

CAT 3 1998:**Sample Answers**

1. a B
b B
c A
d B
e C
2. a (Mg) $1s^2 2s^2 3p^6 3s^2$ (Co) $1s^2 2s^2 3p^6 3s^2 3p^6 3d^7 4s^2$
b i. CrCl_2 and CoCl_2
ii transition metal ions are usually coloured
c i see a text book for details. The diagram should show a Mg^{2+} cation surrounded by six water molecules with the oxygen atoms closest to the Mg^{2+} ion
ii ion- dipole attraction
3. a aluminium: the oxide Al_2O_3 is amphoteric
 $\text{Al}_2\text{O}_3(\text{s}) + 6\text{HCl}(\text{aq}) \rightarrow 2\text{AlCl}_3(\text{aq}) + 3\text{H}_2\text{O}(\text{l})$
 $\text{Al}_2\text{O}_3(\text{s}) + 2\text{NaOH}(\text{aq}) + 3\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{NaAl}(\text{OH})_4(\text{aq})$
b Fe (iron) : +2
c sulfur: since O has a RAM of 16 and there is the same mass in two O atoms as there is in one X atom, the RAM of X must be 32, hence X is sulfur.
 $\text{SO}_2(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightarrow \text{H}^+(\text{aq}) + \text{HSO}_3^-(\text{aq})$
d oxygen: $2\text{F}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow 4\text{F}^-(\text{aq}) + \text{O}_2(\text{g}) + 4\text{H}^+(\text{aq})$: the pH will fall
e urea: NH_2CONH_2 : hydrogen bonding
4. a $2\text{C}_4\text{H}_{10}(\text{g}) + 13\text{O}_2(\text{g}) \rightarrow 8\text{CO}_2(\text{g}) + 10\text{H}_2\text{O}(\text{l or g})$
b 13g of butane is $13/58 = 0.224$ mol
heat released by burning butane = $0.224 \times 2886 = 646.9$ kJ
35% of this energy is available to heat the water = $646.9 \times 0.35 = 226.4$ kJ
Temperature rise is $100 - 12 = 88$ °C
Energy required to raise 1.00 mL of water by 88 °C = $88 \times 4.20 \text{ J} = 369.6 \text{ J}$
Volume of water whose temperature can be raised by 88 °C by 226.4 kJ of energy is $226400/369.6 = 613$ mL
c heating the container, heating the surrounding air, incomplete combustion

5. i The reactants are at zero energy, the products are at - 225
 ii The top of the energy barrier is at +125 for the uncatalysed reaction
 iii The top of the energy barrier is well below +125 and above the zero level for the catalysed reaction
6. a See a textbook for the correct diagrams
 b i. Reaction with water
 ii glycerol: see a text book for a diagram of the structure
 c i the sequence of the amino acids
 ii covalent bonds are too strong to be broken by boiling
 iii boiling destroys the tertiary structure of the enzyme
 iv the tertiary structure provided the correctly shaped site that made the reaction possible
7. a i Acid: $\text{NH}_3^+\text{CH}(\text{CH}_3)\text{COOH}$ and $\text{NH}_3^+\text{CH}(\text{COOH})\text{COOH}$
 ii Base: $\text{NH}_2\text{CH}(\text{CH}_3)\text{COO}^-$ and $\text{NH}_2\text{CH}(\text{COOH})\text{COO}^-$
 b i NH_4NO_3 , $\text{CO}(\text{NH}_2)_2$ or $\text{NH}_2\text{CH}_2\text{COOH}$
 ii $\text{NH}_2\text{CH}_2\text{COOH}$
 iii NH_4NO_3
8. a Left: $\text{H}_2\text{O}_2(\text{aq})$ Right: $\text{NH}_4^+(\text{aq})$ (from an ammonium salt)
 b must be porous to allow the flow of ions
 c $\text{H}_2\text{O}_2(\text{aq}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow 2\text{H}_2\text{O}(\text{l})$
 $2\text{NH}_4^+(\text{aq}) \rightarrow \text{N}_2(\text{g}) + 8\text{H}^+(\text{aq}) + 6\text{e}^-$
 d chemically inert, good electrical conductors, catalysts for the reaction
 e Apply a voltage ≥ 1.3 V and provide a supply of nitrogen at the anode
 f $\text{N}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l}) + 2\text{H}^+(\text{aq}) \rightarrow 3\text{H}_2\text{O}_2(\text{aq}) + 2\text{NH}_4^+(\text{aq})$