CHEMISTRY 1A (CHEM1101) June 2010

NB These answers have not been checked

2010-J-2

- Interaction between one electron and the 2 protons in the nucleus:
  attractive - lowers the energy level

  Interaction between the second electron and the 2 protons in the nucleus:
  attractive - lowers the energy level

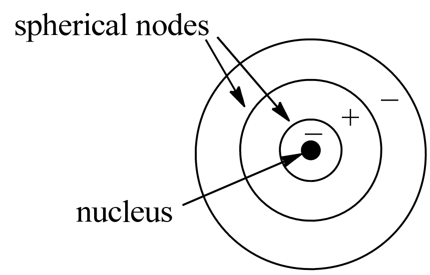
  Interaction between the 2 electrons:
  repulsive - increases the energy

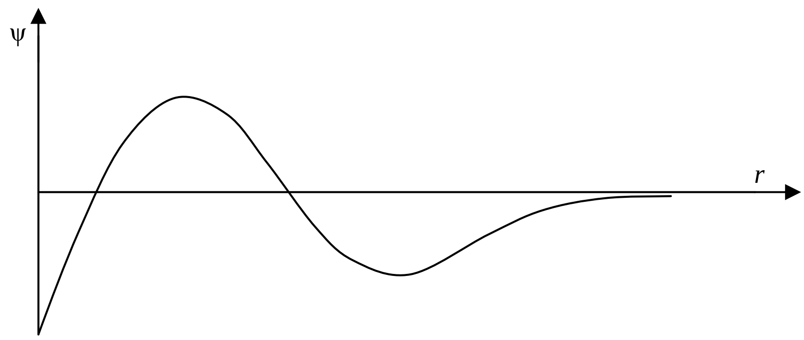
- Its half-life is relatively short and therefore it is highly radioactive

  It's a gas and can therefore easily be inhaled into the lungs.

  It produces alpha particles which cannot escape the body and therefore do internal damage, especially to the lungs.

2010-J-3

- 



  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.

2010-J-4

- CsH is more ionic

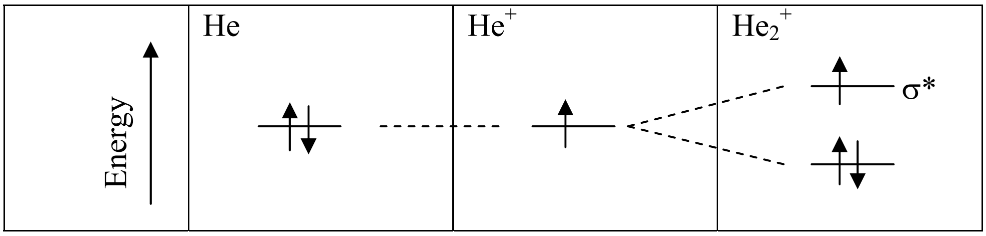
  The first ionisation energy is the energy needed to remove the single electron in the outermost occupied *s* orbital. As you go down the group, the principal quantum number increases and the distance between the nucleus and the orbital increases. The coulombic attraction between nucleus and electron therefore decreases and less energy is required to remove the electron.

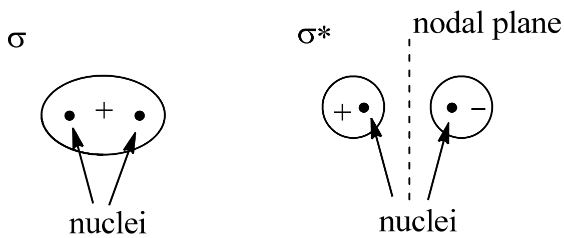
2010-J-5

- Allotropes are different molecular forms of the same element arising from the differences in bonding between the atoms. For carbon, the stable allotropes are diamond, graphite and C_{60}. The electronic bonding in diamond consists of 4 sigma bonds on each atom oriented tetrahedrally to give an “infinite” 3D crystal. In graphite there are 3 sigma bonds in a trigonal planar arrangement to give a flat sheet. The extra electrons occupy delocalised π-orbitals above and below the planes.

- Ionic bonds are the extreme outcome of electronegativity differences. When the highest occupied atomic orbital of one species is energetically far above the lowest unoccupied (or singly occupied) orbital of the other species, there will be no significant advantage to forming a molecular orbital. Rather, the electron will simply transfer into the lower atomic orbital, leaving charged ions which attract each other and form an ionic bond.

2010-J-6

- 



  0.5

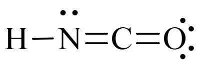
  The bond order of H_2 is 1.0, so we expect He_2^+ to be a weaker bond (roughly half the dissociation energy

2010-J-7

- $^{54}_{25}\text{Mn} + ^{0}_{+1}\text{e} \rightarrow ^{54}_{24}\text{Cr}$

  The newly formed $^{54}_{24}\text{Cr}$ has an electron missing (captured in the decay process) from its core orbitals. Other electrons fall from higher energy orbitals emitting wavelengths characteristic of the differences in energy levels. The same transitions are observed during the electron bombardment of any Cr atom because all Cr atoms have the same energy levels and the bombardment is exciting or ejecting core electrons.

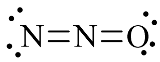
2010-J-8

- 

  2 2

  1

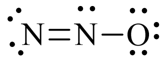
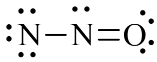
  120° 180°

  2.5 1.5

  0

  180°

  1.5 1.5

  1

  120°

2010-J-9

- $2C_2H_6(g) + 5O_2(g) \rightarrow 4CO(g) + 6H_2O(l)$

  566 kJ mol^{-1}

2010-J-10

- To the right

  5.2×10^{-3} atm

2010-J-11

- 0.027

  0.114 M 0.114 M 0.636 M 0.636 M

2010-J-12

- spontaneous

2010-J-13

- $PbO_2 + 2H_2SO_4 + 2e^- \rightarrow PbSO_4 + 2H_2O + SO_4^{2-}$

  $Pb + H_2SO_4 \rightarrow PbSO_4 + 2H^+ + 2e^-$

  All the redox active species are solids so can be kept apart by initial placement.

  H_2SO_4 dissociates to give H^+, HSO_4^- and SO_4^{2-} ions which carries the current. The H^+ ions migrate to the cathode, whilst the HSO_4^- and SO_4^{2-} ions migrate to the anode.

  $K = [H_2SO_4]^{-2}$

  2.01 V

2010-J-14

- The boiling points in F_2, Cl_2, Br_2 and $I_2$are determined by the size of the dispersion forces between molecules. The bigger the atoms, the more polarisable their electron clouds and the greater the dispersion forces. Hence boiling points are in order:
  $I_2 > Br_2 > Cl_2 > F_2$.

  Dispersion forces also operate in HF, HCl, HBr and HI, but here the dipole formed between the halogen atom and the hydrogen also needs to be considered. F is a very small and very electronegative atom. The H–F bond is therefore highly polarised and H-bonds form in this liquid. These are much stronger than dispersion forces and so HF has an anomalously high b.p. Cl, Br and I are not as electronegative as F: the dispersion forces in HCl, HBr and HI are more significant than the dipole-dipole forces as can be evidenced by the order of boiling points HF > HI > HBr > HCl.

  The values given tell us that the total of the dispersion forces in Br_2 is greater than the H-bonds in HF. Similar comparisons can be made between other members of the 2 series.

2010-J-15

- 82 mL
- Visible light passes through the atmosphere and is absorbed by the Earth's surface. It is then re-emitted as black body radiation, mainly in the infrared region. It is this black body radiation that is absorbed by the greenhouse gases.
- –0.870 K