Paper 3

Questions are applicable for both core and extended candidates

1 A list of symbols and formulae is shown.

Br_2
CH_4
C_2H_4
Cl^-
CO_2
Cr^{3+}
Cu^{2+}
H_2
K^+
N_2
N^{3-}
O_2
SO_4^{2-}

Answer the following questions about these symbols and formulae.
Each symbol or formula may be used once, more than once or not at all.

State which symbol or formula represents:

(a) a molecule containing only five atoms

..... [1]

(b) a diatomic molecule of an element in Group VII of the Periodic Table

..... [1]

(c) an ion formed when an atom gains one electron

..... [1]

(d) an ion which forms a green precipitate when a few drops of aqueous sodium hydroxide are added to it

..... [1]

(e) a compound produced by the thermal decomposition of calcium carbonate

..... [1]

(f) a product of photosynthesis.

..... [1]

[Total: 6]

2 **(a)** Fig. 7.1 shows the displayed formula of compound **S**.

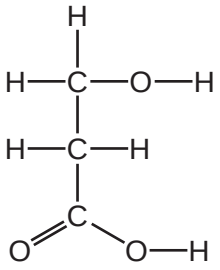


Fig. 7.1

(i) On Fig. 7.1, draw a circle around the carboxylic acid functional group. [1]

(ii) Deduce the molecular formula of compound **S**.

..... [1]

3(e) When cobalt(II) oxide, CoO, is heated in air an oxide with the formula Co_3O_4 is formed.

Balance the equation for this reaction.

..... $CoO + O_2 \rightarrow 2Co_3O_4$ [1]

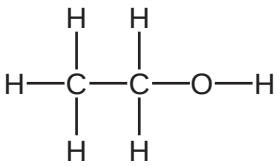
4 **(c)** Hydrogen sulfide burns in air to produce sulfur dioxide and water.

(i) Complete the chemical equation for this reaction.

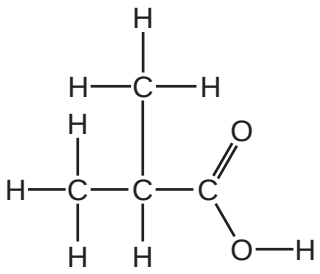
$.....H_2S + ...O_2 \rightarrow 2H_2O + 2SO_2$ [2]

5 **(a)** The structures of four organic compounds, **P**, **Q**, **R** and **S**, are shown.

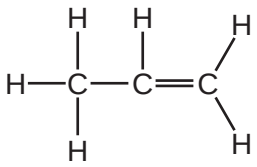
P



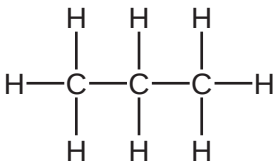
Q



R



S



Answer the following questions about these structures.

Each structure may be used once, more than once or not at all.

(iv) Deduce the molecular formula of structure **Q** to show the number of carbon, hydrogen and oxygen atoms.

..... [1]

6 This question is about chlorine and compounds of chlorine.

Chlorine is an element in Group VII of the Periodic Table.

(c) Chlorine reacts with phosphorus to produce phosphorus(V) chloride.

(i) Balance the equation for this reaction.

$$.....P + ...Cl_2 \rightarrow 2PCl_5$$ [2]

7 This question is about zinc and compounds of zinc.

(b) Zinc reacts with phosphorus to form zinc phosphide, Zn_3P_2.

Complete the equation for this reaction.

$$.....Zn + ...P \rightarrow Zn_3P_2$$ [2]

Paper 4

Questions are applicable for both core and extended candidates unless indicated in the question

8 This question is about acids, bases and alkalis.

Table 3.1 shows the pH values of some substances.

Table 3.1

substance	pH
NaOH(aq)	14
$Ca(OH)_2(aq)$	10
$H_2O(l)$	7
$CH_3COOH(aq)$	4
$HNO_3(aq)$	1

(f) Write the **ionic** equation which represents a neutralisation reaction between any acid and any alkali. **(extended only)**

..... [1]

9 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.

$$.....FeS_2 + ...O_2 \rightarrow .....Fe_2O_3 + ...SO_2$$ [1]

(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. **(extended only)**

..... [1]

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

..... [3]

10 Order of reactivity can be determined by displacement reactions.

(a) A student investigates the reactivities of four metals by carrying out a series of experiments.

Each of the metals lead, manganese, silver and zinc are added separately to aqueous metal nitrates of the other metals.

(i) Table 3.1 shows some of the results.

Table 3.1

aqueous solution	lead Pb	manganese Mn	silver Ag	zinc Zn
lead(II) nitrate		✓		
manganese(II) nitrate				
silver nitrate	✓	✓		✓
zinc nitrate	✗	✗		

key

✓ = displacement reaction occurs

✗ = displacement reaction does not occur

Complete Table 3.1 and place the four metals in their order of reactivity with the most reactive first.

1 ..... most reactive

2 .....

3 .....

4 .....

[3]

(ii) Suggest why the metal nitrates and not the metal sulfates of these four metals are used as the aqueous solutions.

..... [1]

(iii) Write the symbol equation for the reaction between zinc and silver nitrate. **(extended only)**

..... [2]

11 Element **X** can undergo the following physical changes.

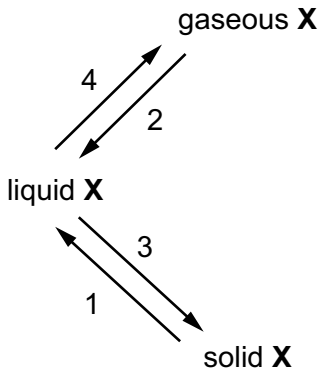


Fig. 1.1

(c) Element **X** is a Group III metal. It burns in air to form an oxide $\mathbf{X}_2O_3$.

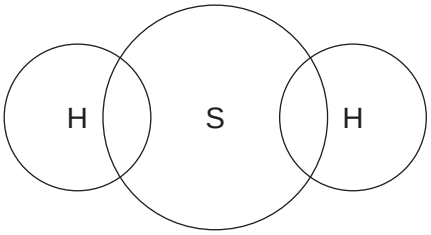
Write a symbol equation for this reaction. **(extended only)**

..... [2]

12 This question is about compounds of sulfur.

(b) Hydrogen sulfide has the formula H_2S.

(i) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of hydrogen sulfide. Show outer shell electrons only.



[2]

(ii) Balance the chemical equation for the reaction of hydrogen sulfide with sulfur dioxide shown.

$$.....H_2S + SO_2 \rightarrow .....S + ...H_2O$$ [1]

13 Ethanoic acid is manufactured by the reaction of methanol with carbon monoxide.

(h) Ester **Y** has the following composition by mass:

C, 48.65%; H, 8.11%; O, 43.24%.

Calculate the empirical formula of ester **Y**. **(extended only)**

empirical formula = ... [3]

(i) Ester **Z** has the empirical formula C_2H_4O and a relative molecular mass of 88.

Determine the molecular formula of ester **Z**. **(extended only)**

molecular formula = ... [1]