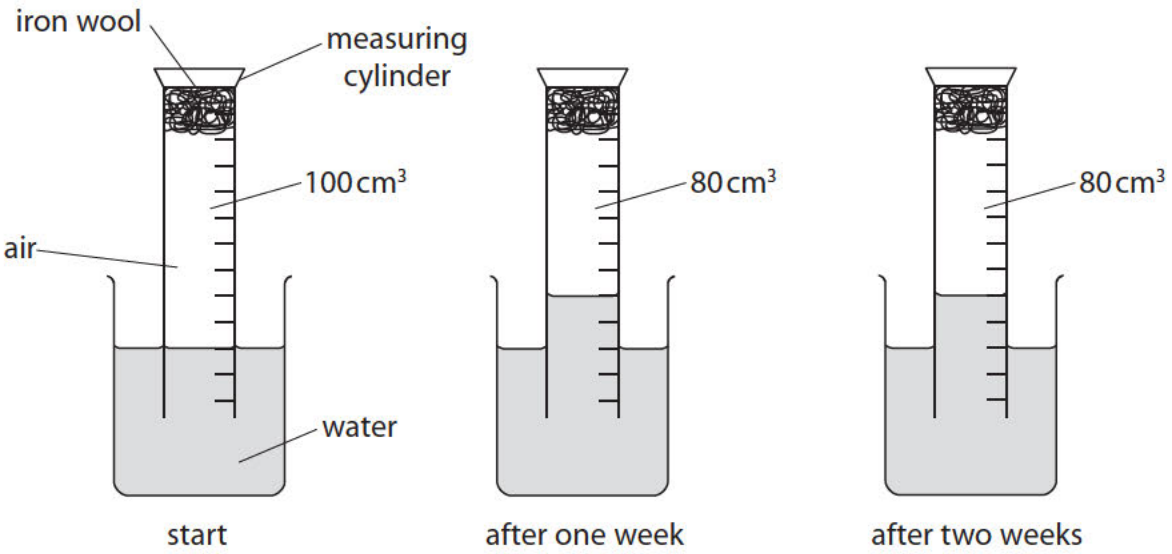
1 The apparatus in the diagram was set up to demonstrate the rusting of iron.



(a) One week after the start of the experiment the volume of gas in the measuring cylinder has decreased.

After two weeks there is no further decrease in volume of gas in the measuring cylinder.

Explain these observations.

(2)

.....

.....

.....

.....

.....

.....

(b) Iron reacts with dilute sulfuric acid. The chemical equation for this reaction is

$$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$$

Complete the word equation for the reaction.

(2)

Iron + sulfuric acid → ..... + ...

(c) Aqueous sodium hydroxide can be used to distinguish between solutions containing iron(II) ions (Fe^{2+}) and iron(III) ions (Fe^{3+}).

State the observation made when aqueous sodium hydroxide is added separately to each solution.

(2)

$Fe^{2+}(aq)$.....

$Fe^{3+}(aq)$.....

(Total for Question 1 = 6 marks)

2 This is a recipe for making Irish soda bread.

- add 170 g of wholemeal flour, 170 g of plain flour, 10 g of salt and 10.5 g of bicarbonate of soda (sodium hydrogencarbonate, $NaHCO_3$) to a bowl and stir
- pour in 290 cm^3 of buttermilk and stir quickly to form a soft dough
- form the dough into a round ball and slightly flatten it
- cut a cross in the top and bake for 30 minutes in an oven at 200 °C

When sodium hydrogencarbonate is heated, it forms carbon dioxide gas.

$$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

(a) Calculate the mass, in grams, of carbon dioxide that would be produced by completely decomposing 10.5 g of sodium hydrogencarbonate.
[M_r of $NaHCO_3$ = 84]

(2)

mass of carbon dioxide = ... g

(b) Use your answer from part (a) to calculate the volume, in cm^3, at room temperature and pressure, of carbon dioxide that would be produced by completely decomposing 10.5 g of sodium hydrogencarbonate.

Assume one mole of carbon dioxide has a volume of 24000 cm^3 at room temperature and pressure.

(2)

volume of carbon dioxide = ... cm^3

(Total for Question 2 = 4 marks)

3 This question is about the reactions of compounds of antimony and phosphorus.

(a) Antimony (Sb) can be obtained from its oxide (Sb_2O_4) by heating it with carbon.

The equation for this reaction is

$$Sb_2O_4(s) + 4C(s) \rightarrow 2Sb(s) + 4CO(g)$$

(i) Give the name of the gas produced in this reaction.

(1)

.....

(ii) State why this gas is poisonous to humans.

(1)

.....

.....

.....

(b) Phosphorus sulfide (P_4S_3) is one of the reactants used in match heads.

When a match is struck, energy is transferred to the reactants in the match head, starting a reaction.

(i) Balance the equation that represents this reaction.

(2)

$6KClO_3(s)$ + ...$S(s)$ + ...$P_4S_3(s)$ → .....$KCl(s)$ + ...$SO_2(g)$ + ...$P_4O_{10}(s)$

(ii) What term is used to describe the energy required to start a reaction?

(1)

.....

(Total for Question 3 = 5 marks)

4 Sodium azide (NaN_3) is a stable compound at room temperature but decomposes when heated to 300 °C. The equation for the decomposition is:

$$2NaN_3(s) \rightarrow 2Na(l) + 3N_2(g)$$

Sodium azide is used to produce nitrogen gas to inflate car airbags.



If a car is involved in a collision, the sodium azide decomposes.

The nitrogen gas is produced very rapidly and the airbag inflates almost immediately.

(a) (i) A fully-inflated airbag has a total volume of 108 dm^3.
Calculate the amount of nitrogen, in moles, in a fully-inflated airbag.
[You should assume that the volume of one mole of nitrogen inside the airbag is 24 dm^3]

(2)

Amount of nitrogen = mol

(ii) Use your answer to (a)(i) to calculate the mass, in grams, of sodium azide required to produce 108 dm^3 of nitrogen.

(3)

Mass of sodium azide required = g

(b) The airbag also contains potassium nitrate. This reacts with sodium formed in the decomposition of sodium azide. The equation for the reaction is:

$$10Na(l) + 2KNO_3(s) \rightarrow K_2O(s) + 5Na_2O(s) + N_2(g)$$

(i) Suggest **one** reason why the makers of the airbag might want this reaction to occur.

(1)

(ii) The airbag also contains silicon dioxide (SiO_2) which reacts with the oxides produced in the reaction above. This forms a glassy solid which seals all the products into the airbag.

The glassy solid contains potassium silicate (K_2SiO_3).

Construct an equation for the formation of potassium silicate from potassium oxide. **Include state symbols**.

(1)

(c) Another use of sodium azide is to make lead(II) azide, which can be used as a detonator for explosives. Lead(II) azide has the formula of $Pb(N_3)_2$

Lead(II) azide can be made by the following reaction:

$$Pb(NO_3)_2(aq) + 2NaN_3(aq) \rightarrow Pb(N_3)_2(s) + 2NaNO_3(aq)$$

(i) What name is given to this type of reaction?

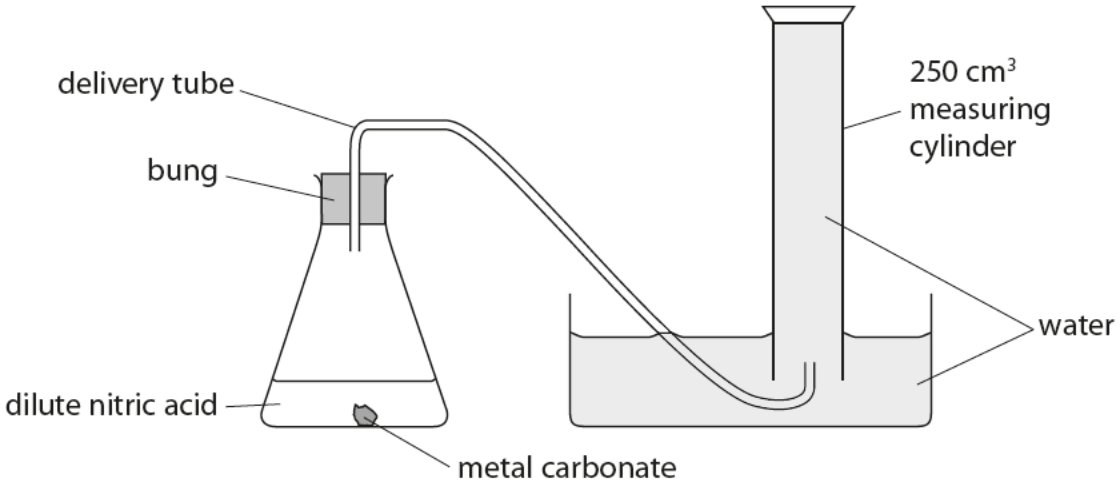
(1)

(ii) What method would you use to remove the lead(II) azide from the final reaction mixture?

(1)

(Total for Question 4 = 9 marks)

5 A student set up this apparatus to measure the volume of carbon dioxide given off when a sample of a carbonate of a Group 2 metal was reacted with dilute nitric acid.



She weighed out some of the carbonate and put it in a conical flask. She then added an excess of dilute nitric acid.

After adding the acid she placed the bung and delivery tube into the conical flask.

She measured the total volume of gas collected at room temperature and pressure (rtp) in the measuring cylinder.

Her results are shown in the table.

Mass of Group 2 carbonate	0.888 g
Volume of gas collected	144 cm^3

The equation for the reaction is

$$XCO_3(s) + 2HNO_3(aq) \rightarrow X(NO_3)_2(aq) + H_2O(l) + CO_2(g)$$

where X is the symbol for the Group 2 metal.

(a) (i) Calculate the amount, in moles, of carbon dioxide gas collected.
(Assume that one mole of gas has a volume of 24 000 cm^3 at rtp)

(2)

Amount of carbon dioxide gas collected = ... mol

(ii) Deduce the amount, in moles, of the carbonate that reacted.

(1)

Amount of carbonate reacted = ... mol

(iii) Using the mass of the carbonate and your answer to (a)(ii), calculate the relative formula mass (M_r) of this carbonate.

Give your answer to the nearest whole number.

(2)

Relative formula mass = ...

(iv) Calculate a value for the relative atomic mass of the Group 2 metal, X, and use the Periodic Table on page 2 to suggest its identity.

(3)

Relative atomic mass of X = ...

Identity of X = ...

(b) After the student had completed the experiment she was told that the metal carbonate was calcium carbonate.

She calculated that 0.888 g of calcium carbonate would produce 213 cm^3 of carbon dioxide.

She was certain that she had measured the mass of the metal carbonate correctly.

Suggest **two** reasons why the volume of gas she collected was less than 213 cm^3.

(2)

1 .....

.....

2 .....

.....

(Total for Question 5 = 10 marks)

6 Sulfur dioxide, SO_2, is used as a preservative in wine.

The sulfur dioxide content of a wine can be found by titration. A chemist found that 25.0 cm^3 of a sample of wine reacted with exactly 15.00 cm^3 of 0.0010 mol/dm^3 aqueous iodine, $I_2(aq)$.

The equation for the reaction is

$$SO_2(aq) + I_2(aq) + 2H_2O(l) \rightarrow SO_4^{2}(aq) + 2I(aq) + 4H^+(aq)$$

(a) Calculate the amount, in moles, of iodine in 15.00 cm^3 of a 0.0010 mol/dm^3 solution.

(2)

(b) Deduce the amount, in moles, of sulfur dioxide in 25.0 cm^3 of the wine.

(1)

(c) Calculate the concentration, in mol/dm^3, of sulfur dioxide in the wine.

(2)

(d) Calculate the concentration, in g/dm^3, of sulfur dioxide in the wine.

(2)

(e) A concentration of sulfur dioxide that is greater than 0.16 g/dm^3 makes wine unpleasant to drink.

Use the value you have calculated in (d) to state whether the wine is drinkable.

(1)

.....

.....

(Total for Question 6 8 marks)

7 (a) The list shows some techniques used to separate mixtures.

A crystallisation

B filtration

C fractional distillation

D paper chromatography

E simple distillation

Complete the table to show the best method of obtaining each substance from the mixture.

In each case, choose one of the letters A, B, C, D or E. Each letter may be used once, more than once or not at all.

(4)

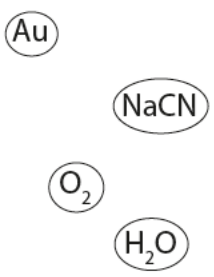
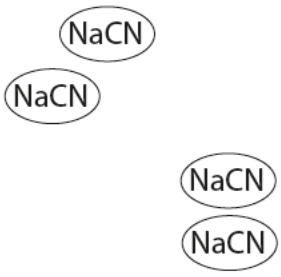
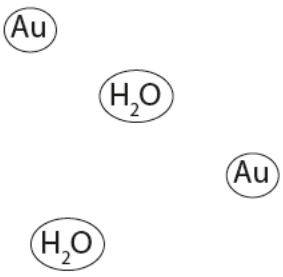
Substance	Mixture	Letter
sand	sand and water	
solid copper(II) sulfate	aqueous copper(II) sulfate	
red food dye	mixture of food dyes	
kerosene	crude oil	

(b) Gold occurs in ores, which are mixtures of gold and other substances. Several elements and compounds are used in the extraction of gold from its ores.

Each box below represents the substances present in one part of the extraction process.

Classify the contents of each box as a compound, an element or a mixture by writing your choice below each box.

(3)

			
Compound, element or mixture			

(Total for Question 7 = 7 marks)