Cambright Solved Paper

Tags	2023 CIE IGCSE Chemistry May/June P4 V1
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Status	Done

1 Some symbol equations and word equations, **A** to **J**, are shown.

A $Fe^{3+} + 3OH^- \rightarrow Fe(OH)_3$

B $H^+ + OH^- \rightarrow H_2O$

C ethane + chlorine → chloroethane + hydrogen chloride

D $C_{12}H_{26} \rightarrow C_8H_{18} + C_4H_8$

E ethene + steam → ethanol

F chlorine + aqueous potassium iodide → iodine + aqueous potassium chloride

G $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

H ethanoic acid + ethanol → ethyl ethanoate + water

I calcium carbonate → calcium oxide + carbon dioxide

J $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

Use the equations to answer the questions that follow.
Each equation may be used once, more than once, or not at all.

Give the letter, **A** to **J**, for the equation that represents:

(a) a neutralisation reaction B ..... [1]

(b) a precipitation reaction A ..... [1]

(c) the formation of an ester H ..... [1]

(d) photosynthesis J ..... [1]

(e) fermentation D ..... [1]

(f) cracking. G ..... [1]

[Total: 6]

2 **(a)** The symbols of the elements in Period 2 of the Periodic Table are shown.

Li Be B C N O F Ne

Use the symbols of the elements in Period 2 to answer the questions that follow.
Each symbol may be used once, more than once or not at all.

Give the symbol of the element that:

(i) makes up approximately 78% of clean, dry air ....N.... [1]

(ii) contains atoms with only three electrons in the outer shell ....B.... [1]

(iii) contains atoms with only nine protons ....F.... [1]

(iv) exists as graphite ....C.... [1]

(v) is an alkali metal ....Li.... [1]

(vi) **only** has an oxidation number of zero. ....Ne.... [1]

(b) Boron, B, has two isotopes.

(i) State the meaning of the term isotopes.

Isotopes are **atoms of the same element with the same number of protons** (1 mark) **but with different number of neutrons** (1 mark).

(ii) Table 2.1 shows the relative masses and the percentage abundances of the two isotopes of boron.

Table 2.1

relative mass of isotope	percentage abundance of isotope
10	20
11	80

Calculate the relative atomic mass of boron to **one** decimal place.

10 × 20 = 200, 11 × 80 = 880, total = 1080
1080/100 = 10.8

relative atomic mass = ...10.8.... [2]

[Total: 10]

3 This question is about ionic and covalent compounds.

(a) (i) Sodium reacts with oxygen to form the ionic compound sodium oxide.
The electronic configurations of an atom of sodium and an atom of oxygen are shown in Fig. 3.1.

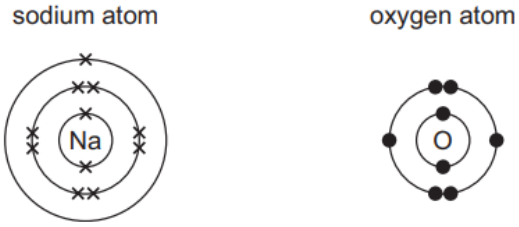
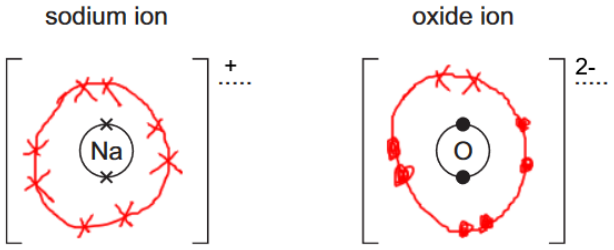


Fig. 3.1

Ions are formed by the transfer of electrons from sodium atoms to oxygen atoms.

Complete the dot-and-cross diagrams in Fig. 3.2 to show the electronic configuration of **one** sodium ion and **one** oxide ion. Show the charges on the ions.

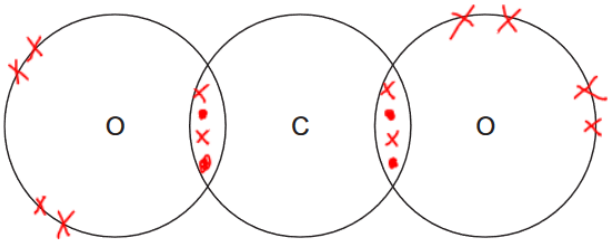


(ii) Write the formula of sodium oxide.

Na_2O

(b) Carbon dioxide, CO_2, is a covalent compound.

Complete the dot-and-cross diagram in Fig. 3.3 to show the electronic configuration in a molecule of carbon dioxide. Show outer shell electrons only.



(c) The melting points of sodium oxide and carbon dioxide are shown in Table 3.1.

Table 3.1

	melting point/°C
sodium oxide	1275
carbon dioxide	–78

(i) Explain, in terms of bonding, why sodium oxide has a high melting point.

Sodium oxide is an ionic compound, so the positive ions and negative ions in it have very strong bonds with each other and they are hard to break. So, it has a high melting point.

(ii) Carbon dioxide has a low melting point.

State the general term for the weak forces that cause carbon dioxide to have a low melting point.

Intermolecular forces.

4 Oxygen is produced by the decomposition of aqueous hydrogen peroxide. Manganese(IV) oxide, MnO_2, is a catalyst for this reaction.

(a) State the meaning of the term catalyst.

A catalyst is a substance which increases the rate of the reaction while remaining unchanged at the end of the reaction.

(b) A student adds powdered manganese(IV) oxide to aqueous hydrogen peroxide in a conical flask as shown in Fig. 4.1. The mass of the conical flask and its contents is measured at regular time intervals. The mass decreases as time increases.

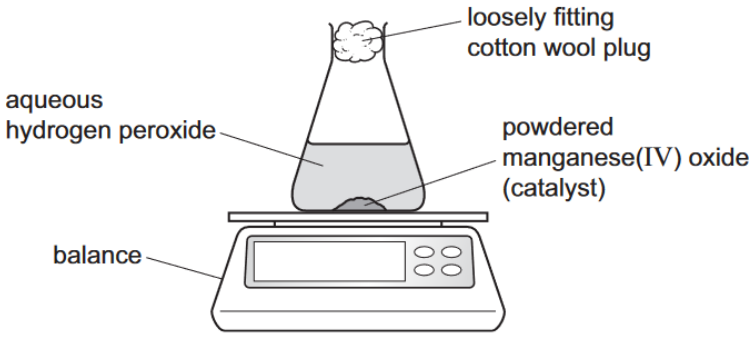


Fig. 4.1

(i) State why the mass of the conical flask and its contents decreases as time increases.

Oxygen is produced during the reaction and it escapes the flask.

(ii) The rate of reaction is highest at the start of the reaction. The rate decreases and eventually becomes zero.

Explain why the rate of reaction is highest at the start of the reaction.

The concentration of hydrogen peroxide is greatest in the beginning of the reaction.

(iii) Explain why the rate of reaction eventually becomes zero.

All of the hydrogen peroxide has been used up in the reaction.

(c) The experiment is repeated at an increased temperature.
All other conditions stay the same.

Explain in terms of collision theory why the rate of reaction is higher at an increased temperature.

When the temperature increases, the average kinetic energy of the particles increase. So, the particles collide more frequently. There are also more particles with enough activation energy to react.

(d) The equation for the decomposition of aqueous hydrogen peroxide, $H_2O_2(aq)$, is shown.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

$50.0\,cm^3$ of a $0.200\,mol/dm^3$ solution of $H_2O_2(aq)$ is used.

Calculate the mass of O_2 that forms.
Use the following steps.

- Calculate the number of moles of H_2O_2 used.

$$mol = mol/dm^3 \times volume(cm^3)$$

$$mol = 0.200\ mol/dm^3 \times \frac{50}{1000}\ dm^3$$

$$mol = 0.01$$

- Determine the number of moles of O_2 produced.

2 moles of H_2O_2 produces 1 mole of O_2

0.01 mole of H_2O_2 will produce 0.005 mole of O_2

(e) State the effect on the mass of oxygen produced if the mass of powdered manganese(IV) oxide catalyst is increased.

No effect

(f) Oxygen can also be produced by the decomposition of mercury(II) oxide, HgO.
The only products of this decomposition are mercury and oxygen.

Write a symbol equation for this decomposition.

$2HgO \rightarrow 2Hg + O_2$

5 This question is about electricity and chemical reactions.

(a) The electrolysis of concentrated aqueous potassium bromide using graphite electrodes forms:
- hydrogen at the cathode
- bromine at the anode.

The electrolyte becomes aqueous potassium hydroxide.

(i) State what is meant by the term electrolysis.

It is the breakdown of an ionic compound in the molten or aqueous state by passage of electricity.

(ii) State why graphite is suitable for use as an electrode.

Graphite is inert and also conducts electricity. (You need to answer both points)

(iii) Write an ionic half-equation for the formation of hydrogen at the cathode.

$2H^+ + 2e^- \rightarrow H_2$

(iv) Name the type of particle responsible for the transfer of charge in the conducting wires.

Electrons

(v) Name the type of particle responsible for the transfer of charge in aqueous potassium bromide.

Ions

(vi) State the names of the products formed when electricity is passed through **dilute** aqueous potassium bromide using graphite electrodes.

At the anode $\rightarrow$ oxygen

At the cathode $\rightarrow$ hydrogen

(b) Bauxite is an ore containing aluminium.
Aluminium is extracted by electrolysis of purified bauxite in molten cryolite using carbon electrodes.

(i) Name the aluminium compound in purified bauxite.

Aluminium oxide

(ii) State **two** reasons why cryolite is used in this electrolysis.

1. It lowers the operating temperature
2. It increases conductivity
3. It is used as a solvent

Any 2 of these is enough.

(iii) The anode is made from carbon.

Explain why the carbon anode has to be replaced regularly.

The carbon anode reacts with the oxygen to form carbon dioxide and dissolves.

(c) Hydrogen–oxygen fuel cells can be used to produce electricity in vehicles.

(i) Write the symbol equation for the overall reaction in a hydrogen–oxygen fuel cell.

$2H_2 + O_2 \rightarrow 2H_2O$

(ii) State **one** advantage of using hydrogen–oxygen fuel cells instead of petrol in vehicle engines.

No carbon dioxide is produced OR It is more efficient.

6 This question is about sulfur and compounds of sulfur.

Sulfur is converted into sulfuric acid, H_2SO_4, by the Contact process.

The process involves four stages.

stage 1 Molten sulfur is converted into sulfur dioxide.

stage 2 Sulfur dioxide reacts with oxygen to form sulfur trioxide.

stage 3 Sulfur trioxide combines with concentrated sulfuric acid to form oleum, $H_2S_2O_7$.

stage 4 Oleum reacts to form concentrated sulfuric acid.

(a) (i) In **stage 1**, iron pyrites, FeS_2, can be used instead of molten sulfur.
The iron pyrites is heated strongly in air.

Balance the equation for the reaction occurring when iron pyrites reacts with oxygen in the air.

$$4\,FeS_2 + 11\,O_2 \rightarrow 2\,Fe_2O_3 + 8\,SO_2 \qquad [1]$$

(ii) Name Fe_2O_3. Include the oxidation number of iron.

Iron (III) oxide

(b) The equation for **stage 2** is shown.

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

The forward reaction is exothermic.
The reaction is carried out at a temperature of 450 °C and a pressure of 2 atm.

Using explanations that do **not** involve cost:

(i) explain why a temperature greater than 450 °C is **not** used

At a higher temperature, the yield of SO_3 is less. (Because the forward reaction is exothermic)

(ii) explain why a pressure lower than 2 atm is **not** used.

At a lower pressure, the yield of SO_3 is less.

OR

The rate of reaction is reduced.

(c) When sulfuric acid reacts with ammonia the salt produced is ammonium sulfate.

Write the symbol equation for this reaction.

$$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$$

(d) Lead(II) sulfate is an insoluble salt.

Lead(II) sulfate can be made from aqueous ammonium sulfate using a precipitation reaction.

(i) Name a solution that can be added to aqueous ammonium sulfate to produce a precipitate of lead(II) sulfate.

Lead (II) nitrate

(ii) Write an ionic equation for this precipitation reaction. Include state symbols.

$$Pb^{2+}(aq) + SO_4^{-}(aq) \rightarrow PbSO_4(s)$$

(iii) The precipitate of lead(II) sulfate forms in an aqueous solution.

Describe how pure lead(II) sulfate can be obtained from the mixture.

Filter the solution, wash the residue with distilled water, and dry the residue using a clean cloth or let it to dry in the air.

7 This question is about organic compounds.

(a) Butane reacts with chlorine in a photochemical reaction.

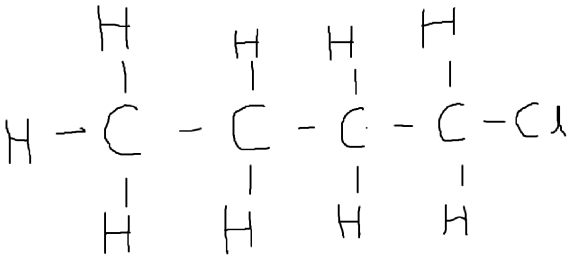
$$C_4H_{10} + Cl_2 \rightarrow C_4H_9Cl + HCl$$

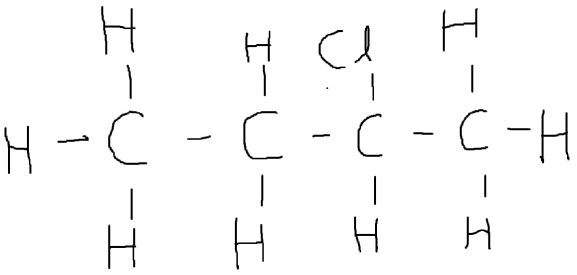
(i) State the meaning of the term photochemical.

The reaction needs or uses ultraviolet light.

(ii) An organic compound with the formula C_4H_9Cl is formed when one molecule of butane reacts with one molecule of chlorine.

Draw the displayed formulae of **two** possible structural isomers with the formula C_4H_9Cl formed in this reaction.





(b) The structure of compound **A** is shown in Fig. 7.1.

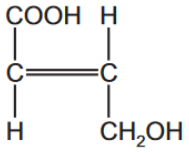


Fig. 7.1

(i) Deduce the molecular formula of compound **A**.

$C_4H_6O_3$

(ii) There are three functional groups in compound **A**.

Name the homologous series of compounds that contain the following functional groups:

$-C=C-$: alkene

$-OH$: alcohol

$-COOH$: carboxylic acid

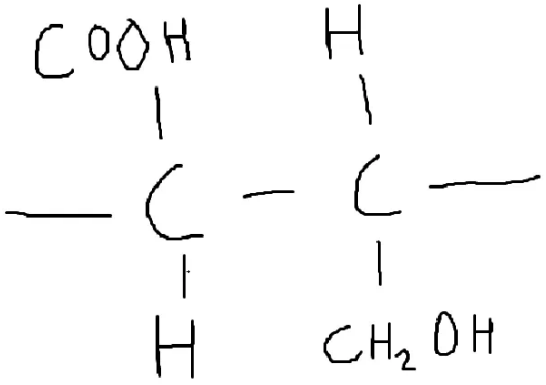
(iii) State what is observed when compound **A** is added to:

Aqueous bromine: turns colourless

Aqueous sodium carbonate: bubbling/ fizzing/ effervescence

(iv) Compound **A** can be used as a single monomer to produce two different polymers.

Draw **one** repeat unit of the addition polymer formed from compound **A**.



(v) Compound **A** can be converted into a dicarboxylic acid.

Name the type of condensation polymer formed from a dicarboxylic acid and a diol.

Polyester

Additional notes

If you find any errors or mistakes within this paper, please contact us and we will fix them as soon as possible.