Core 1

Many buildings are made of concrete. Concrete is a mixture of cement, sand, water and small stones.

(a) Explain what is meant by the term *mixture*.

....

....[2]

(b) Sand is largely silicon(IV) oxide. Pure silicon(IV) oxide is a compound. Explain what is meant by the term *compound*.

....

....[2]

(c) Cement is made by roasting clay with crushed chalk. Chalk is largely calcium carbonate. When cement is made, some of the calcium carbonate breaks down to calcium oxide.

$$\underset{\text{calcium carbonate}}{CaCO_3(s)} \rightarrow \underset{\text{calcium oxide}}{CaO(s)} + \underset{\text{carbon dioxide}}{CO_2(g)}$$

(i) What type of chemical reaction is this?

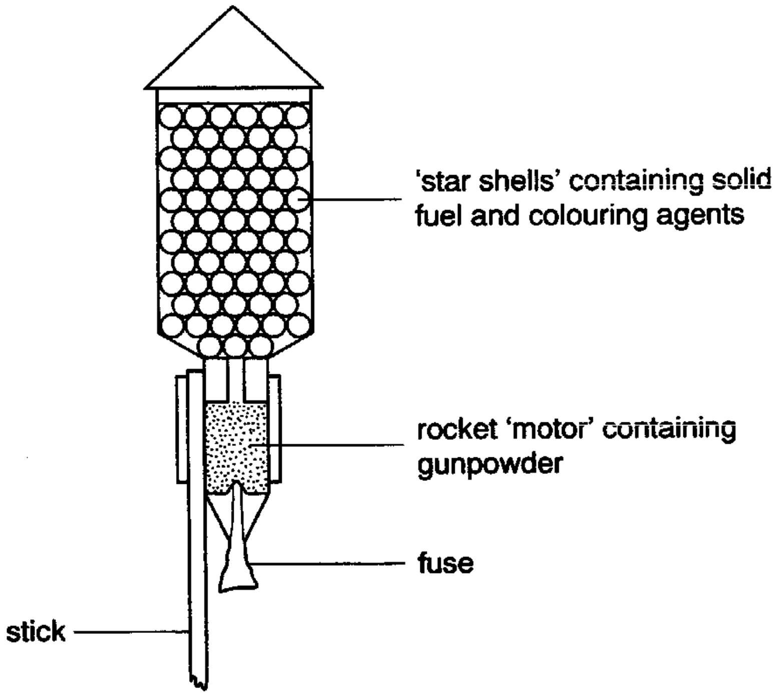
....[1]

(ii) Which of the three chemicals in this reaction (calcium carbonate, calcium oxide or carbon dioxide) has the lowest relative formula mass?

....[1]

Core 2

The diagram shows the inside of a firework rocket.



(a) When gunpowder is ignited, energy is released.

What is the name given to the type of reaction which releases energy?

....[1]

(b) Gunpowder contains two fuels, powdered charcoal and sulphur.
These burn in oxygen supplied by potassium nitrate to form carbon dioxide and sulphur dioxide.

Write a balanced equation for the complete combustion of sulphur in oxygen.

[2]

(c) Explain why the charcoal and sulphur in fireworks are present as fine powders rather than as large lumps.

....

....[2]

(d) Lactose, $C_{12}H_{22}O_{11}$, is sometimes used in place of charcoal in fireworks.

(i) State the total number of atoms present in a molecule of lactose.

....[1]

(ii) Name the products formed from the complete combustion of lactose.

....[2]

(g) Some copper compounds absorb water. At high temperatures, this water may react with other chemicals in the firework, such as magnesium.

Complete the equation, showing the reaction of magnesium with steam.

magnesium + steam → .... + ...

[2]

Extenion 1

A sample of impure copper was dissolved in nitric acid. The solution of copper(II) nitrate was filtered to remove solid impurities and evaporated to dryness. The solid nitrate was heated to constant mass to leave only copper(II) oxide.

Results
Mass of impure copper = 4.21 g
Mass of copper oxide = 4.80 g

$2Cu(NO_3)_2(s) \longrightarrow 2CuO(s) + 4NO_2(g) + O_2(g)$

(i) Complete the following to determine the percentage purity of the sample of copper.

The mass of one mole of CuO = 80 g

number of moles of CuO formed = ... [1]

mass of copper in copper(II) oxide = ... [1]

percentage of copper = ... [1]

(ii) Calculate the total volume of gas formed at r.t.p.

total number of moles of gas formed = ... [2]

volume of gas formed = ...dm^3 [1]

Extension 2

(b) The main ore of scandium is thortveitite, $Sc_2Si_2O_7$. This is converted into scandium fluoride which reacts with calcium to produce scandium metal.

(i) Balance the ionic equation for the reaction between scandium fluoride and calcium.

.....Ca + ...Sc^{3+} $\longrightarrow$ ....Ca^{2+} + ...Sc [1]

(ii) Which change in the above reaction is oxidation? Give a reason for your choice.

....

....

....[2]

(iii) An alternative method of extracting scandium is by the electrolysis of a molten mixture that contains scandium chloride. Write ionic equations for the reactions at the electrodes.

reaction at cathode ....

reaction at anode ....[2]

Extension 3

(d) A 43 g sample of scandium ore, $Sc_2Si_2O_7$ produced 12 g of scandium. Calculate the percentage yield by completing the following calculation.

The mass of one mole of $Sc_2Si_2O_7$ is 258 g

Number of moles of $Sc_2Si_2O_7$ in 43 g of the ore = ...

One mole of $Sc_2Si_2O_7$ will give ....moles of Sc

43 g of $Sc_2Si_2O_7$ will produce ....moles of Sc

43 g of $Sc_2Si_2O_7$ will produce ....g of Sc

Percentage yield of scandium = ...

= .... [5]

Extension 4

You will need to use the Periodic Table of the Elements to answer this question.

(a) A radioactive isotope of the element iodine, ^{125}I, is used to treat cancer. How many electrons and how many neutrons are there in one atom of this isotope of iodine?

number of electrons ....[1]

number of neutrons ....[1]

(b) Given below are the formulae of the oxides of some of the elements. They are given in the same order as in the Periodic Table.

MgO	Al_2O_3	SiO_2	P_2O_3
CaO			
SrO			

(i) Use the electronic structures of the elements to explain why oxides of elements in the same group have the same type of formula.

....

....

....[2]

(ii) Use the electronic structures of the elements to explain why oxides of elements in the same period have different formulae.

....

....

....[1]

(iii) Complete the table that shows the reaction, if any, of the oxides with acid and alkali. Indicate a reaction with "R" and no reaction with "NR".

oxide	type of oxide	reaction with acid	reaction with alkali
magnesium oxide	basic		
aluminium oxide	amphoteric		
silicon(IV) oxide	acidic		

[3]

(c) **(i)** Predict the formula for:

the strontium ion, ...

the phosphide ion. ....

[2]

(ii) Write the formula for strontium phosphide ....[1]

(ii) How could you show that the carbonate gave off carbon dioxide on heating?

....[2]

(iii) Explain why sodium hydroxide reacts with the non-metal oxide carbon dioxide.

....

....[2]

(d) Use the following information to calculate *x* and *y* and to write the formula for the basic lead(II) carbonate.

$$PbCO_3 \longrightarrow PbO + CO_2$$
$$Pb(OH)_2 \longrightarrow PbO + H_2O$$

The basic lead(II) carbonate when heated gave 1.056 g of carbon dioxide and 0.216 g of water.

The mass of one mole of CO_2 = ... g [1]

Number of moles of CO_2 formed = ... [1]

The mass of one mole of H_2O = 18 g

Number of moles of H_2O formed = ... [1]

Therefore x = ... and y = ...

The formula for the basic carbonate is .... [1]

Core 1

a several different substances present
which can be separated by physical means / not chemically bonded

b two or more elements / more than one type of atom
chemically combined / bonded / joined

c(i) thermal decomposition

(i) carbon dioxide CO_2

Core 2

a exothermic

b $S + O_2 = SO_2$

c powder has larger (overall) surface area / lumps have smaller surface area
reaction faster with powder / slower with lumps

d(i) 45

(ii) carbon dioxide
water

e magnesium oxide; hydrogen

Extension 1

i $4.8/80 = 0.06$

$64*0.06 = 3.84$ g

$3.84/4.21*100 = 91\%$

ii moles of $CuO = 0.06$

total moles of gas $= 0.06 \times 2.5 = 0.15$

$0.15 \times 24 = 3.6\ dm^3$

Extension 2

ai $3Ca + 2Sc^{3+} \longrightarrow 3Ca^{2+} + 2Sc$

ii Ca (to Ca^{2+})

iii $Sc^{3+} + 3e \longrightarrow Sc$

$2Cl^- \longrightarrow Cl_2 + 2e$

b 43/258 = 0.167 or 1/6

2

0.333 * 45 = 15 g

12/15 * 100 = 80%

Extension 3

a 54
1235 – 54 = 71

b(i) have same number of outer electrons
same valency or need to lose or gain same number

(ii) have different number of outer electrons

(iii)

R	**NR**
R	**R**
NR	**R**

c(i) Sr^{2+}
P^{3-}

(ii) Sr_3P_2

Extension 4

44 g

1.056/44 = 0.024

0.216/18 = 0.012

x = 2 and y = 1

$2PbCO_3.yPb(OH)_2$