PEARSON EDEXCEL IGCSE CHEMISTRY · 4CH1

CHEMISTRY



EXAM QUESTION PACK

SECTION 1: PRINCIPLES OF CHEMISTRY (PACK 4)

SCORE	PERCENTAGE
/212	%

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Q1.

(a) The box shows some changes of state.

boiling	condensation	evaporation
freezing	melting	sublimation

The table lists some physical changes.

Complete the table using words from the box to show the change of state for each physical change.

(4)

Physical change	Change of state
water to ice	
steam to water	
solid wax to liquid wax	
iodine crystals to iodine vapour	

(b) A student plans to obtain salt crystals from a mixture of salt and sand.

The student adds pure water to the mixture to dissolve the salt.

(i) State two things the student could do to make the salt dissolve quickly.

(2)

1 .....

2 .....

(ii) State what the student should do next to separate the sand from the salt solution.

(1)

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(iii) Describe how the student can obtain pure dry crystals of salt from the salt solution.

(4)

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(Total for question = 11 marks)

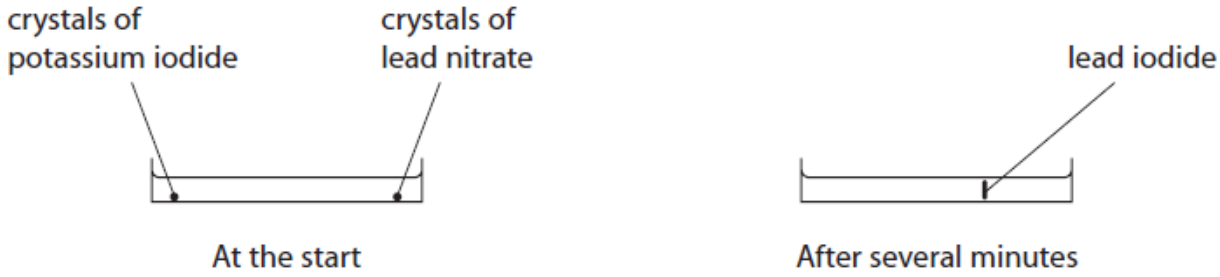
Q2.

Lead nitrate and potassium iodide react to form the insoluble solid lead iodide.

Crystals of lead nitrate and potassium iodide are placed at opposite ends of a container of water.

Solid lead iodide forms after several minutes.

The diagram shows the container at the start and after several minutes.



(a) Name the two processes that occur before the solid lead iodide forms.

(2)

1 .....

2 .....

(b) Explain why solid lead iodide takes less time to form when the reaction is repeated using water at a higher temperature.

(2)

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(c) The formula for lead nitrate is $Pb(NO_3)_2$

(i) Give the number of different elements in lead nitrate.

(1)

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(ii) Give the charge on the lead ion in $Pb(NO_3)_2$

(1)

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(d) Complete the chemical equation for the reaction between lead nitrate and potassium iodide.

(1)

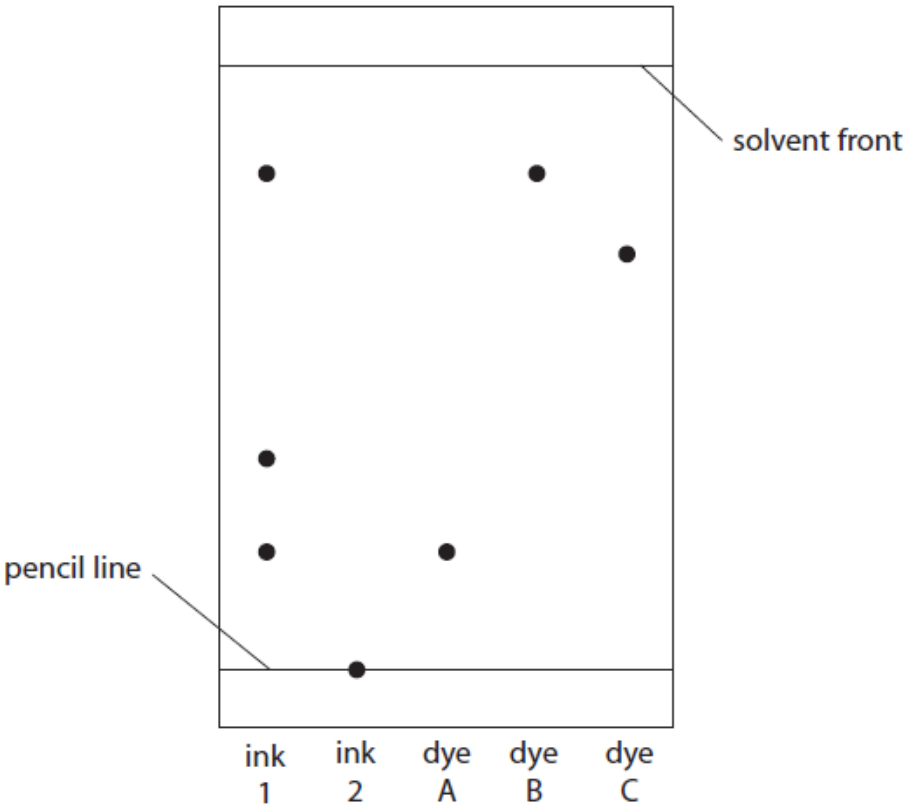
$Pb(NO_3)_2(aq)$ + ... $KI(aq) \rightarrow PbI_2(s)$ + ... $KNO_3(aq)$

(Total for question = 7 marks)

Q3.

A student does a chromatography experiment using ink 1, ink 2, and three known dyes A, B and C. The student uses water as the solvent.

The diagram shows the student's chromatogram.



(a) Deduce what conclusions can be made about the composition of ink 1.

(2)

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(b) (i) Give one conclusion that can be made about ink 2.

(1)

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(ii) Suggest how the student could change the experiment to find the composition of ink 2.

(1)

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.....

(c) Calculate the R_f value of dye C, giving your answer to 2 significant figures.

(3)

R_f value = ...

(Total for question = 7 marks)

Q4.

This question is about chromatography.

Two students carry out separate chromatography experiments to find the R_f values for five different food dyes, A, B, C, D and E.

(a) State two things that should be the same in both experiments so that the students can compare their results fairly.

(2)

1 .....

2 .....

(b) After doing the experiments the students calculate the R_f value for each food dye.

The table shows their results.

Dye	Student 1 R_f value	Student 2 R_f value
A	0.45	0.45
B	0.63	0.64
C	0.00	0.00
D	0.83	1.20
E	0.30	0.30

(i) State what can be concluded about dye C.

(1)

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(ii) Explain which R_f value cannot be correct.

(2)

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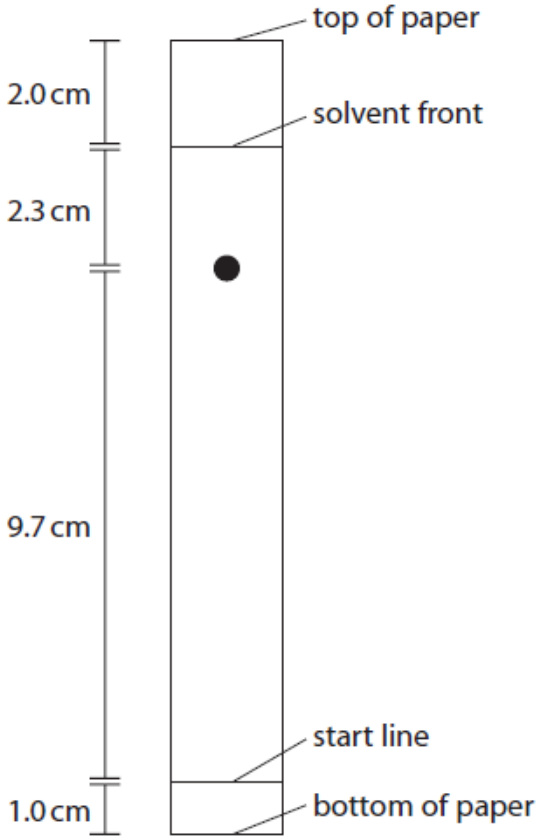
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(c) The diagram shows a chromatogram for a different food dye.

Some distances are shown on the diagram.



Calculate the R_f value for this food dye.

Give your answer to two significant figures.

(3)

R_f = ...

(Total for question = 8 marks)

Q5.

The table shows the molecular formulae of six organic compounds, A, B, C, D, E and F.

A	B	C	D	E	F
C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4H_8	C_4H_{10}

(a) (i) Explain which homologous series compound B belongs to.

(2)

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(ii) Give the letter of the compound that has the same empirical formula as its molecular formula.

(1)

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(iii) Compound F exists as two isomers.

Explain what is meant by the term **isomers**.

Include the structures of the two isomers of compound F in your answer.

(3)

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(b) Describe how compound D can be obtained from crude oil using the industrial process of fractional distillation.

(4)

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(c) Compound C can be used to make a polymer.

(i) State the type of polymer formed from compound C.

(1)

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(ii) Name the polymer formed from compound C.

(1)

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(iii) Draw the structure of this polymer.

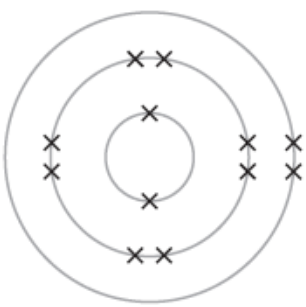
Include the displayed formula of the repeat unit.

(2)

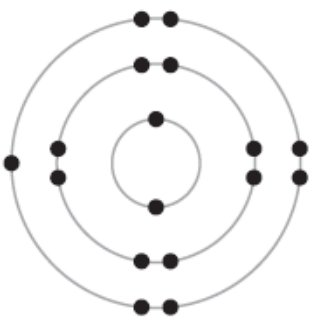
(Total for question = 14 marks)

Q6.

(a) The diagram shows the electronic configuration of an atom of magnesium and an atom of chlorine.



Magnesium



Chlorine

Describe the changes in the electronic configurations of magnesium and chlorine when they react to form magnesium chloride, $MgCl_2$

(2)

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(b) A sample of chlorine contains these percentages of two isotopes.

Cl-35 = 70% Cl-37 = 30%

(i) Use this information to calculate the relative atomic mass (A_r) of this sample of chlorine.

(2)

A_r = ...

(ii) Both chlorine isotopes react with magnesium in the same way.

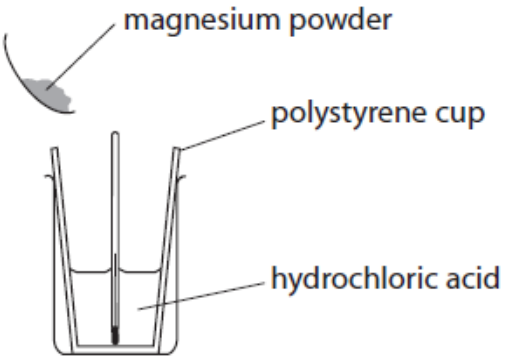
Give a reason why both isotopes react in the same way.

(1)

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(c) A student uses this apparatus to investigate the temperature change when magnesium powder reacts with hydrochloric acid.



The student uses this method.

- pour 100 cm^3 of hydrochloric acid into a polystyrene cup
- measure the initial temperature of the acid
- add the magnesium powder and stir
- measure the highest temperature reached by the mixture

The table shows the student's results.

Initial temperature of the acid in °C	18.1
Highest temperature of the mixture in °C	45.6

(i) Use the student's results to explain the type of reaction that occurs when magnesium is added to hydrochloric acid.

(2)

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(ii) Give a reason why the student uses a polystyrene cup.

(1)

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(iii) Use the student's results to calculate the heat energy change (Q), in joules, for this reaction.

[for 1.00 cm^3 of the mixture, mass = 1.00 g]

[for the mixture, c = 4.2 J / g / °C]

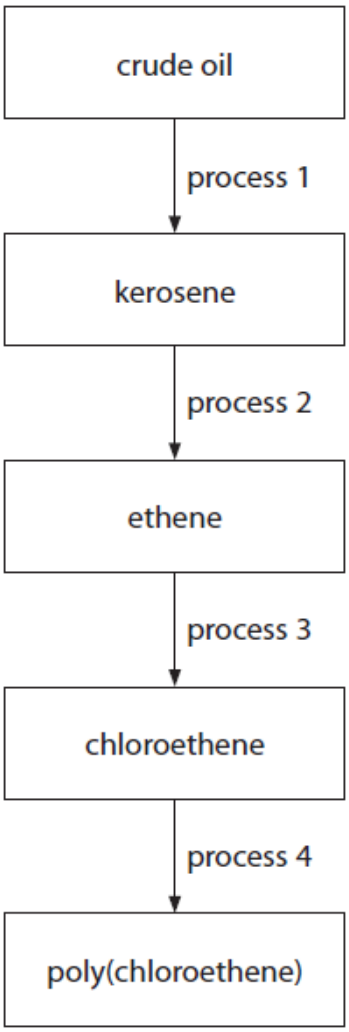
(3)

Q = ... J

(Total for question = 11 marks)

Q7.

The diagram shows some important conversion processes used in the oil industry.



(a) Describe how kerosene is produced from crude oil in process 1.

(5)

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(b) $C_{12}H_{26}$ is present in kerosene.

In process 2, $C_{12}H_{26}$ is cracked to produce two molecules of ethene and one molecule of another hydrocarbon.

(i) Complete the equation for the cracking of $C_{12}H_{26}$

(1)

$$C_{12}H_{26} \rightarrow 2C_2H_4 + \text{.....}$$

(ii) Explain why cracking is a useful process in the oil industry.

(4)

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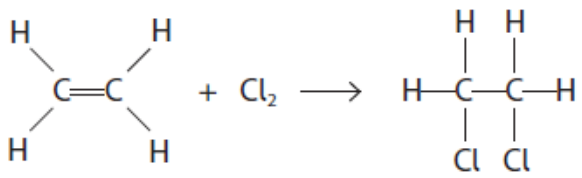
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(c) This is the equation for one of the reactions that may occur during process 3.



What is the name of this type of reaction?

(1)

☒ **A** addition

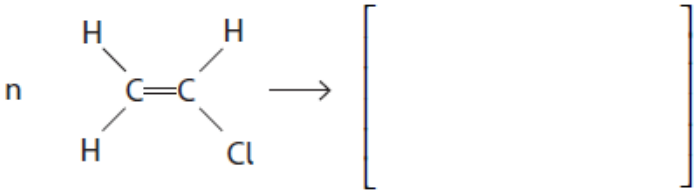
☒ **B** combustion

☒ **C** decomposition

☒ **D** substitution

(d)(i) Complete the equation for the polymerisation of chloroethene in process 4.

(2)



(ii) Explain why the disposal of polymers such as poly(chloroethene) is difficult.

(2)

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(Total for question = 15 marks)

Q8.

Ethene (C_2H_4) can be converted into chloroethene (C_2H_3Cl) in a two-stage process.

(a) The first stage is to convert ethene into 1,2-dichloroethane, $C_2H_4Cl_2$

Ethene is reacted with hydrogen chloride and oxygen.

Complete the chemical equation for this reaction.

(1)

..... C_2H_4 + ... HCl + ... O_2 → ..... $C_2H_4Cl_2$ + ... H_2O

(b) In the second stage, 1,2-dichloroethane is converted into chloroethene.

$$C_2H_4Cl_2 \rightarrow C_2H_3Cl + HCl$$

This is a thermal decomposition reaction.

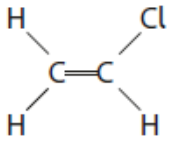
State what is meant by the term **thermal decomposition**.

(1)

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.....

(c) The diagram shows the displayed formula of chloroethene.



(i) State why chloroethene is described as an unsaturated compound.

(1)

.....

.....

(ii) Describe a test to show that chloroethene is unsaturated.

(2)

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.....

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.....

(d) Name the polymer formed from chloroethene.

(1)

.....

(Total for question = 6 marks)

Q9.

This question is about copper and copper compounds.

(a) A sample of copper contains two isotopes.

- Cu-63 with relative abundance 69.5%
- Cu-65 with relative abundance 30.5%

(i) State what is meant by the term **isotopes**.

(2)

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.....

(ii) Calculate the relative atomic mass (A_r) of this sample of copper.

Give your answer to three significant figures.

(3)

A_r of copper = ...

(b) When copper(II) carbonate is heated, copper(II) oxide and carbon dioxide are formed.

(i) What is the name of this type of reaction?

(1)

☒ **A** decomposition

☒ **B** neutralisation

☒ **C** oxidation

☒ **D** reduction

(ii) Which colour change occurs during this reaction?

(1)

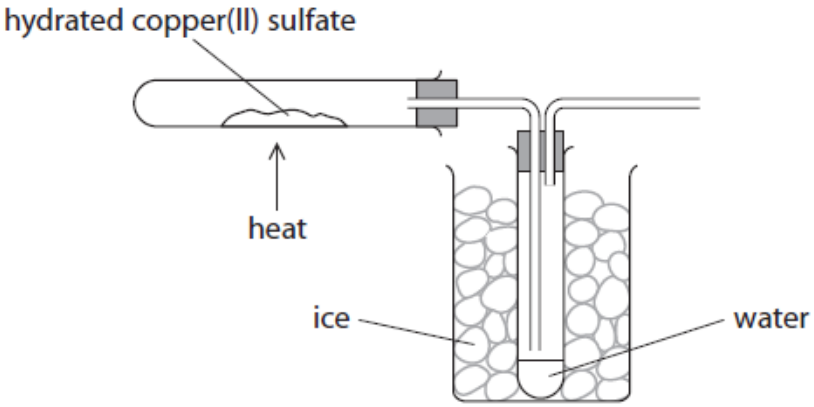
☒ **A** blue to black

☒ **B** blue to white

☒ **C** green to black

☒ **D** green to orange

(c) A student uses this apparatus to find the value of x in the formula $CuSO_4.xH_2O$



This is the student's method.

- find the mass of an empty boiling tube
- add hydrated copper(II) sulfate to the tube and record the new mass
- heat the hydrated copper(II) sulfate until it changes colour
- allow the tube to cool and record the mass again

The table shows the student's results.

mass of empty tube in g	20.52
mass of tube and $CuSO_4.xH_2O$ in g	31.77
mass of tube and $CuSO_4$ in g	28.20

(i) Calculate the mass of $CuSO_4$ formed.

(1)

mass of $CuSO_4$ = ... g

(ii) Calculate the mass of water formed.

(1)

mass of water = ... g

(iii) Show that the value of x is approximately 4

[M_r of $CuSO_4$ = 159.5 M_r of H_2O = 18]

(3)

(iv) The actual value of x is 5

Give a reason why the calculated value of x is lower than the actual value.

(1)

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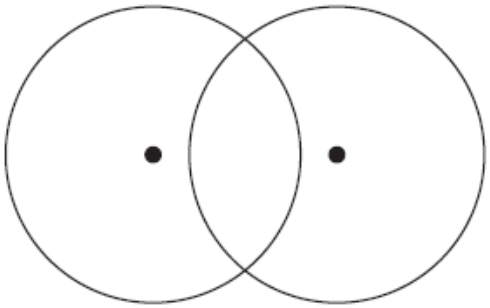
(Total for question = 13 marks)

Q10.

This question is about substances with covalent bonds.

(a) (i) Draw a dot and cross diagram to show the outer shell electrons in a molecule of nitrogen, N_2

(2)



(ii) Describe the forces of attraction in a covalent bond.

(2)

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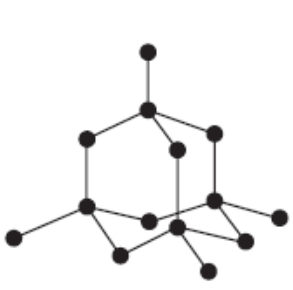
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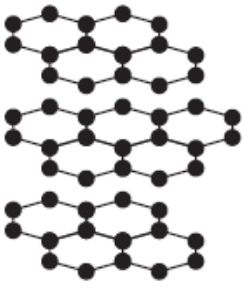
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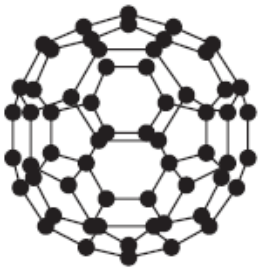
(b) The diagram shows three different structures of carbon.



Structure A



Graphite



C_{60} fullerene

(i) Name structure A.

(1)

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(ii) Graphite and C_{60} fullerene contain covalent bonds, but have different structures.

Explain why C_{60} fullerene has a much lower melting point than graphite. Refer to structure and bonding in your answer.

(4)

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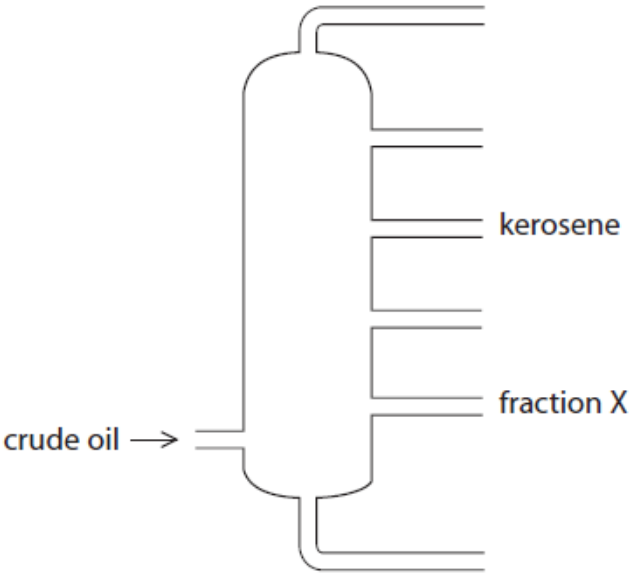
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(Total for question = 9 marks)

Q11. This question is about fractions obtained from crude oil.

(a) The diagram shows a fractional distillation column and two of the fractions obtained from crude oil.



Describe how the colour, boiling point and viscosity of fraction X differs from the kerosene fraction.

(3)

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(b) Octane (C_8H_{18}) is part of the gasoline fraction.

In a limited supply of air, octane undergoes incomplete combustion.

(i) Complete the chemical equation for the incomplete combustion of octane.

(2)

C_8H_{18} + ...O_2 → 5CO + ...CO_2 + ...H_2O

(ii) Give a reason why carbon monoxide (CO) gas is poisonous.

(1)

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(iii) Explain how the combustion of a common impurity in gasoline may cause an environmental problem.

(3)

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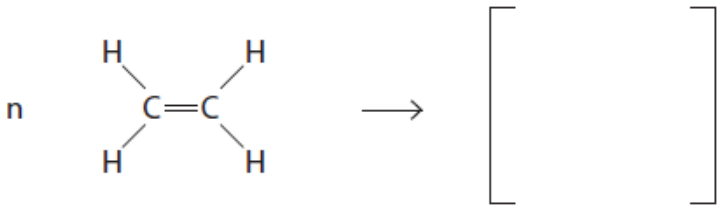
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(c) Ethene is obtained from one of the fractions in crude oil.

Ethene is used to make the polymer poly(ethene).

(i) Complete the equation for the conversion of ethene to poly(ethene).

(2)



(ii) Explain why poly(ethene) is difficult to dispose of in landfill sites.

(2)

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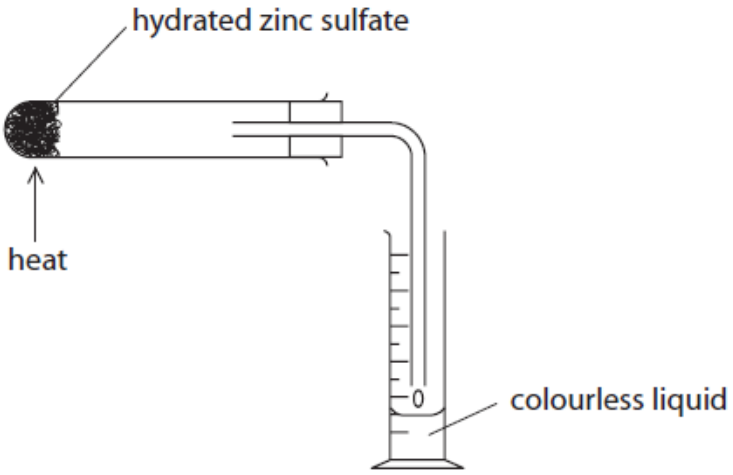
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(Total for question = 13 marks)

Q12.

A student uses this apparatus to heat crystals of hydrated zinc sulfate and collect the liquid produced.



(a) (i) Describe a chemical test to show that the colourless liquid contains water.

(2)

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(ii) Describe a physical test to show the colourless liquid is pure water.

(2)

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(b) The equation for the decomposition of hydrated zinc sulfate is

$$ZnSO_4Â{\cdot}7H_2O(s) \rightarrow ZnSO_4(s) + 7H_2O(l)$$

The student records these masses.

mass of boiling tube = 41.64 g

mass of boiling tube + $ZnSO_4Â{\cdot}7H_2O$ = 54.46 g

Calculate the maximum volume, in cm^3, of pure water that could be produced.

[1.00 cm^3 of pure water has a mass of 1.00 g]

[M_r of $ZnSO_4Â{\cdot}7H_2O$ = 287 M_r of H_2O = 18]

(5)

maximum volume of pure water = ... cm^3

(c) In an experiment using a different mass of $ZnSO_4Â·7H_2O$ the maximum volume of pure water that could be produced is 8.5 cm^3.

The student collected the pure water and calculated the percentage yield to be 20.3 %.

(i) Calculate the volume, in cm^3, of pure water collected.

(1)

volume of pure water = ... cm^3

(ii) Explain an improvement to the apparatus that would increase the percentage yield of pure water.

(2)

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(Total for question = 12 marks)

Q13.

A solution of hydrogen peroxide decomposes when a catalyst of manganese(IV) oxide is added.

The products of the reaction are water and oxygen.

(a) Complete the chemical equation for this reaction.

(1)

..... H_2O_2 → ..... H_2O + ... O_2

(b) Give a test for oxygen.

(1)

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(c) State the reason for adding a catalyst.

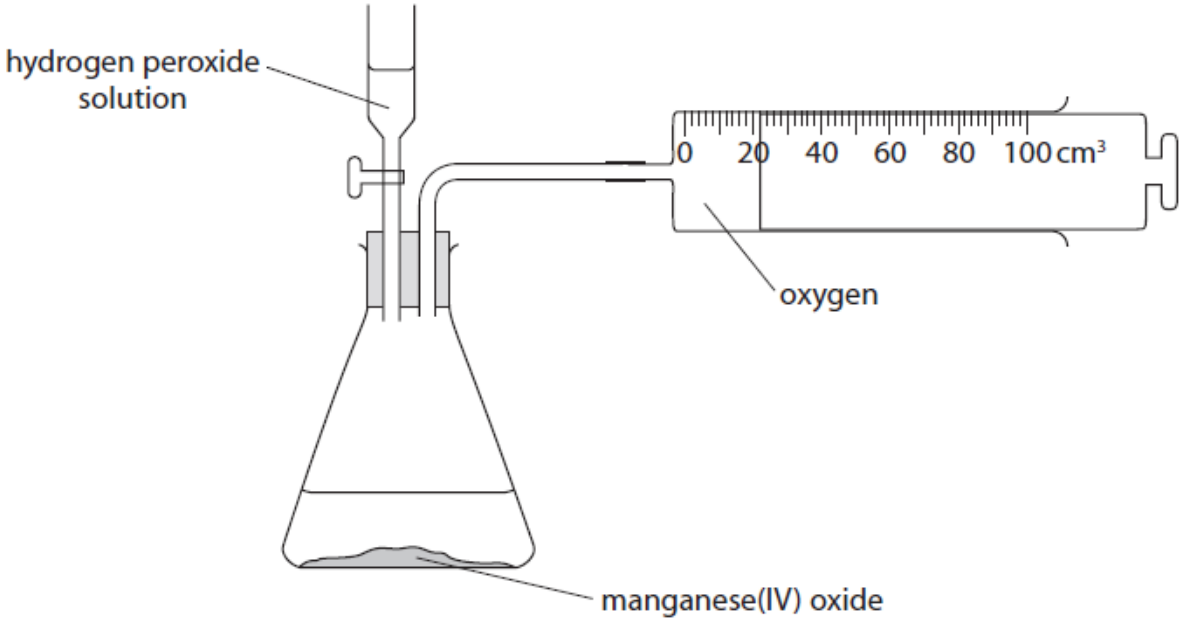
(1)

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(d) A student investigates how changing the concentration of the hydrogen peroxide solution affects the rate of this reaction.

She uses this apparatus.



The student records the volume of oxygen that collects every 2 minutes for 16 minutes.

The table shows her results.

Time in minutes	0	2	4	6	8	10	12	14	16
Volume of oxygen in cm³	0	22	38	50	55	69	76	80	80

(i) Plot the student's results on the grid.

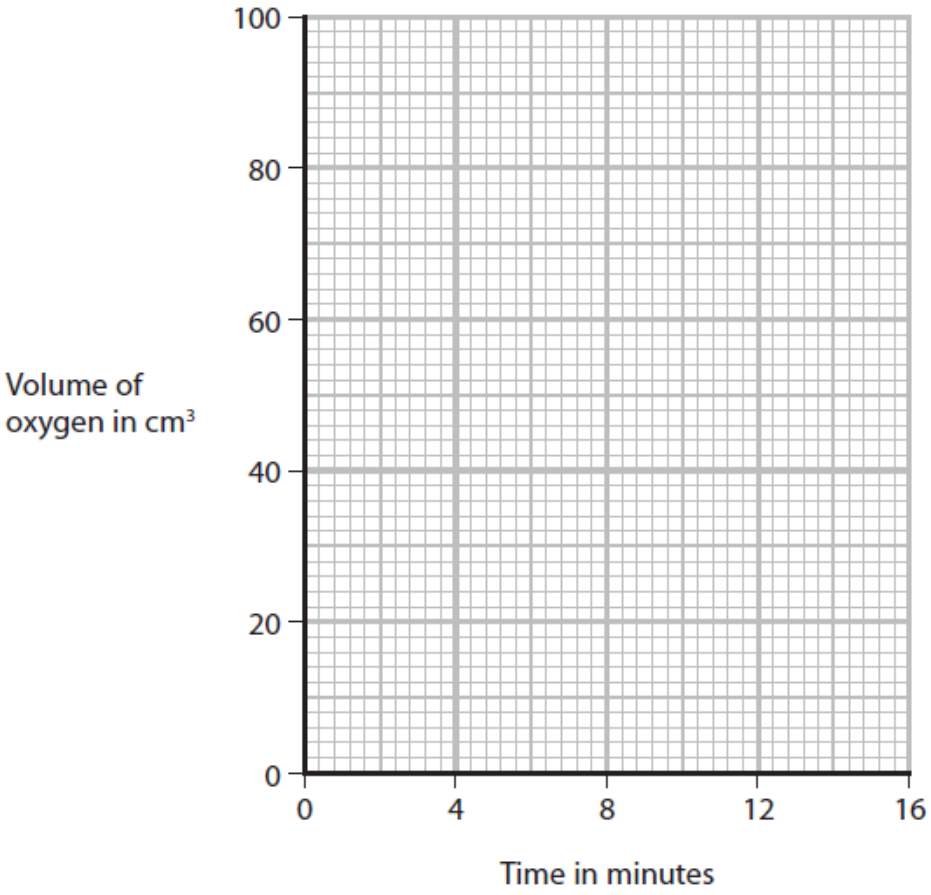
(1)

(ii) Draw a circle on the grid around the anomalous result.

(1)

(iii) Draw a curve of best fit through the points, ignoring the anomalous result.

(1)



(iv) Suggest a mistake that the student might have made to cause the anomalous result.

(1)

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(v) Determine the volume of oxygen collected during the first 3 minutes.

Show on your graph how you obtain your answer.

(2)

volume of oxygen = ... cm^3

(e) The student repeats the experiment using hydrogen peroxide solution of half the concentration of the original solution.

She keeps the volume of the hydrogen peroxide solution and all other conditions the same.

(i) Draw on the grid the curve you would expect the student to obtain.

(2)

(ii) Explain how using hydrogen peroxide solution of half the concentration affects the rate of the reaction.

Refer to particle collision theory in your answer.

(3)

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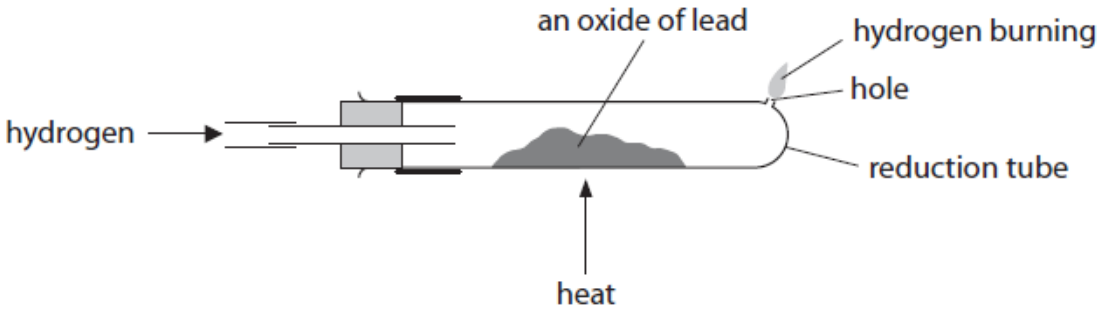
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(Total for question = 14 marks)

Q14.

(a) The diagram shows the apparatus a teacher uses to determine the formula of an oxide of lead.



This is the teacher's method.

Step 1 find the mass of the reduction tube

Step 2 add some of the lead oxide to the reduction tube

Step 3 find the mass of the reduction tube and lead oxide

Step 4 pass hydrogen gas over the lead oxide and ignite the hydrogen at the hole

Step 5 heat the lead oxide strongly for 10 minutes

Step 6 keep passing hydrogen through the reduction tube until the tube and contents are cool

Step 7 find the new mass of the reduction tube and its contents

(i) Give a reason why hydrogen is passed through the reduction tube until the tube and contents are cool.

(1)

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(ii) Describe what the teacher should do next to make sure all the lead oxide has been reduced to lead.

(2)

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(b) The teacher completes the experiment and obtains these results.

mass of reduction tube = 23.50 g

mass of tube + lead oxide = 28.64 g

mass of tube + lead = 28.16 g

(i) Calculate the mass of lead formed.

(1)

mass of lead = ... g

(ii) Calculate the mass of oxygen removed from the lead oxide.

(1)

mass of oxygen = ... g

(iii) Determine the empirical formula of the lead oxide.

(4)

empirical formula of the lead oxide .....

(c) The insoluble salt lead(II) chloride ($PbCl_2$) can be prepared by reacting a solution of lead(II) nitrate with dilute
hydrochloric acid.

(i) Complete the equation for the reaction by adding the state symbols.

(1)

$Pb(NO_3)_2(.....) + 2HCl(.....) \rightarrow PbCl_2(.....) + 2HNO_3(.....)$

(ii) Show that the maximum mass of lead(II) chloride that can be made from 0.0370 mol of hydrochloric acid is
about 5 g.

[M_r of $PbCl_2$ = 278]

(3)

maximum mass = ... g

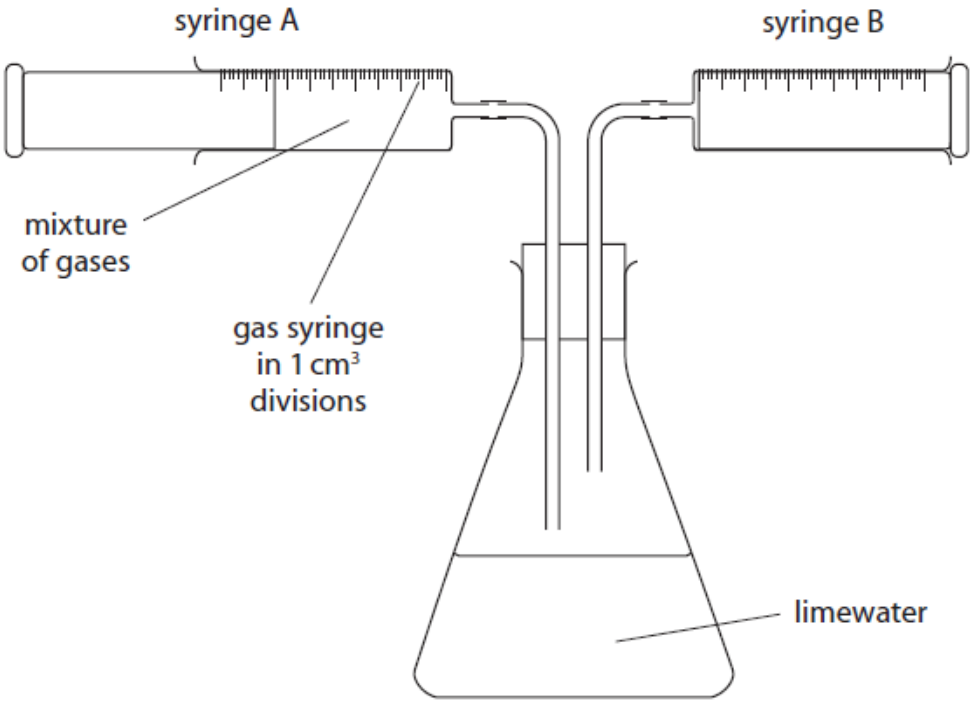
(Total for question = 13 marks)

Q15.

Two experiments are done to determine the percentage composition by volume of a mixture of three gases, carbon dioxide, oxygen and argon.

(a) In experiment 1, a student bubbles the mixture of gases through limewater. Carbon dioxide reacts with limewater.

The diagram shows the apparatus the student uses.



The student pushes the mixture of gases out of syringe A, but no gas bubbles appear in the limewater.

Give one change the student needs to make to the apparatus for gas bubbles to appear in the limewater.

(1)

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(b) When the apparatus in experiment 1 is set up correctly, the mixture of gases is bubbled gently through the limewater so that all the carbon dioxide is removed.

The volume of the mixture of gases in syringe A at the start is 76 cm^3.

The volume of the mixture of gases in syringe B at the end is 66 cm^3.

(i) Calculate the percentage by volume of carbon dioxide in the mixture of gases in syringe A.

(2)

percentage of carbon dioxide = ... %

(ii) Give the change in the appearance of the limewater.

(1)

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(iii) Explain why the gas syringes in experiment 1 cannot be used to find the percentage of carbon dioxide in a typical sample of air.

(2)

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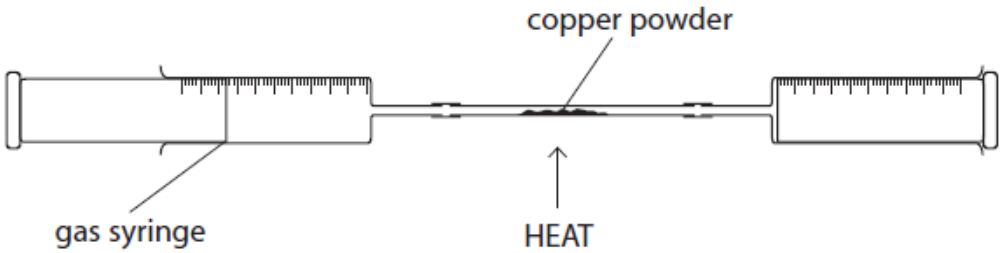
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In experiment 2, a teacher pushes the remaining gases over hot copper powder.

The diagram shows the apparatus the teacher uses.



The copper powder turns black as it reacts with oxygen.

Argon is extremely unreactive, so it does not react with copper.

(i) Name the black substance that forms on the copper powder.

(1)

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(ii) Suggest why the teacher uses copper powder instead of the same mass of large pieces of copper.

(1)

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(iii) Explain why argon is extremely unreactive.

(2)

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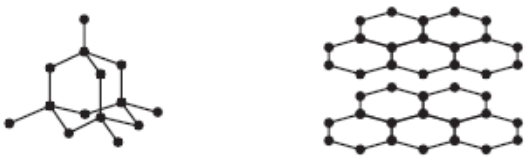
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(Total for question = 10 marks)

Q16.

Diamond and graphite are giant covalent structures made of carbon atoms.

The diagram shows their structures.



Diamond Graphite

(a) Discuss the differences between diamond and graphite.

Refer to structure and bonding, electrical conductivity and hardness in your answer.

(6)

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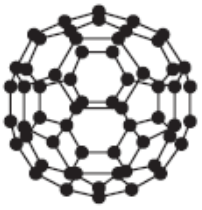
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(b) C_{60} fullerene is a simple molecular substance made of 60 carbon atoms.

The diagram shows its structure.



The table shows the approximate melting points of diamond, graphite and C_{60} fullerene.

Substance	Approximate melting point in °C
diamond	4000
graphite	3600
C_{60} fullerene	600

Explain why C_{60} fullerene has a much lower melting point than diamond and graphite.

(4)

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(Total for question = 10 marks)

Q17.

A student investigates how the electrical conductivity changes as dilute sulfuric acid is added to barium hydroxide solution.

This is the student's method.

Step 1 add 50.0 cm^3 of barium hydroxide solution to a beaker

Step 2 measure the electrical conductivity of the solution

Step 3 add 10.0 cm^3 of dilute sulfuric acid to the beaker

Step 4 stir the mixture

Step 5 measure the electrical conductivity of the mixture

Step 6 repeat steps 3 to 5 until a total of 100 cm^3 of dilute sulfuric acid has been added

The table shows the student's results.

Total volume of acid added in cm^3	Electrical conductivity in arbitrary units
0.0	10.0
10.0	8.0
20.0	7.2
30.0	4.0
40.0	2.0
50.0	0.0
60.0	1.4
70.0	2.8
80.0	4.2
90.0	5.6
100.0	7.0

(a)(i) Name a piece of apparatus the student could use to add 10.0 cm^3 of dilute sulfuric acid to the beaker.

(1)

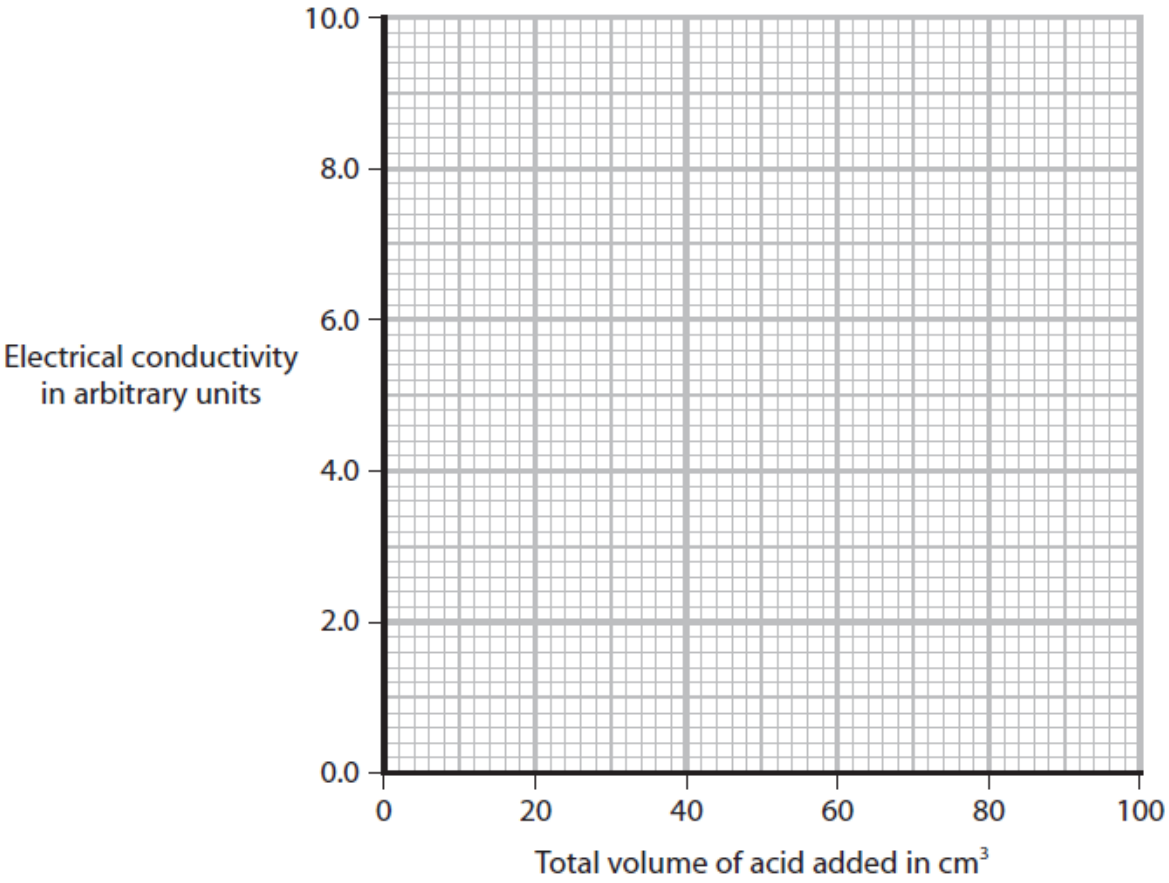
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(ii) Plot the student's results.

(2)

(iii) Ignoring the anomalous result, draw two lines of best fit, making sure that the two lines cross.

(1)



(iv) Give the trend shown on the graph for the first 50 cm^3 of acid added.

(1)

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(v) Suggest a mistake the student could have made to cause the anomalous result.

(1)

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(b) This is the equation for the reaction.

$$Ba(OH)_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$$

(i) When 50 cm^3 of dilute sulfuric acid have been added, only barium sulfate and water are present in the mixture.

Explain why this mixture does not conduct electricity.
Refer to the type of bonding in barium sulfate and in water in your answer.

(3)

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(ii) Name a technique the student could use to separate barium sulfate from the mixture after 100 cm^3 of dilute sulfuric acid has been added.

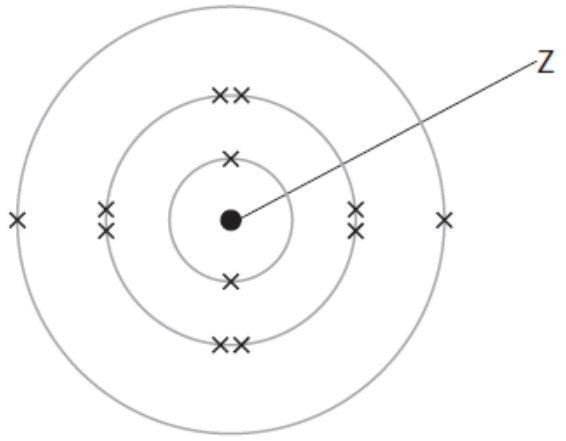
(1)

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(Total for question = 10 marks)

Q18.

The diagram shows the electronic configuration of an atom of an element.



(a) Complete the table by giving the missing information about this atom.

(5)

name of the part of this atom labelled Z	
number of protons in this atom	
number of the group that contains this element	
number of the period that contains this element	
the charge on the ion formed from this atom	

(b) This element has three isotopes.

The table shows the mass number and percentage abundance of each isotope in a sample of this element.

Mass number	Percentage abundance (%)
24	79.2
25	10.0
26	10.8

Calculate the relative atomic mass (A_r) of this element.

Give your answer to one decimal place.

(3)

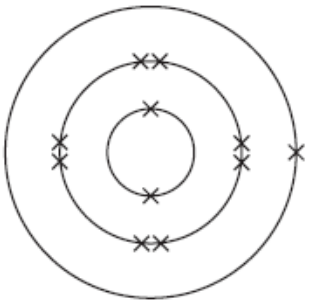
relative atomic mass = ...

(Total for question = 8 marks)

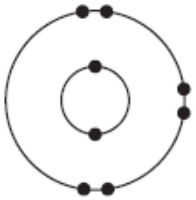
Q19.

This question is about sodium oxide, Na_2O

(a) The diagram shows the electronic configuration of atoms of sodium and oxygen.



Sodium



Oxygen

Describe the changes in the electronic configuration of the atoms of sodium and oxygen to form the ions in sodium oxide.

(3)

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(b) Calculate the relative formula mass (M_r) of sodium oxide, Na_2O, using information from the Periodic Table.

(1)

M_r = ...

(c) Explain why solid sodium oxide does not conduct electricity.

(2)

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(d) Give a test to show that sodium oxide contains sodium ions.

(2)

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(e) When sodium oxide is heated it reacts to form sodium metal and sodium peroxide, Na_2O_2

Complete the equation for this reaction.

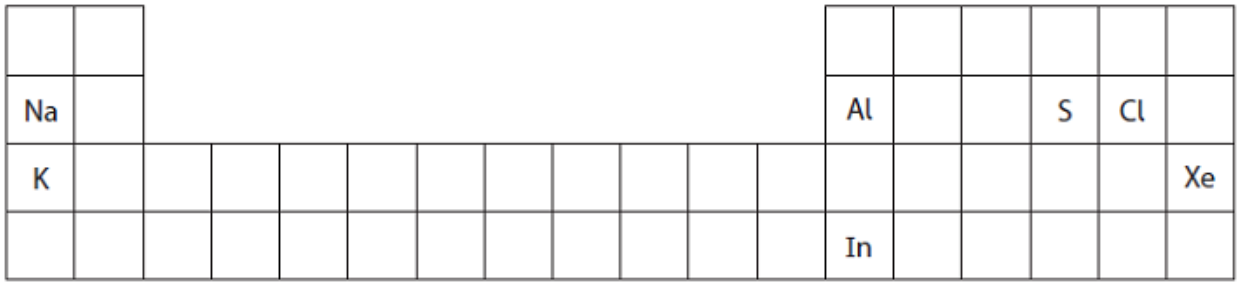
(1)

$Na_2O \rightarrow$

(Total for question = 9 marks)

Q20.

The diagram shows the positions of some elements in part of the Periodic Table.



(a)(i) Give the symbol of a metal from the diagram.

(1)

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(ii) Give the symbol of an element from the diagram that forms an acidic oxide.

(1)

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(b) Give a similarity in the electron configurations of Al and In.

(1)

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(c) Explain which element in the diagram is unreactive.

(2)

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(d) A teacher adds a small piece of sodium to a glass trough containing water and universal indicator.

The universal indicator changes colour.

The equation for the reaction is

$$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$$

(i) Explain the final colour of the universal indicator.

(2)

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(ii) The teacher repeats the experiment with potassium instead of sodium.

Give one similarity and one difference observed with potassium.

(2)

similarity

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.....

difference

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(iii) The reaction with sodium produces 0.036g of hydrogen gas.

One mole of hydrogen gas contains 6.0×10^{23} molecules.

Calculate the number of molecules of hydrogen gas produced in the reaction with sodium.

Give your answer to two significant figures.

(3)

number of molecules of hydrogen gas = ...

(Total for question = 12 marks)