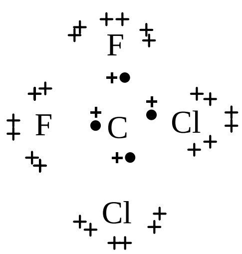
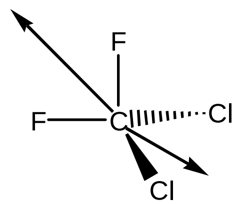
CH1011   Tutorial 2 Answers

1. Draw a Lewis dot structure for the chlorofluorocarbon CF_2Cl_2.
   Would this molecule be polar? - justify your answer.





VSEPR: electronic: tetrahedral, molecular: tetrahedral (FCF < 109.5^o).
Fluorine is more electronegative than Cl so the molecule will be polarised towards the F_2 end of the molecule.

2. Give the electronic configuration for chlorine.

Cl   atomic number = 17   therefore 17 electrons
$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$ or   [Ne] $3s^2\ 3p^5$

3. How does the first ionization energy vary as move down the group 2 elements? Explain the trend.

The ionization energy decreases as we move down the group 2 elements.
The reason is that as we descend a period we are adding electrons to the shell outside the last one that was being filled. The electrons being added are therefore shielded from the nuclear charge by the previously filled shell. The **effective nuclear charge** is therefore reduced as we descend the group. As we go down the period the electrons are to be found further from the nucleus and given that the effective nuclear charge is reduced the energy needed to remove an electron from the atom is reduced.

4. What type of bonding would you expect to find in the compound $Mg(OH)_2$? Justify your answer.

Ionic bonding. Mg is in Group 2A it has a low IE1 and so readily loses 2 electrons to form the 2^+ cation. Hydroxide is an anion with 1^- charge. Charge balance is achieved with Mg^{2+} and 2 x OH^-.

5.   Identify the following materials as either ionic or covalent:

$CH_3C(=O)OH$,	MgO,	NF_3,	LiF
Covalent	ionic	covalent	ionic

6. The first step in the reduction of a nickel sulphide ore (Ni_3S_2) to form nickel metal is roasting in air. Balance the following equation and determine how many kg of nickel oxide (NiO) can be formed from 20.0 kg of Ni_3S_2 and 10 m^3 of compressed air (which contains 5.0 kg of oxygen) upon roasting.

$$Ni_3S_2(s) + O_2(g) \rightarrow NiO + SO_2(g)$$

Balanced $2Ni_3S_2 + 7O_2(g) \rightarrow 6NiO + 4SO_2(g)$

M_{Ni3S2} = (3 x 59) + (2 x 32) = 241 g mol^{-1}
M_{O2} = (2 x 16) = 32 g mol^{-1}
M_{NiO} = 59 + 16 = 75 g mol^{-1}

Actual number of moles
n_{Ni3S2} = 20 000g / 241 g mol^{-1} = 82.99 mol
n_{O2} = 5 000 g / 32 g mol^{-1} = 156.25 mol

Ideal number of moles
$Ni_3S_2 + 7/2O_2(g) \rightarrow 6/2NiO + 4/2SO_2(g)$
n_{O2} = 7/2 x 82.99 mol = 290.46 mol
Limiting reagent is oxygen as 156.25 mol is less than 290.46 mol

$2/7Ni_3S_2 + O_2(g) \rightarrow 6/7NiO + 4/7SO_2(g)$
nNiO = 6/7 x 156.25 mol = 133.93 mol

mNiO = 133.93 mol x 75 g mol^{-1} = 10044 g
= 10 kg (rounded to 2 sig figs based on 5.0kg O_2)

7. When lead nitrate solution { $Pb(NO_3)_2$ } is reacted with sodium iodide solution a precipitate of lead iodide is generated. The reaction goes to completion so this reaction may be used as the basis of a quantitative method for working out the concentration of lead nitrate solutions if a standard sodium iodide solution is available. In such a standardisation experiment 500mL of 0.502M sodium iodide solution was reacted with 70.0mL of lead nitrate to generate 1.256g of lead iodide.

- ▶ Write down the balanced equation.
  - ▶ What is the concentration of the lead nitrate solution in mol/L?
  - ▶ What is the concentration of the lead nitrate solution in ppm (hint: 1ppm = 1mg/L)?
  - ▶ Would all the sodium iodide have reacted? Justify your answer.

$Pb(NO_3)_2 + 2NaI \rightarrow PbI_2 + 2NaNO_3$
Pb 2N 6O 2Na 2I Pb 2I 2Na 2N 6O ✓ Balanced

c = n / V n = m / *M* equations needed

M_{PbI2} = 207 + (2 *127) = 461g mol^{-1}
$M_{Pb}(NO_3)_2$ = 207 + 2*(14 +(3 *16)) = 331g mol^{-1}

n_{PbI2} = m_{PbI2} / M_{PbI2} = 1.256g / 461 g mol^{-1} = 2.72 x 10^{-3}mol

At the end of the reaction: $nPbI_2$ = $nPbNO_3$ = 2.72 x 10^{-3}mol

$c_{Pb(NO3)2}$ = $n_{Pb(NO3)2}$ / $V_{Pb(NO3)2}$ = 2.72 x 10^{-3}mol / 70.0 x 10^{-3} L
= **3.89 x 10^{-2} mol L^{-1}**

$c_{Pb(NO3)2(ppm)}$ = $c_{Pb(NO3)2}$ * $M_{Pb}(NO_3)_2$*10^3
= 3.89 x 10^{-2} mol L^{-1} x 331g mol^{-1} * 10^3
= 12 876ppm
= **12. 9x10^3 ppm**.

Check that NaI is in excess
n_{NaI} = c_{NaI} V_{NaI} = 0.502 x 500x10^{-3} L = **2.51 x 10^{-1}mol** **ie. a large excess**

1 $Pb(NO_3)_2$ + 2 NaI → PbI_2

⇒ 2.72 x 10^{-3}mol + 2 x (2.72 x 10^{-3}mol) → 2.72 x 10^{-3}mol

The number of moles of NaI consumed is 5.44 x10^{-3}mol,
leaving 2.51 x10^{-1}mol - 5.44 x10^{-3}mol = 2.4556 x10^{-1}mol unreacted.