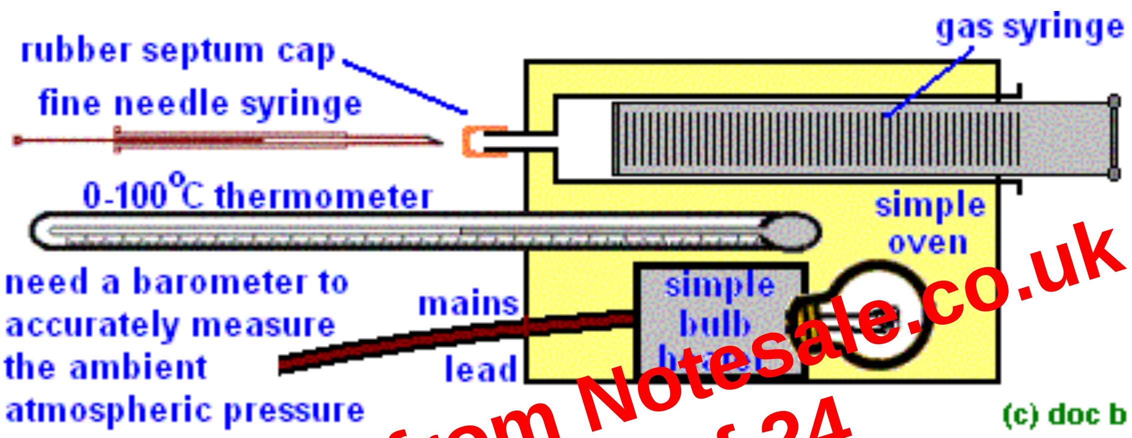
- Avogadro's hypothesis - equal volumes of gases measured at the same volume and pressure contain the same number of molecules.
- Gas molar volume - 22.414dm3 @ s.t.p. (273K, 1atm) & 24.414dm3 @ r.t.p. (293K, 1 atm)
- Boyle's Law* - At a constant temperature, the volume of a fixed mass of gas is inversely proportional to pressure P = 1/V
- P1V1 = P2V2
- Charles' Law - The volume of a fixed mass of a gas at constant pressure is directly proportional to its temperature in Kelvin V = T
- V1/T1 = V2/T2
- A gas which obeys both Boyle's and Charles' Law is said to behave ideally.
- Ideal gas equation: P1V1/T1 = P2V2/T2
- PV = nRT (P in Pa; V in m3; T in K; R = 8.314 J mol / K)
- P = p x RT / RMM

# Finding RMM of volatile liquid using a gas syringe

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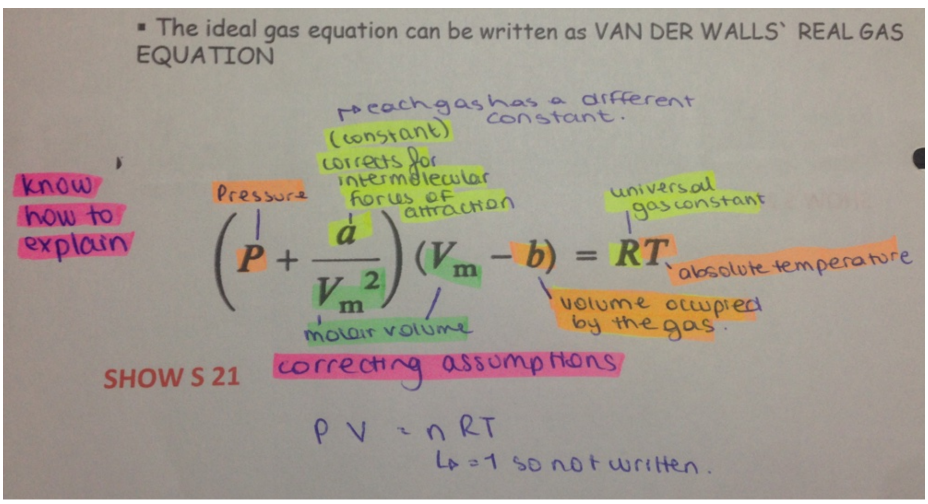
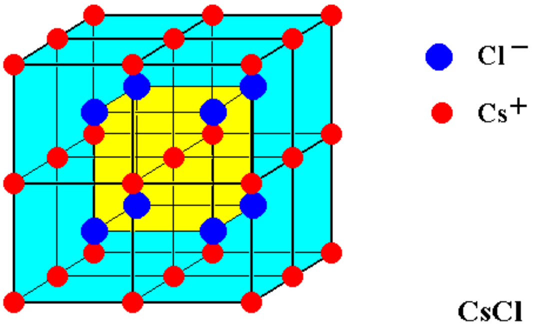
- Gas syringe containing a little air is placed into steam jacket - with heat air expands and volume is noted when a steady reading is obtained.
- Liquid is weighed accurately in syringe & injected into the gas syringe (empty syringe weighed).
- As the liquid vaporises the gas syringe barrel is pushed out and the total volume of air vapour is measured when the reading is steady.
- Temp and atmospheric pressure in the steam jacket are noted.

# Real Gases

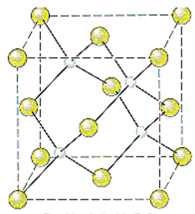
- Ideal gas equation not obeyed at high pressure and low temperature.
- Assumes that mols move randomly, occupy negligible volume, exert no pressure on each other & have elastic collisions (assume that no energy is lost).



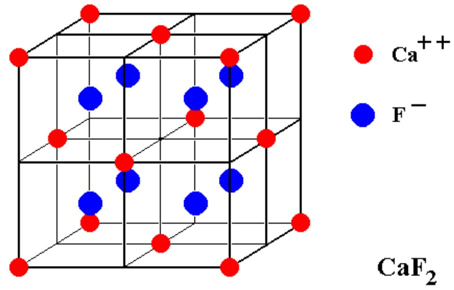
- CsCl - Body Centred Cubic Structure
  - 8:8 coordination
  - Other examples - CsBr, CsCN




- ZnS
  - Anion at the centre of a tetrahedron of cations and vice-versa
  - 4:4 coordination


Zinc blende (cubic ZnS)

- $CaF_2$ - 1:2 structure
  - Similar to CsCl with half of the positive ions missing since F- is very electronegative.
  - Each F- has 4 $Ca^{2+}$ ions tetrahedrally arranged around it.
  - 8:4 coordination




- If cationic radius inc - coordination no inc —> can accommodate more ions around it

# Properties of Ionic compounds

- High melting/boiling point
  - Electrostatic forces between oppositely charged ions are very strong.
  - Large amount of energy must be supplied to make ions vibrate & eventually break off.
  - Also have a high latent heat of vaporisation.

- Brittle
  - Crystals are hard but can be cleaved - split using a very sharp razor edge.
  - Occurs due to a slight shift - similarly charged ions come in contact with each other.
  - Repulsion results which fractures the crystal.
    - In a metal - metallic bond is a cluster of anions surrounded by a delocalised cloud which fills gaps between anions. When you apply force, metal will change shape as electron cloud moves quickly to surround moved anions .: no repulsion occurs & won't break —> malleable.
    - If you bend constantly - will heat up due to constant movie of the e- cloud. Inc in KE - can overcome forces of attraction & break.

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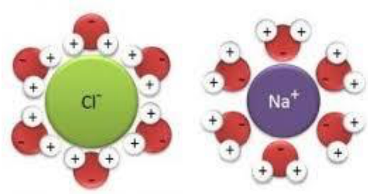
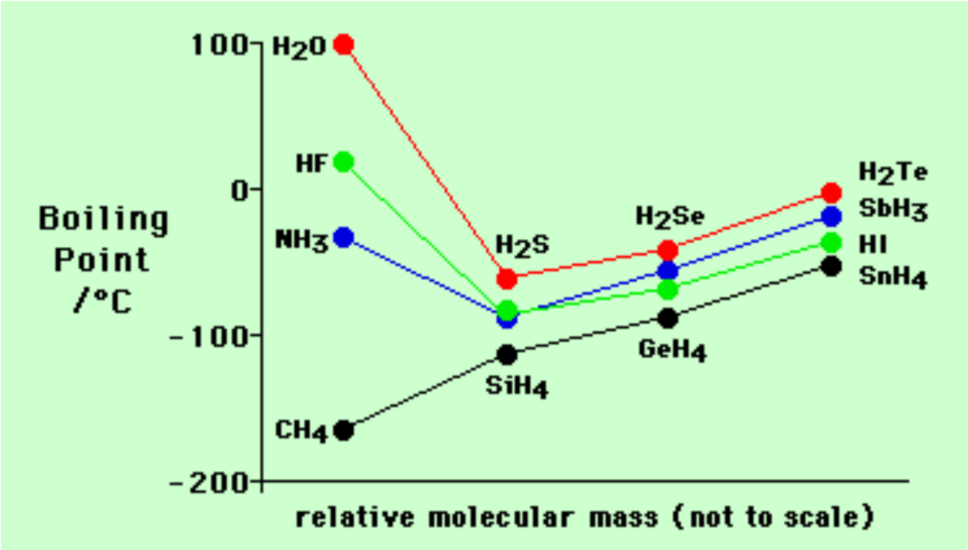
- Conduction of Electricity
  - Only when molten or in solution
  - When solid - ions held together in crystal - unable to move .: no electricity can be conducted.
  - When molten/in solution ions are free to move and an electrical current can pass through.

- Solubility in water
  - When dissolves in water the ionic crystal breaks down, forming separate Na+ and Cl- in solution.
  - Water has an uneven e- distribution - polar molecule. There is a greater $e^-$ conc. near the O atom rather than the H atom.
  - Positive ions are attracted from the negative end of a water mol, and anions are attracted from the positive end.
  - The new ion-solvent bonds formed results in a release of energy which helps break down the strong electrostatic forces in the crystal lattice.




  - Process is called Solvation/Hydration.
  - Do not dissolve in organic solvents since these have weak molecular forces between them which are not strong enough to penetrate the crystal lattice.
  - Why is there a diff in solubility in some compounds? - diff in ionic radius

# Graph of Group 4,5,6,7 hydrides




- Group 4 - inc in b.p.t's .: inc in mol size down group .: inc in Van der Waals.
- Group 5 - trend like Group 4 except $NH_3$ - mostly H-bonds .: higher b.p.t.
- Group 6 - same concept with $H_2O$ - extremely higher b.p.t. since 2 H-bonds.
- Group 7 - inc. Van der Waals HF - H-bonding. B.p.t. should be higher than Group 6 —> F has 3 lone pairs, but can only form 1 H-bond because of stearic hindrance.

- F —> dense e- cloud (small molecule) - difficult for another HF molecule to approach another - strong repulsion. Doesn't form more than 1 H-bond due to stearic hindrance - packing problems - geometry of electronegativity - atom doesn't allow formation of 2nd H-bond.

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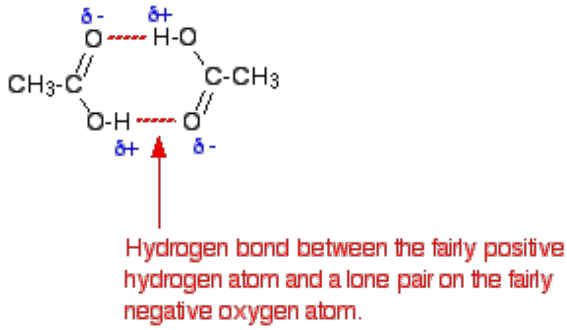
# Dimerisation of Carboxylic acids

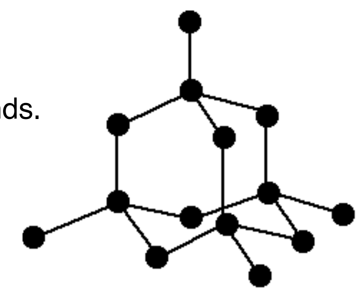
- Dimer - forms H-bonds with itself.
- Occurs when ethanoic acid is dissolved in benzene.
- Benzene —> non-polar solvent, so ethnic acid would rather bond with itself than interact with benzene.
- Dimers do not form in water - water is very polar so forces of attraction between ethanoic acid & water is stronger than forces attraction between itself (to form dimer) .: weak acid.
- Inc non-polar chain length —> sol. in water dec. accordingly.
- Solubility of longer chained acids decreases rapidly with size. The hydrophobic tails het between $H_2O$ mols and breaks H-bonds. The H-bonds are replaced with weaker Van der Waals.




# Giant Covalent Structures

- Allotropes of Carbon - Polymorphic - exist in more than one crystalline form.

  - Diamond
    - Each C forms 4 bonds (sp³ hybridised) forming tetrahedral arrangement.
    - Strong arrangement where all atoms are bounded by strong covalent bonds.
    - Virtually non-reactive.
    - No free electrons.



- Enthalpy of Neutralisation $\triangle H^o_{neutralisation}$
  - The heat absorbed when an acid and a base react to form 1 mole of water under standard conditions.

- Bond Dissociation Enthalpy of $\triangle H^o_{BDE}$
  - Enthalpy change when 1 mole of bonds are broken in the gaseous state.
  - $X\text{-}Y_{(g)} \longrightarrow X_{(g)} + Y_{(g)}$

# Experiment to find the Enthalpy of Neutralisation

- **Calorimeter** - used to measure heat evolved when 1 mole of strong acid reacts with 1 mole of a strong base.

1. Determine heat capacity of calorimeter by pouring a known mass of substance at known temperature with know SHC. The temp is notes. The Heat Capacity (C) is the energy required to raise the temp by 1K.

2. A neutralisation reaction is carried out in the cal. Note the rise in temp. when known amounts of standard acids and alkalis are reacted in the calorimeter.
- In all thermochemical measurements, it is the usually practice to consult a cooling curve to compensate for any heat losses, even though the cal used is highly insulated.
- The cooling curve is obtained by taking a number of measurements before the actual experiment begins and the temp also recorded a no of times after the expt is started.

3. The cooling curve is then extrapolated backwards to the time of the reaction and the corrected temp rise read from graph.

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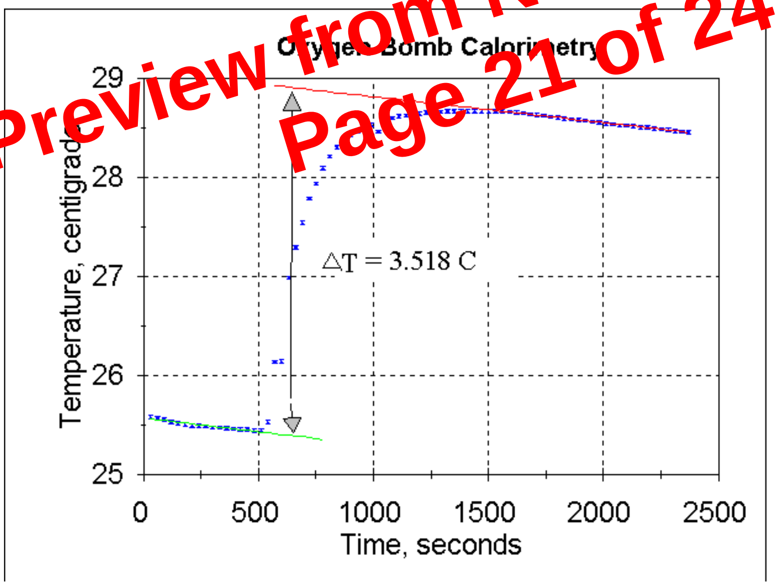


# Experiment to find enthalpy of combustion

- Spirit burner contains fuel : weight after - weight before = mass of fuel burnt
- Metal cal. contains known mass of water.
- Thermometer to measure change in temp
- Draught shield to reduce heat losses.
- Burn as much fuel as possible to reduce error.