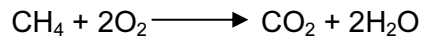


1 (a) Exothermic reactions produce heat energy.

An important fuel is methane, natural gas. The equation for its combustion is as follows.



(i) In chemical reactions bonds are broken and new bonds are formed.

Using this reaction give an example of

a bond that is broken,

a bond that is formed. [2]

(ii) Explain, using the idea of bonds forming and breaking, why this reaction is exothermic, that is it produces heat energy.

.....

..... [2]

(b) Some radioactive isotopes are used as nuclear fuels.

(i) Give the symbol and the nucleon number of an isotope that is used as a nuclear fuel.

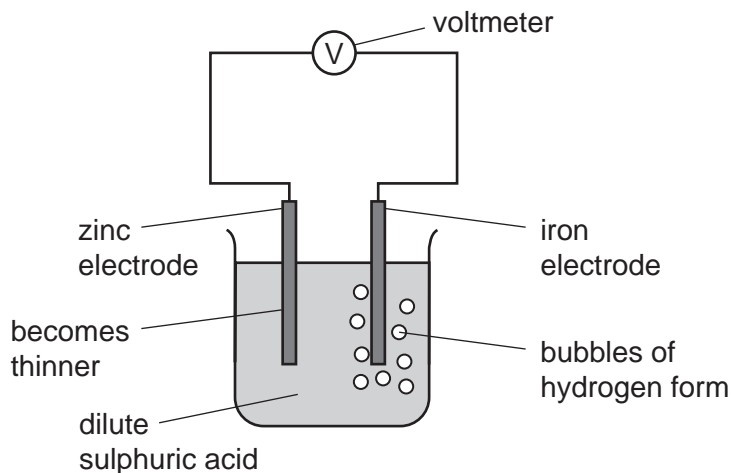
..... [2]

(ii) Give another use of radioactive isotopes.

..... [1]

(c) Cell reactions are both exothermic and redox. They produce electrical energy as well as heat energy.

(i) The diagram shows a simple cell.



Which substance in this cell is the reductant and which ion is the oxidant?

reductant

oxidant [2]

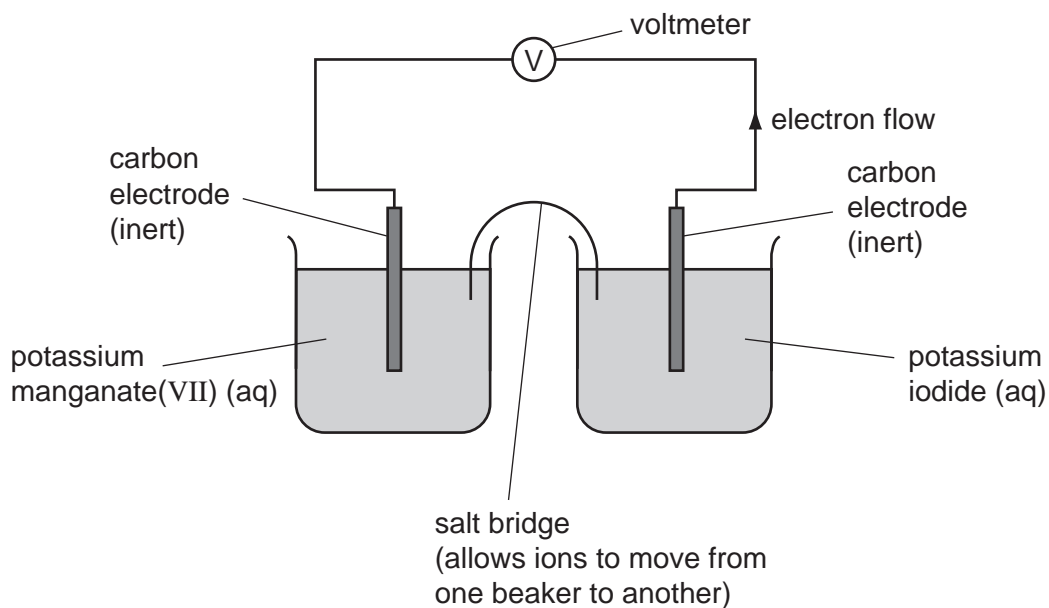
(ii) How could the voltage of this cell be increased?

..... [1]

(iii) What is the important large scale use, relating to iron and steel, of this type of cell reaction?

..... [1]

(d) Cells can be set up with inert electrodes and the electrolytes as oxidant and reductant.



The potassium manganate(VII) is the oxidant and the potassium iodide is the reductant.

(i) Describe the colour change that would be observed in the left hand beaker.

..... [2]

(ii) Write an ionic equation for the reaction in the right hand beaker.

..... [2]

2 An ore of copper is the mineral, chalcopyrite. This is a mixed sulphide of iron and copper.

(a) Analysis of a sample of this ore shows that 13.80 g of the ore contained 4.80 g of copper, 4.20g of iron and the rest sulphur.

Complete the table and calculate the empirical formula of chalcopyrite.

	copper	iron	sulphur
composition by mass /g	4.80	4.20	
number of moles of atoms			
simplest mole ratio of atoms			

The empirical formula is

[3]

..... [1]

(b) Impure copper is extracted from the ore. This copper is refined by electrolysis.

(i) Name;
the material used for the positive electrode (anode),

.....

the material used for the negative electrode (cathode),

.....

a suitable electrolyte.

..... [3]

(ii) Write an ionic equation for the reaction at the negative electrode.

..... [1]

(iii) One use of this pure copper is electrical conductors, another is to make alloys.
Name the metal that is alloyed with copper to make brass.

..... [1]

- (c) Two of the elements in chalcopyrite are the metal, copper, and the non-metal, sulphur. These have different properties. Copper is an excellent conductor of electricity and is malleable. Sulphur is a poor conductor and is not malleable, it is brittle. Explain, in terms of their structures, why this is so.

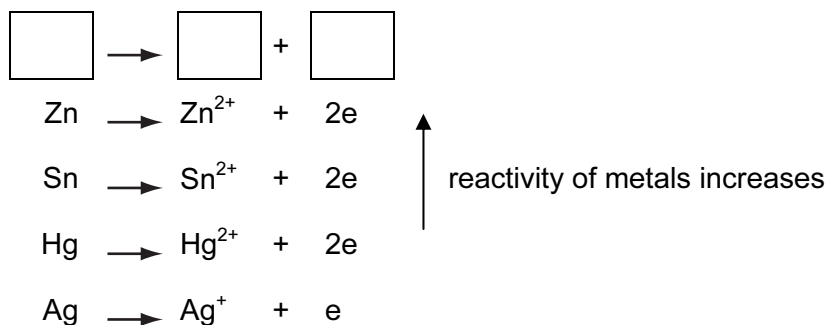
difference in electrical conductivity

.....
..... [2]

difference in malleability

.....
..... [2]

3 In the following list of ionic equations, the metals are in order of reactivity.



(a) (In the space at the top of the series, write an ionic equation that includes a more reactive metal. [1]

(ii) Define *oxidation* in terms of electron transfer.

[1]

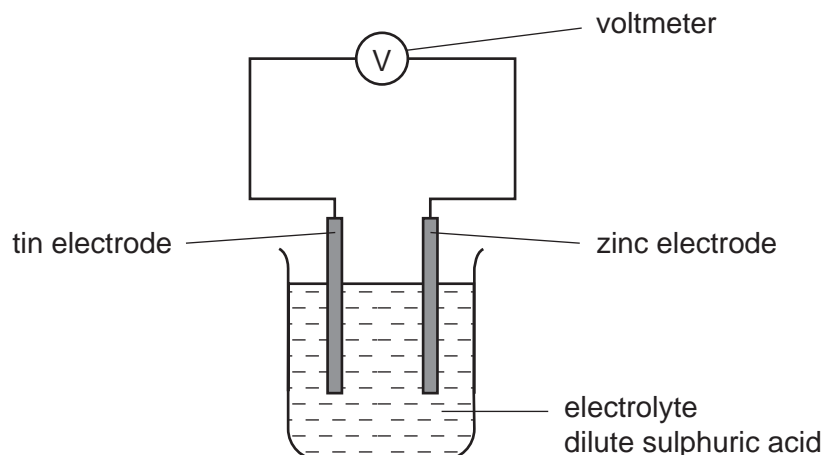
(iii) Explain why the positive ions are likely to be oxidising agents.

[1]

(iv) Which positive ion(s) can oxidise mercury metal (Hg)?

[1]

(b) The following diagram shows a simple cell.



- (i) Predict how the voltage of the cell would change if the tin electrode was replaced with a silver one.

[1]

- (ii) Which electrode would go into the solution as positive ions? Give a reason for your choice.

[1]

- (iii) State how you can predict the direction of the electron flow in cells of this type.

[1]

4 For over 5000 years copper has been obtained by the reduction of its ores. More recently the metal has been purified by electrolysis.

(a) Copper is used to make alloys.

(i) Give **two** other uses of copper.

.....[2]

(ii) Alloys have similar structures to pure metals. Give a labelled diagram that shows the structure of a typical alloy, such as brass.

[3]

(b) Copper is refined by the electrolysis of aqueous copper(II) sulphate using copper electrodes. Describe the change that occurs at the electrodes.

(i) cathode (pure copper)
.....[1]

(ii) anode (impure copper)
.....[1]

(iii) Write an ionic equation for the reaction at the cathode.
.....[1]

(iv) If carbon electrodes are used, a colourless gas is given off at the anode and the electrolyte changes from a blue to a colourless solution.

The colourless gas is

The solution changes into [2]

(c) Electrolysis and cells both involve chemical reactions and electricity.

What is the essential difference between them?

.....
.....[2]

(d) Copper is an unreactive metal. Its compounds are easily reduced to the metal or decomposed to simpler compounds. Complete the following equations.

(i) ...CuO + → ...Cu +

(ii) Copper(II) hydroxide $\xrightarrow{\text{(heat)}}$ +

(iii) $\text{Cu}(\text{NO}_3)_2 \xrightarrow{\text{(heat)}}$ + +

[4]