

**Chemistry 1Adv/1SSP (Chem1901/1903) June 2004**

2004-J-2

- a) A molecular orbital formed from 2 atomic orbitals with a nodal plane perpendicular to the interatomic axis and between the nuclei. It is higher in energy than the original atomic orbitals.

b) The enthalpy change that occurs when an atom gains an electron.  
ie  $\Delta H$  for the reaction  $M(g) + e^- \rightarrow M^-(g)$

c) The splitting of an unstable neutron rich nucleus into smaller nuclides and neutrons and releasing energy in the process.

d) A measure of the relative ability of an atom to attract electrons in covalent bonds.

e) Valence Shell Electron Pair Repulsion Theory. It describes how molecular shapes arise through the minimisation of the electrostatic repulsion of the electron pairs around an atom.

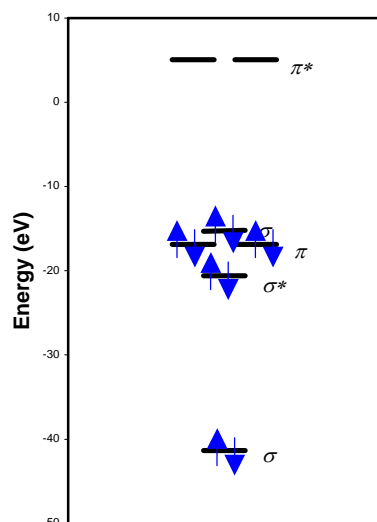
2004-J-3

- ${}_{16}^{36}\text{S}$   
 ${}_0^1\text{n}$   
 ${}_{43}^{99}\text{Tc}$
- 160,183 years
- Nuclear radiation is of sufficient energy to ionise atoms in living tissues. The free radicals thus formed are highly reactive (due to having unpaired electrons) and cause unwanted chemical reactions in the tissues. This in turn can lead to cell damage, destruction of DNA, etc.

2004-J-4

- |   |                 |           |
|---|-----------------|-----------|
| $\begin{array}{c} \cdot\ddot{\text{O}}\cdot \\ \parallel \\ \text{H}-\text{C}-\text{H} \end{array}$                         | trigonal planar | polar     |
| $\begin{array}{c} \text{H} \\   \\ \text{:}\ddot{\text{Cl}}-\text{C}-\ddot{\text{Cl}}\text{:} \\   \\ \text{H} \end{array}$ | tetrahedral     | polar     |
| $\text{:}\ddot{\text{Cl}}-\text{C}\equiv\text{C}-\ddot{\text{Cl}}\text{:}$  | linear          | non-polar |
- $n = 4 \rightarrow n = 2$  transition

2004-J-5



Diamagnetic. It has no unpaired electrons.

2.5

- The electrons are delocalised over two nuclei in H<sub>2</sub>, as opposed to being localised around one nucleus in the case of two isolated H atoms. This delocalisation results in a decrease of the kinetic energy of the electrons and hence H<sub>2</sub> is lower in energy.

2004-J-6

- 1.34 J K<sup>-1</sup> g<sup>-1</sup>  
11 °C

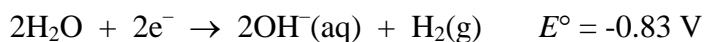
2004-J-7

- The reagents are solids or very concentrated solutions.

Both the anode and cathode are solids so can be placed in the same electrolyte.

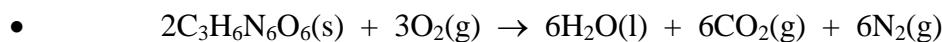
The products are solids so remain trapped in the same electrode. External voltage can therefore reverse the reaction and regenerate the cathode and anode.

- Water is reduced rather than aluminium ions due to the relevant reduction potentials.



Al<sub>2</sub>O<sub>3</sub> has a very high melting point. Adding cryolite (Na<sub>3</sub>AlF<sub>6</sub>) produces a mixture of much lower melting point (an important energy consideration in industrial processes) and provides a source of ions, Na<sup>+</sup> and [AlF<sub>6</sub>]<sup>3-</sup>, so that the melt conducts a current.

2004-J-8



There is no  $\text{O}_2(\text{g})$  as one of the reactants. The products will be slightly different, eg  $\text{H}_2(\text{g})$ ,  $\text{H}_2\text{O}(\text{g})$ ,  $\text{CO}(\text{g})$ .

High nitrogen content results in large  $-\Delta H$  for combustion/explosion reaction.

$\Delta H_f^\circ$  of  $+65 \text{ kJ mol}^{-1}$  results in large  $-\Delta H$  for combustion/explosion reaction.

Large number of moles of gas produced per mole of explosive.

High oxygen content promotes explosive reaction.

$948 \text{ kJ mol}^{-1}$

Yes, many moles of gaseous products are produced from 1 mole of explosive.

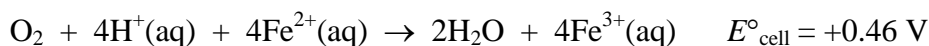
2004-J-9



$\text{SiO}_2$ :  $-2.45 \text{ kJ g}^{-1}$        $\text{Fe}_2\text{O}_3$ :  $-3.96 \text{ kJ g}^{-1}$

$\text{Fe}_2\text{O}_3/\text{Al}$  is better fuel than  $\text{SiO}_2/\text{Al}$

2004-J-10

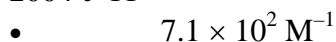


So  $\text{Fe}(\text{s})$  is oxidised preferentially to  $\text{Fe}^{2+}(\text{aq})$ .

negative

0.71 V

2004-J-11



2004-J-12

• The entropy of the universe always increases: ie  $\Delta S_{\text{univ}} = \Delta S_{\text{sys}} + \Delta S_{\text{surr}} > 0$

At constant pressure,  $\Delta S_{\text{surr}} = -\Delta H_{\text{sys}}/T$

Therefore  $\Delta S_{\text{univ}} = \Delta S_{\text{sys}} - \Delta H_{\text{sys}}/T$

Therefore  $-T\Delta S_{\text{univ}} = \Delta H_{\text{sys}} - T\Delta S_{\text{sys}}$

The Gibbs Free Energy is defined as  $\Delta G_{\text{sys}} = \Delta H_{\text{sys}} - T\Delta S_{\text{sys}}$

As  $T$  and  $S_{\text{univ}}$  are always positive for spontaneous reactions,  $\Delta G_{\text{sys}}$  must be negative.

melting of ice at 300 K:  $\text{H}_2\text{O}(\text{s}) \rightarrow \text{H}_2\text{O}(\text{l})$

burning of ethane  $\text{C}_2\text{H}_6(\text{g}) + 7/2\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\text{g})$

freezing of water at 200 K:  $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{s})$