mole of oxygen, 6 moles of H and 3 moles of C.

$$0.4\ moles\ O \times \frac{6\text{ moles H}}{1\text{ mole O}} = 2.4\text{ moles H} \qquad 2.4\ moles\ H \times \frac{1g\ H}{1\ mole\ H} = 2.4\ g\ H$$

$$0.4\ moles\ O \times \frac{3\text{ moles C}}{1\text{ mole O}} = 1.2\text{ moles C} \qquad 1.2\ moles\ C \times \frac{12\text{ g C}}{1\text{ mole O}} = 14.4\text{ g C}$$

Total grams of acetone = 6.4g O + 2.4g H + 14.4 g C= **32g C_3H_6O**

B) How many moles of each atom are in 3.20 moles of calcium carbonate?
The formula for calcium carbonate is $CaCO_3$, so in 1 mole of $CaCO_3$, there is 1 mole of Ca, 1 mole of C and 3 moles of O.

$$3.2\ moles\ \text{CaCO3} \times \frac{1\text{ mole C}}{1\text{ mole CaCO3}} = \mathbf{3.2\ moles\ C}$$

$$3.2\ moles\ \text{CaCO3} \times \frac{1\text{ mole Ca}}{1\text{ mole CaCO3}} = \mathbf{3.2\ moles\ Ca}$$

$$3{,}2\ moles\ \text{CaCO3} \times \frac{3\text{ moles O}}{1\text{ mole CaCO3}} = \mathbf{9.6\ moles\ Ca}$$

5

A) Convert these temperatures to SI units:

26°F = **269,817 K**

24°C = **297 K**

B) Convert the following measurements into mL.

I. 0.75 liters = **750 mL**
II. 3.2 x 10^4 µL = **32 mL**
III. 0.5 m^3 = **500000 mL**

6

A) 3 x (4 x 5^2) ÷ 6 + 7 – 8 = **49**

B) 4(2a + p) = c + p + a. Express a in terms of c and p

1. 8a+4p=c+p+a
2. 8a-a=c+p-4p
3. 7a=c-3p
4. $\mathbf{a = \frac{c-3p}{7}}$

7

A) Give the electron designations for the following species

I. Cl atom. Cl (z=17) $1s^2\ 2s^2 2p^6 3s^2\ 3p^5$. $3p^5$: n=3; l=1; m=0; s= ½, -1/2
II. S^{2-} ion. S^{2-} (Z=16) $1s^2\ 2s^2 2p^6 3s^2\ 3p^6$. $3p^6$: n=3; l=1; m= 1; s=½, -1/2
III. Ca atom. Ca (Z=20) $1s^2\ 2s^2 2p^6 3s^2\ 3p^6\ 4s^2$. $4s^2$:n=4; l=0; m=0; s=½, -1/2

C) According to VSEPR, what shape would you expect the following to have?

Carbon Dioxide (CO_2): there are 4 places on the central atom in CO_2, which is carbon. The atom form 2 double bonds with each oxygen and there aren't any lone pairs (AX_2) Repulsion between electrons is minimized when the oxygens form a 180º angle. O=C=O. This means that the molecular geometry is **linear.**

Ammonia: there are 5 places on the central atom in NH_3, which is nitrogen. The atom forms 3 bonds with the atoms of hydrogen and is left with one lone pair (AX_3E_1) Repulsion between electrons is minimized when the geometry of the molecule is **triagonal pyramidal**.

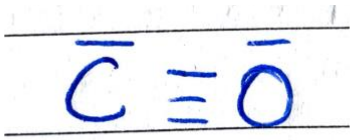
8

A) For electromagnetic radiation with the following wavelengths, calculate the frequency and energy of each

Using C=λ*v → v=$\frac{c}{\lambda}$ and E= h*v

I. 750 nm = 7,5x10^{-7}m. v=$\frac{3.0x10^8\ m/sec}{7.5x10^{-7}m} = \mathbf{4x10^{14}Hertz}$
E=6.6262x10^{-34}* 4x10^{14}= **2.65x10^{-19} J**
II. 25 micrometers = 2.5x10^{-5}m. v=$\frac{3.0x10^8\ m/sec}{2.5x10-5\ m} = \mathbf{1.2x10^{13}Hertz}$
E=6.6262x10^{-34}*1.2x10^{13}= **7.95x10^{-21}J**
III. 1.5 m v=$\frac{3.0x10^8\ m/sec}{1.5\ m} = \mathbf{2x10^8Hertz}$
IV. E=6.6262x10^{-34}*2x10^8=**1.33x10^{-25} J**

B) Show, using Lewis dot notation, the bonding in carbon monoxide



9

A sample of green crystals of nickel (II) sulphate heptahydrate was heated and produced bluish green nickel (II) sulphate hexahydrate. What are the formulas of the hydrates? If 8.753g of the heptahydrate produces 8.192g of the hexahydrate, how many moles of anhydrous nickel (II) sulphate could be obtained?

Nickel (II) sulphate heptahydrate: $NiSO_47H_2O$
Nickel (II) sulphate hexahydrate: $NiSO_46H_2O$

8.753g $NiSO_47H_2O$-8.192g $NiSO_46H_2O$= 0.561g H_2O

8.753g $NiSO_47H_2O$- (0.561g H_2O*7) = 4.826g $NiSO_4$

4.826g $NiSO_4$ $\frac{1\ mole\ NiSO4}{154.76\ g\ NiSO4} = \mathbf{0.031\ moles\ NiSO4}$

10

A) Calculate the number of grams of magnesium hydroxide which will be dissolved by 5000 L of 6.00 x 10^{-4} M HCl.

M= n (moles)/v(Litre) → n(moles)= M (moles/litre) * v (litre)
n (moles)= 5000L*6.00 x 10^{-4} M= 3 moles HCl

We need the same number of HCl moles as $Mg(OH)_2$
3 moles HCl = 3 moles $Mg(OH)_2$, 3 moles $Mg(OH)_2$ $\frac{58.32\ g\mathrm{Mg(OH)2}}{1\ mole\ \mathrm{Mg(OH)2}} = \mathbf{174.96\ g\ Mg(OH)2}$

B) The equation for the combustion of glucose is:

$C_6H_{12}O_{6(s)} + 6O_{2(g)} \rightarrow 6CO_{2(g)} + 6H_2O_{(l)}$

when 8.0 g of glucose is burned in excess oxygen.

- How many grams of CO_2 are formed?

6g $C_6H_{12}O_6$ $\frac{1\ mole\ \mathrm{C6H12O6}}{180\ g\ \mathrm{C6H12O6}} = 0.04$ moles $C_6H_{12}O_6$
0.04 moles $C_6H_{12}O_6$ $\frac{6\ moles\ CO2}{1\ mole\ \mathrm{C6H12O6}} = 0.267\ moles\ CO2$ $\frac{44g\ CO2}{1\ mole\ CO2} = \mathbf{11.75g\ CO_2}$

- How many moles of water are formed?

6g $C_6H_{12}O_6$ $\frac{1\ mole\ \mathrm{C6H12O6}}{180\ g\ \mathrm{C6H12O6}} = 0.04$ moles $C_6H_{12}O_6$

0.04 moles $C_6H_{12}O_6 \frac{6\ moles\ H2O}{1\ mole\ C6H12O6} = \mathbf{0.267\ moles\ H2O}$