

## CHEMISTRY 1A (CHEM1101) November 2003

2003-N-2

- A beam of electrons produced by applying an electrical potential across a vacuum.  
A point at which the amplitude of the wave is zero.  
A semiconductor produced by doping a non-conductor (eg Si) with an impurity (eg As), which results in a few electrons filling the unoccupied conduction band.  
The principle that states that the ground state of an atom is found by adding the next electron to the lowest energy orbital available.

2003-N-3

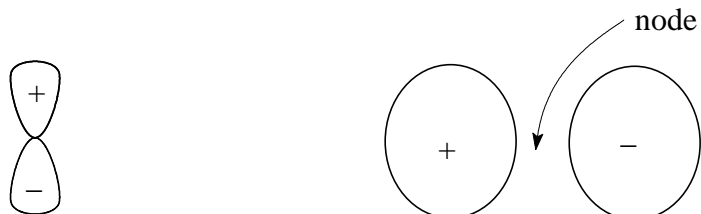
- ${}_{-1}^0e$   
 $\gamma$   
 ${}_{2}^4\text{He}$  or  ${}_{2}^4\alpha$   
 $\gamma$
- 8570 years before present (to 3 significant figures)
- $1.71 \times 10^{11}$  Ci
- ${}^{17}\text{F}$  decays via positron emission ( ${}^{17}_{9}\text{F} \rightarrow {}^{17}_{8}\text{O} + {}^0_1\beta$ ) so should be suitable. The emitted positron annihilates with a nearby electron to produce 2  $\gamma$  particles, which are detected. The F atom must be incorporated in a molecule that will be taken up by the organ to be imaged. The half-life of  ${}^{17}\text{F}$  is approx 1 minute.  ${}^{18}\text{F}$ , which also decays via positron emission, has a half life of about 110 minutes and is the preferred F nuclide for PET.  ${}^{18}\text{F}$  is usually incorporated into a glucose analogue and the entire synthetic process takes about 35 minutes. This wouldn't be acceptable with  ${}^{17}\text{F}$  because of its short half-life.

2003-N-4

- Any of: The photoelectric effect  
Discrete atomic spectral lines  
Black body radiation

The diffraction of electrons and the Compton effect (scattering of photons by electrons) were observed after the development of quantum mechanics, so aren't strictly correct. Although significant, the inconsistency of electron orbits with classical electromagnetic theory isn't really experimental evidence.

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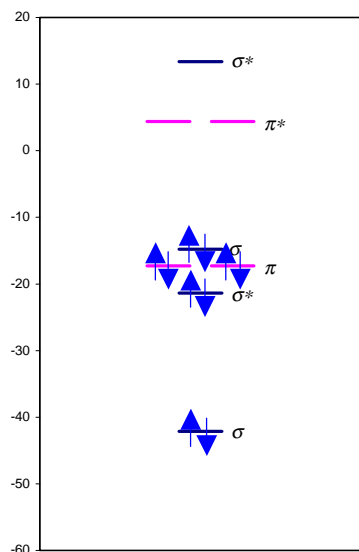
- $4.1 \times 10^{-11}$  m

2003-N-5

- $1s^2 2s^2 2p^4$   
 $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^2$
- 7800 K

2003-N-6

- 10



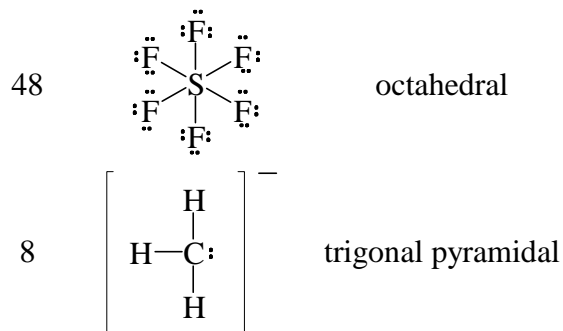
3

62 nm

No. It has no unpaired electrons.

2002-N-7

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- Neon has a fully filled electron shell ( $n = 2$ ). The extra electron in going to sodium is accommodated in the  $n = 3$  shell ( $3s$  orbital) This orbital is higher in energy and shielded from the nuclear charge by the  $n = 2$  electrons and is therefore much further from the nucleus.

2003-N-8

- amine (tertiary)

alkene

alcohol

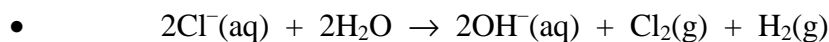
$109.5^\circ$

$120^\circ$

$109.5^\circ$

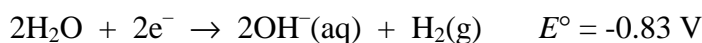
$109.5^\circ$

2003-N-9

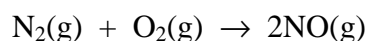


The two top 10 chemicals are chlorine gas and sodium hydroxide (it's an aqueous solution of NaCl that is electrolysed). The third product is hydrogen gas. There is not a sufficient market to harness the production of  $\text{H}_2$  at the moment.

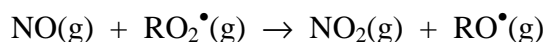
Water is reduced rather than sodium ions due to the relevant reduction potentials.



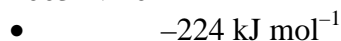
- $\text{NO}(\text{g})$  forms from the combination of  $\text{N}_2$  and  $\text{O}_2$  that are in the atmosphere. The equilibrium to form  $\text{NO}(\text{g})$  is much more favourable at the high temperatures in the car engine than at normal atmospheric temperatures.



Once emitted,  $\text{NO}(\text{g})$  reacts with peroxy radicals in the air to form  $\text{NO}_2(\text{g})$ .



2003-N-10



HCl was the limiting reagent. 0.05 mol of  $\text{OH}^-$  was consumed in both experiments.

2003-N-11

- 31 atm                                      93 atm                                      174 atm
- 0.204 atm

2003-N-12

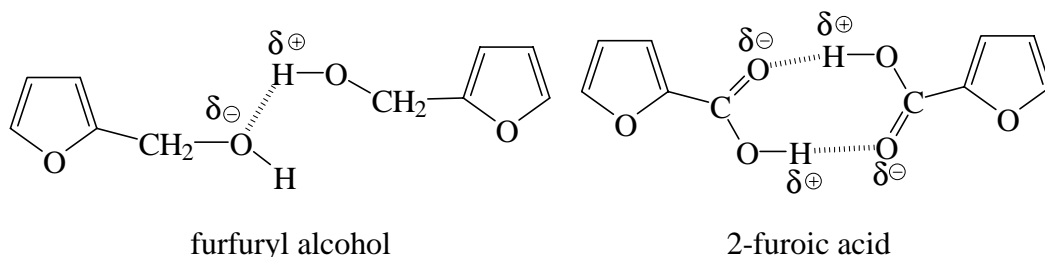
- $36 \text{ kJ mol}^{-1}$
- The iron is connected to a more active metal. This ensures that in any electrochemical reaction, the iron will be the cathode and the more active metal the anode. The more active metal will therefore undergo any oxidation reaction that occurs and be sacrificed to protect the iron.  $E^\circ$  for oxidation of Fe to  $\text{Fe}^{2+}$  is 0.44 V. Zn and Al have greater  $E^\circ_{\text{ox}}$  than Fe and hence can provide cathodic protection of iron.

2003-N-13

- Dissolving electrode on left is anode. Electrode on right is cathode.  
Noble metals do not undergo oxidation at voltage used. As it doesn't form ions, the solid metal just falls to the bottom of the tank as the electrode dissolves.  
 $\text{Cu}^{2+}$  has higher electrode reduction potential than  $\text{Fe}^{2+}$  and  $\text{Zn}^{2+}$  so is more readily reduced.  
2.85 kg

2003-N-14

- Oxygen is more electronegative than carbon, so increasing the number of oxygen atoms attached to a carbon is equivalent to increasing its oxidation number. Similarly, hydrogen is less electronegative than carbon, so increasing the number of hydrogen atoms attached to a carbon is equivalent to decreasing its oxidation number.  
The O.N. of carbon in  $-\text{CH}_2\text{OH}$  is  $-I$ .  
The O.N. of carbon in  $-\text{CHO}$  is  $+I$ .  
The O.N. of carbon in  $-\text{COOH}$  is  $+III$ .



2003-N-15

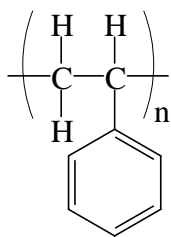
- The tetrahydrides are non-polar, so intermolecular attraction is due to dispersion forces only. As the period increases, the central atom gets bigger (more electrons) and its polarisability increases - hence the dispersion forces and boiling points increase.

The monohydrides are polar, so they have dipole - dipole attractions as well as dispersion forces. Hence they have higher boiling points than corresponding tetrahydride from same period.

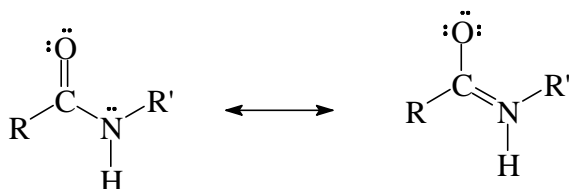
HF is anomalous as the F atom is very small and very electronegative. HF is therefore able to form H-bonds, which are relatively strong intermolecular attractions. This results in an exceptionally high boiling point for HF.

2003-N-16

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3.90 nm



The resonance structures show that there is double bond character between the C and N that form part of the backbone of the polypeptide. There is therefore restricted rotation around the C-N bond. There is however, free rotation about the C-C bonds in the backbone.