CHEMISTRY 1A (CHEM1101) June 2009

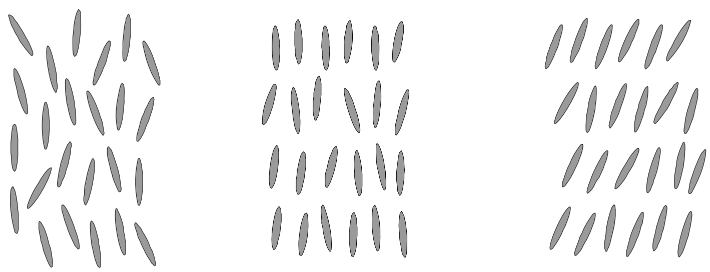
2009-J-2

- 3.1×10^{-4} Ci g^{-1}
- ^{11}C has too many protons relative to neutrons within the nucleus. Electrostatic repulsion between protons destabilises the nucleus.

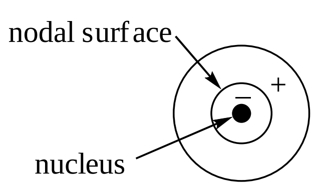
  The one extra neutron increases the strength of the strong nuclear force between all nucleons. This overcomes the electrostatic repulsion of the protons and results in a stable nucleus.

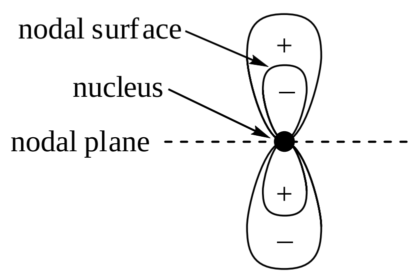
2009-J-3

- 1×10^{4} m s^{-1}
- nematic phase smectic A smectic C



2009-J-4

- 



The lobes define the volume within which there is a certain probability (*e.g.* 95 %) of finding the electron.

The nodes represent surfaces where there is zero probability of finding the electron.

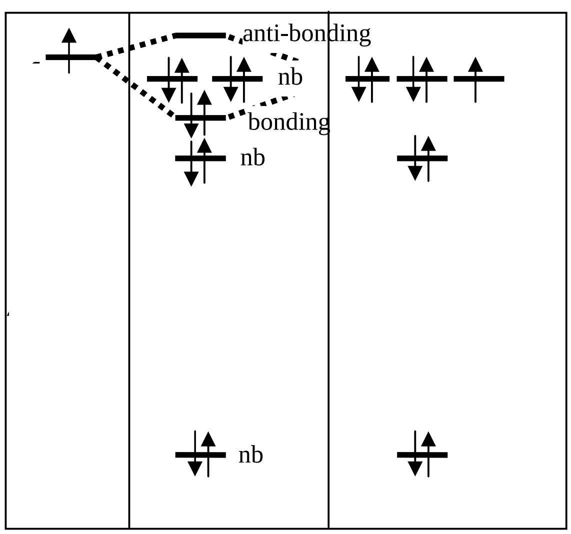
The sign of the wavefunction is not relevant to the probability of finding the electron. The probability distribution depends on the square of the wavefunction, which is always positive.

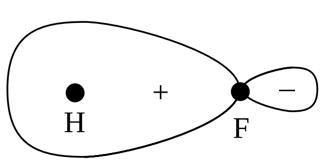
2009-J-5

- Electron configuration of Li is [He] $2s^1$ - it has a single unpaired electron in its outer shell. Adding an extra electron to complete the 2*s* orbital lowers its energy.
  Electron configuration of Be is [He] $2s^2$ - it has a filled 2*s* orbital. Any an extra electron would have to go into the 2*p* orbital which is energetically unfavourable.
  Electron configuration of B is [He] $2s^1\ 2p^1$ - it has a single unpaired electron in its 2*p* orbital. Adding an extra electron with parallel spin into another 2*p* orbital is therefore relatively easy.
  Electron configuration of C is [He] $2s^1\ 2p^2$ - it has 2 unpaired electrons in its 2*p* orbitals. Adding an extra electron with parallel spin into the unoccupied *p* orbital would give a half filled subshell and maximise the energy gain due to Hund's rule.
  Electron configuration of N is [He] $2s^1\ 2p^3$ - it has 3 unpaired electrons in its 2*p* orbitals, a configuration that maximises the energy gain due to Hund's rule. Adding an extra electron results in 2 unpaired and 2 paired electrons in the *p* orbitals, reducing that energy gain.

- Paramagnetism is the property of any substance that is attracted by a magnetic field. It is due to the presence of unpaired electrons.
  When the electron density in a covalent bond is not shared equally between the 2 atoms, a polar bond is formed. This is often due to the atoms having different electronegativities.

2009-J-6

- 

- 

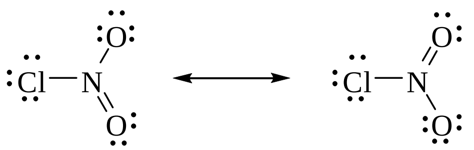
2009-J-7

- The energy difference between the conductance band and the valence band. It is small in conductors (*e.g.* metals) and large in insulators (*e.g.* diamond).

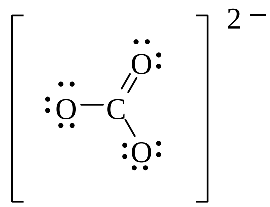
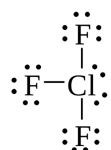
  wavelengths shorter than 490. nm

  yellow-orange-red

2009-J-8

- 

  1.5

CO_3^{2-}	24		trigonal planar
ClF_3	28		T-shaped

2009-J-9

- 0.146 M

- Froth flotation is a technique to separate a mineral from unwanted dirt and rocks. The crude ore is crushed to a fine powder and then treated with water to produce a slurry. A surfactant that selectively coats the mineral, thus making it more hydrophobic, is added and the mixture agitated and aerated. The mineral attaches to the air bubbles and floats to the surface (as a froth) where it is collected before undergoing further refining.

  Electrorefining is a technique for purifying a metal, *e.g.* copper. An electrolytic cell consisting of a pure copper cathode and an impure copper anode is constructed. A voltage is selectively applied so that noble metals (less electropositive than Cu) do not dissolve. When operating, the current causes the impure copper anode to dissolve, including metal impurities more electropositive than copper. The noble metals do not dissolve and form a sludge. Only pure copper is deposited at the cathode - the more electropositive metals stay in solution as cations.

2009-J-10

- (a) No effect. Solids are not included in the expression for K_p.

  (b) It will increase. Decreasing the volume of the container will increase the partial pressures of both gases. Reaction will move to the left to try and decrease the partial pressures.

  (c) It will decrease. The reaction is endothermic so heating it will push it to the right.

2009-J-11

- $$C : H = \frac{\%C}{\text{at. wt. C}} : \frac{\%H}{\text{at. wt. H}}$$

  $$= \frac{85.6}{12.01} : \frac{17.4}{1.008}$$

  $$= 7.13 : 17.3$$

  $= 1 : 2.44$ i.e. consistent with empirical formula of C_2H_5

  $$n = \frac{PV}{RT} = \frac{1.00 \times 10.0}{0.08206 \times 298} = 0.409 \text{ mol}$$

  Hence 1 mol has mass $\frac{23.78}{0.409}$ = 58 g also consistent C_4H_{10}

  1180 kJ (ΔH = –1180 kJ)

2009-J-12

- 1.2 atm

  Rearranging $PV = nRT$ gives $\frac{n}{V} = (\frac{P}{R}) \times \frac{1}{T}$ *i.e.* the density of the gas (proportional to $\frac{n}{V}$) is inversely proportional to its temperature. (As the balloon is elastic, the pressure inside the balloon will be the same as that outside.) As the temperature increases, the gas density decreases and hence the balloon rises.

2009-J-13

- $p(CO)$ = 0.264 atm $p(CO_2)$ = 0.714 atm

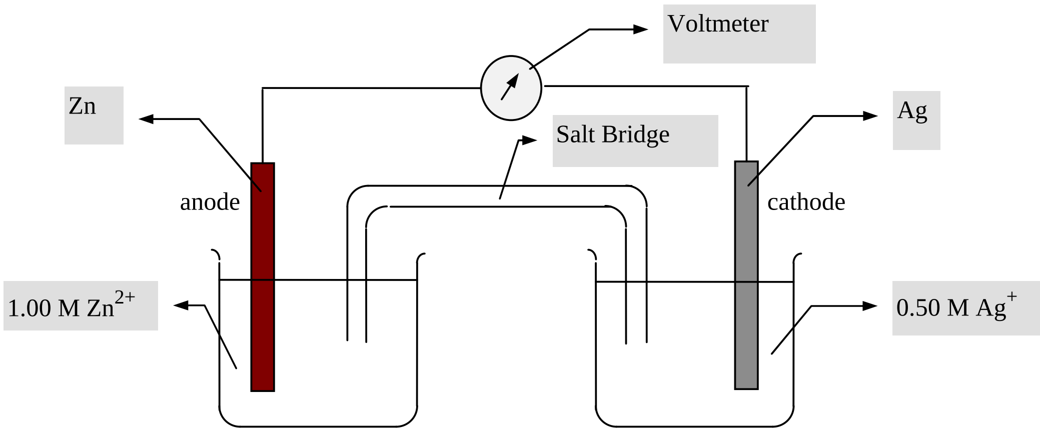
2009-J-14

- CH_3CH_3 and $CH_3CH_2CH_2CH_3$ have weak dispersion forces only, so have the lowest boiling points. $CH_3CH_2CH_2CH_3$ has more atoms, so more dispersion forces and hence the higher b.p. $CH_3CH_2OCH_2CH_3$ is similar, but has dipole-dipole forces as well, continuing the upward trend in b.p. CH_3CH_2OH and H_2O have strong intermolecular H-bonds. Water has 2 per molecule, ethanol just 1, so water has the higher b.p.

  Butane has the greater intermolecular forces as in has a greater surface area that can interact with other molecules. 2-Methylpropane is ball-like in structure with a smaller surface area.

2009-J-15

•



$Zn(s) + 2Ag^{+}(aq) \rightarrow Zn^{2+}(aq) + 2Ag(s)$

1.54 V

The cell is spontaneous.

$\Delta G = -nFE$

E is positive, so ΔG must be negative. Therefore reaction is spontaneous.