EDEXCEL INTERNATIONAL GCSE CHEMISTRY
EDEXCEL CERTIFICATE IN CHEMISTRY
ANSWERS

SECTION C

Chapter 16

1. Burn sulfur in air to give sulfur dioxide.

    $$S(s) + O_2(g) ----> SO_2(g)$$
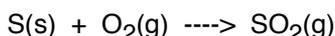
    Pass this with more air over a vanadium(V) oxide catalyst at a temperature of 450°C and a pressure of 1 to 2 atmospheres to give sulfur trioxide.

    $$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

    Absorb the sulfur trioxide in concentrated sulfuric acid to give fuming sulfuric acid.

    $$H_2SO_4(l) + SO_3(g) ----> H_2S_2O_7(l)$$
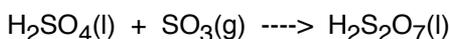
    Dilute this carefully with water to give concentrated sulfuric acid.

    $$H_2S_2O_7(l) + H_2O(l) ----> 2H_2SO_4(l)$$
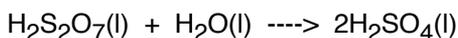
2. a)   (i) % ammonia decreases. Rate increases.
         (ii) % ammonia increases. Rate increases.
         (iii) % ammonia no change. Rate increases.

    b) High pressures increase both the percentage conversion and the rate of the reaction. However, *very* high pressures are very expensive to produce. Typically, about 200 atmospheres is as high a pressure as it is economic to use.

    c) nitrogen: air.   hydrogen: natural gas

3. a) That makes sure that the flow of liquid is always from left to right, preventing any of the sodium hydroxide solution formed finding its way back to where chlorine is being produced. That stops the two from reacting.

    b) Titanium anode. Steel cathode.

    c)   (i) $H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq)$
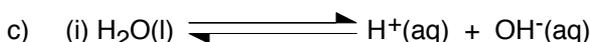
        (ii) sodium and hydrogen

        (iii) hydrogen

        (iv) The sodium ions in the sodium hydroxide solution are there because they are attracted to the cathode. As the hydrogen ions are discharged to give hydrogen gas, the equilibrium in part (i) moves to the right to replace them (Le Chatelier's Principle), producing hydroxide ions. There is therefore a build-up of sodium ions and hydroxide ions in the cathode compartment.

    d)   (i) Any valid use for sodium hydroxide solution (see chapter)
         (ii) Any valid use for chlorine (see chapter)
    (Care over phrasing! For example, sodium hydroxide isn't used *as* a bleach - it is used to *make* bleach.)

4. a) Add a measured volume of ammonia solution to a flask using a pipette (or measuring cylinder). Add a named indicator. Add sulfuric acid from a burette until a correctly stated colour change. Note the volume of acid added. Mix the same volumes of acid and ammonia solution without the indicator.

b) Any sensible design involving a control. For example, germinate at least two lots of grass seed in identical trays of weakly fertilised compost (John Innes seed compost, or similar). When the grass is growing properly, water one with plain water, and the other with the same volume of a very dilute solution of ammonium sulfate. Keep side-by-side under the same conditions. Compare the growth and appearance of the two trays.

(The dilution of the solution would be fairly hit-and-miss. It would be better to have more trays so that you could compare the effects of varying concentrations in order to find the best one.)

5. a) The reaction is strongly exothermic (large negative number for ΔH). Once the reaction starts, there is enough heat produced to keep the catalyst hot.

b) The catalyst isn't used up, and without it the reaction would be too slow. (In fact, the catalyst is in the form of a number of very large platinum-rhodium gauzes, which do get damaged over time. They can, however, be sent back to the manufactures and remade.)

c) $2NO(g) + O_2(g) ----> 2NO_2(g)$

d) $2H_2O(l) + 4NO_2(g) + O_2(g) ----> 4HNO_3(aq)$
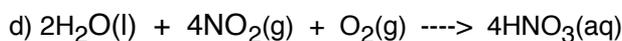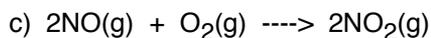
e) Any valid use. Easy to find ones include the manufacture of explosives, drugs, dyes. (The question isn't looking for any detail. A simple answer, for example "Manufacture of explosives", is enough.)

Chapter 17

1. a) Sodium is high in the Reactivity Series, and so will need to be produced by electrolysis. Manufacture it by electrolysing molten sodium chloride using suitable electrodes (industrially, carbon anode, steel cathode), keeping the sodium and chlorine apart to prevent them from reacting back to give sodium chloride again.

   Sodium would be released at the cathode: $Na^+(l) + e^- \longrightarrow Na(l)$

   b) Needed discovery of electricity.

   c) Any other metals high in the RS - e.g. potassium, lithium, calcium, magnesium.

   d) An alloy of copper and tin. Both metals are lowish in the RS and easily produced by heating their ores with carbon.

2. a) bauxite

   b) a solution of aluminium oxide in molten cryolite

   c) cathode (or negative)

   d) $Al^{3+}(l) + 3e^- \longrightarrow Al(l)$ reduction

   e) Reacts with the carbon anodes and burns them away.

   f) (i) low density
   (ii) alloys are stronger

3. a) A

   b) (i) coke
   (ii) air
   (iii) iron ore
   (iv) limestone

   c) $CaO(s) + SiO_2(s) \longrightarrow CaSiO_3(l)$

   d) $Fe_2O_3(s) + 3C(s) \longrightarrow 2Fe(l) + 3CO(g)$
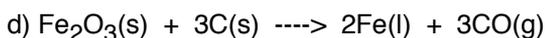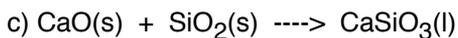
4. a) (i) carbon, about 4%
   (ii) Makes it brittle.

   b) Mixture of iron, nickel and chromium. Nickel and chromium form thin layers of strongly adherent oxides which protect the iron from air and water attack. Any valid use (see chapter for examples).

   c) (i) Iron coated with zinc.
   (ii) It would take much longer before the car went rusty. Zinc is more reactive than iron and so corrodes more easily. The corrosion of zinc forms zinc ions and releases electrons. These electrons flow to the iron and prevent its ionisation (which would lead to rusting). Painting has no similar effect, so galvanising lengthens the life of the car.

End of Section C questions

1. a) Removal of oxygen (allow addition of electrons) (1)

   b) iron(III) oxide (1) (must include oxidation state)

   c) exothermic (1)

   d) $C(s) + CO_2(g) ----> 2CO(g)$ (1)

   e) $Fe_2O_3(s) + 3CO(g) ----> 2Fe(l) + 3CO_2(g)$ (1)

   f) Limestone is calcium carbonate (1). Decomposes to give calcium oxide (1), which combines with silicon dioxide to give calcium silicate (1). Or 3 marks for both correct equations.

   g)   (i) One valid use for each (see chapter) (4 x 1)
         (ii) Makes it harder (1) and more brittle (1).

2. a)   (i) bauxite (1)
         (ii) cathode (or negative) (1)
         (iii) carbon (1) electrode burns (1) and needs replacing (1). Max 2.
         (iv) needs large quantities of expensive electricity (1)

   b)   (i) less dense (1)
         (ii) strengthened (1)
         (iii) e.g. stronger (1), cheaper (1)
         (iv) iron coated with zinc (1)
         (v) Zinc more reactive than iron (1). Sacrificial protection (*or* zinc corrodes in preference to iron) (1). Corrosion of zinc forms ions and releases electrons (1). These flow to iron and prevent its ionisation (1). (Maximum 2)

3. a) manufacture of sulfuric acid (1)

   b) $ZnO(s) + C(s) ----> Zn(g) + CO(g)$ (1)

   c) dilute sulfuric acid (1). $ZnO(s) + H_2SO_4(aq) ----> ZnSO_4(aq) + H_2O(l)$ (1)

   d) cathode (or negative) (1). $Zn^{2+}(aq) + 2e^- ----> Zn(s)$ (1)

4. a) hydrogen (1), chlorine (1), sodium hydroxide (1) + a valid use for each (see chapter) (3 x 1)

   b) chlorine (1) $2Cl^-(aq) ----> Cl_2(g) + 2e^-$ (1)

5. a)   (i) the air (1)
         (ii) natural gas (methane) (1)

   b) A reversible reaction (strictly, a reversible reaction in a state of dynamic equilibrium) (1)

   c) an exothermic reaction (1)

   d) iron (1)

   e)   (i) 450°C (1)
         (ii) 200 atmospheres (allow anything in the region of ~150 to 1000 atm) (1)

   f) It is cooled and condenses to a liquid. (1)

   g) Any two valid uses - e.g. making fertilisers (allow "as a fertiliser" - some ammonia is injected directly into the soil), making nitric acid, making nylon (2 x 1)

6. a) burnt in air (1)

   b)   (i) vanadium(V) oxide (1)

   (ii) Greater at a low temperature (1). Equilibrium moves to counter a lower temperature by doing the exothermic change - in this case the formation of more sulfur trioxide (1).

   (iii) At a lower temperature, the rate of the reaction is too slow (1). 450°C is a compromise giving a good yield reasonably quickly (1).

   (iv) Good yield even at low pressures (1). Not economically worthwhile to use higher pressures (1).

   c) $H_2SO_4(l)$ + $SO_3(g)$ ----> $H_2S_2O_7(l)$ (1)
        $H_2S_2O_7(l)$ + $H_2O(l)$ ----> $2H_2SO_4(l)$ (1)

   d) Any two valid uses - e.g. manufacture of fertilisers, manufacture of detergents, and manufacture of paints. (2 x 1)