Jun 2003 CHEM1001 & Nov 2003 CHEM1101 Combination Practice Paper

2003-J-2 (Chem1001)

- $(24.0 \times 0.79) + (25 \times 0.10) + (26.0 \times 0.11) = 24.3$
- Allotropes are different structural arrangements of the same atoms of an element: eg graphite and diamond for carbon, O_2 and O_3 (ozone) for oxygen
- sodium carbonate

  Fe_2O_3

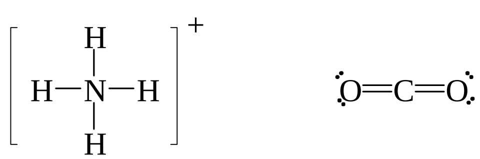
  phosphorus trichloride

  NH_3

2003-J-3 (Chem1001)

- Ionic solids are composed of cations and anions in a fixed lattice structure in which attractive forces (between oppositely charged ions) are maximised and repulsive forces (between similarly charged ions) are minimised.

  Displacement of ions in the lattice brings like charges near each other and results in repulsive forces. This results in the characteristic of brittleness.

  The very strong electrostatic attractions in the crystal result in high melting point. A lot of energy is required to overcome these forces. Once molten, the liquid can conduct electricity because the charged ions are free to move and can conduct the current.
- 

2003-J-4 (Chem1001)

- $Ca_3(PO_4)_2 + 2H_2SO_4 \rightarrow 2CaSO_4 + Ca(H_2PO_4)_2$

  0.63 tonne
- $NClH_4$

2003-N-5 (Chem1101)

- amine (tertiary)

  alkene

  alcohol

  109.5°

  120°

  109.5°

  109.5°

2003-N-6 (Chem1101)

- $2Cl^{-}(aq) + 2H_2O \rightarrow 2OH^{-}(aq) + Cl_2(g) + H_2(g)$

  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 H_2 at the moment.

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

  $2H_2O + 2e^{-} \rightarrow 2OH^{-}(aq) + H_2(g)$ $E° = -0.83$ V

  $Na^{+}(aq) + e^{-} \rightarrow Na(s)$ $E° = -2.71$ V

- NO(g) forms from the combination of N_2 and O_2 that are in the atmosphere. The equilibrium to form NO(g) is much more favourable at the high temperatures in the car engine than at normal atmospheric temperatures.

  $$N_2(g) + O_2(g) \rightarrow 2NO(g)$$

  Once emitted, NO(g) reacts with peroxy radicals in the air to form $NO_2(g)$.

  $$NO(g) + RO_2^{\bullet}(g) \rightarrow NO_2(g) + RO^{\bullet}(g)$$

2003-N-7 (Chem1101)

- -224 kJ mol^{-1}

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

2003-N-8 (Chem1101)

- 31 atm 93 atm 174 atm
- 0.204 atm

2003-N-9 (Chem1101)

- 36 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. $E°$ for oxidation of Fe to Fe^{2+} is 0.44 V. Zn and Al have greater $E°_{ox}$ than Fe and hence can provide cathodic protection of iron.

2003-N-10 (Chem1101)

- Dissolving electrode on left is anode. Electrode on right is cathode.

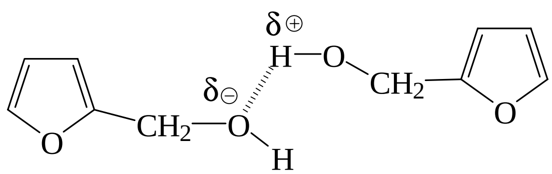
  Noble metals do not undergo oxidation at voltage used. As it doesn't form ions, the solid metal just falls to the bottom of the tank as the electrode dissolves.

  Cu^{2+} has higher electrode reduction potential than Fe^{2+} and Zn^{2+} so is more readily reduced.

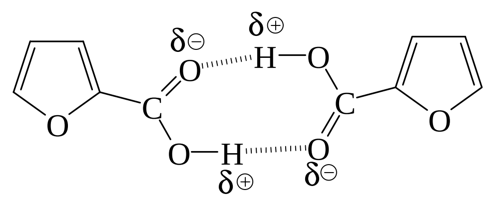
  2.85 kg

2003-N-11 (Chem1101)

- 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 -CH_2OH is –I.
  The O.N. of carbon in -CHO is +I.
  The O.N. of carbon in -COOH is +III.



furfuryl alcohol



2-furoic acid

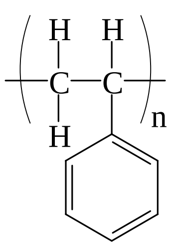
2003-N-12 (Chem1101)

- 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.

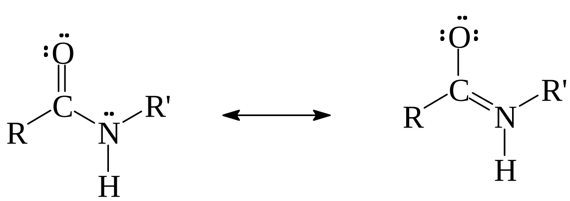
  The monohydrides are polar, so they have dipole - dipole attractions as well as dispersion forces. Hence they have higher boiling points than corresponding tetrahydride from same period.

  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-13 (Chem1101)

- 

  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.