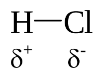
CH1011 Tutorial 2 Answers

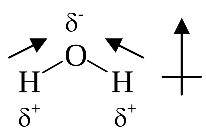
1. What is meant by a "polar covalent bond"? Give an example of a molecule with such a bond (or bonds).

A polar covalent bond is a bond where two (or more) electrons are shared unequally between two atoms, resulting in a partial negative charge on the atom with the higher electronegativity and a partial positive charge for the atom with the lower electronegativity.

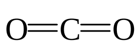


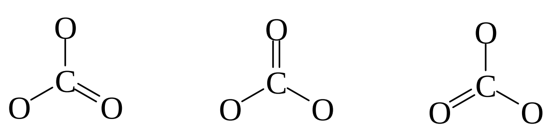
2. Define the term electronegativity. How does the dipole moment in a molecule arise?

Electronegativity is a number which gives a relative measure of the attraction of a bonded atom for the electrons involved in a covalent bond.
A net dipole moment will come about as a result of a non-symmetrical disposition of atoms in a molecule and the differences in electronegativity between the bonded atoms.



3. Give Lewis dot structures for CO_2 and CO_3^{2-}. Predict which of these, if any, would have (a) resonance forms or (b) a dipole moment.

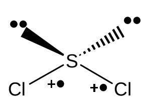


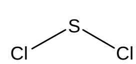


no resonance forms, no dipole resonance forms no dipole

4. Using VSEPR theory, what are the electronic and molecular geometries for SCl_2.

S 6 valence electrons, Cl 7 valence electrons





4 regions tetrahedral bent ClSCl < 109.5°

5. Give the electronic configuration for:
iron

^{26}Fe: $[1s^2 2s^2 2p^6 3s^2 3p^6]4s^2 3d^6$

6. A lead acetate solution { $Pb(CH_3COO)_2$ } is reacted with sodium chloride solution to form a precipitate of lead(II) chloride. A solution of 1068 mL of 244g/L lead acetate is reacted with 500 mL of 0.850 M sodium chloride.

- ▶ Write down the balanced equation.
- ▶ What is the concentration of the lead acetate solution in mol/L?
- ▶ How many kg of lead chloride are formed?

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

Balanced equation: $Pb(CH_3COO)_2 + 2NaCl \rightarrow PbCl_2 + 2CH_3COONa$
Pb 4C 4O 2Na 2Cl Pb 2Cl 4C 2Na 4O ✓ Balanced

M_{PbCl2} = 207.2 + (2 *35.5) = 278.1g mol^{-1}
$M_{Pb(CH3COO)2}$ = 207.2 + 2*((2*12) +(3 *1)+(2*16)) = 325.2g mol^{-1}
M_{NaCl} = 22.9 + 35.45 = 58.35 g mol^{-1}

$n_{Pb(CH3COO)2}$ = $m_{Pb(CH3COO)2}$ / $M_{Pb(CH3COO)2}$ = 244g / 325.2 g mol^{-1} = 0.750 mol $\Rightarrow$ **0.750 mol/L**

Limiting reagent solution.
$n_{Pb(CH3COO)2}$ = 1.068L x 0.750 mol/L = 0.801mol

n_{NaCl} = 0.500L x 0.850mol/L = 0.425mol

1 mol of $Pb(CH_3COO)_2$ requires 2 mol of NaCl. Therefore by inspection NaCl is the limiting reagent (there is clearly much less than 2 x 0.801mol = 1.602mol of NaCl).
Check 0.801/1 > 0.425/2 ✓ Check NaCl is limiting.

Normalise balanced equation based on limiting reactant.
$\frac{1}{2}Pb(CH_3COO)_2 + 1NaCl \rightarrow \frac{1}{2}PbCl_2 + 1CH_3COONa$

$n_{PbCl2} = \frac{1}{2} n_{NaCl}$ = ½ x 0.425mol
= 0.213mol

m_{PbCl2} = n_{PbCl2} x M_{PbCl2} = 0.213mol x 278.1g mol^{-1}
= 59.2g
= **59.2x10^{-3} kg (0.0592kg)**