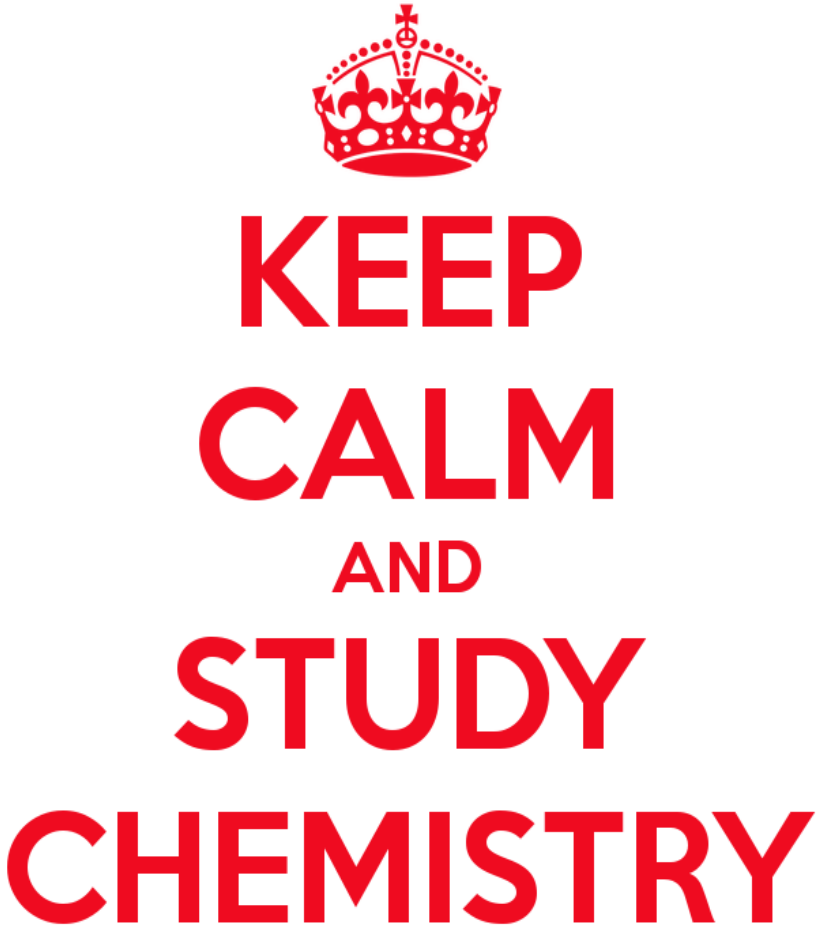
Robert Carre

Multi Academy Trust



Transition Work

This transition work MUST be completed by the time you start your course and it will be assessed in September. The aims are for you to re-familiarise yourself with work studied during GCSE but largely ignored for the past 10 weeks, but vital for progression at post 16 level.

Chemistry can be a fun subject but requires hard work to succeed with few shortcuts. Please use resources such as the internet, library and your Chemistry GCSE notes to help you complete this work.

To obtain the full A-level you will complete twelve set practical activities which you will be internally assessed on. You must pass these to obtain your Practical Endorsement.

Exam board: AQA Chemistry

Paper 1	Paper 2	Paper 3
What's assessed: Relevant physical chemistry topics (sections 3.1.1 to 3.1.4, 3.1.6 to 3.1.8 and 3.1.10 to 3.1.12) Inorganic chemistry (section 3.2) Relevant practical skills **Assessed** by written exam: 2 hours 105 marks 35% of A-level **Questions** 105 marks of short and long answer questions	**What's assessed:** Relevant physical chemistry topics (sections 3.1.2 to 3.1.6 and 3.1.9) Organic chemistry (section 3.3) Relevant practical skills **Assessed** by written exam: 2 hours 105 marks 35% of A-level **Questions** 105 marks of short and long answer questions	**What's assessed:** Any content. Any practical skills. **Assessed by** written exam: 2 hours 90 marks 30% of A-level **Questions** 40 marks of questions on practical techniques and data analysis 20 marks of questions testing across the specification 30 marks of multiple choice questions

Task 1 - Fundamental Particles

Atoms are the basic building blocks of matter. It is not the smallest of particles, and within Chemistry, we are interested in electrons, protons and neutrons.

Using a periodic table, draw the *electronic configuration*, as well as identifying *how many sub-atomic particles* there are for the following atoms and its corresponding ions:

Hydrogen Number of: e^-: p: n:	**Oxygen** Number of: e^-: p: n:	**Calcium** Number of: e^-: p: n:
Hydrogen ion, H^+ Charge: Number of: e^-: p: n:	**Oxygen ion** Charge: Number of: e^-: p: n:	**Calcium ion** Charge: Number of: e^-: p: n:

Task 2 – Constructing formulae from common ions

Writing chemical formulae is an essential skill for both AS and A2 Chemistry and requires a knowledge of both the common positive and negative ions.

Positive ions		**Negative ions**	
Name	Formula	Name	Formula
Hydrogen	H^+	Chloride	Cl^-
Sodium	Na^+	Bromide	Br^-
Silver	Ag^+	Fluoride	F^-
Potassium	K^+	Iodide	I^-
Lithium	Li^+	Hydroxide	OH^-
Ammonium	NH_4^+	Nitrate	NO_3^-
Barium	Ba^{2+}	Oxide	O^{2-}
Calcium	Ca^{2+}	Sulfide	S^{2-}
Copper(II)	Cu^{2+}	Sulfate	SO_4^{2-}
Magnesium	Mg^{2+}	Carbonate	CO_3^{2-}
Zinc	Zn^{2+}		
Lead	Pb^{2+}		
Iron(II)	Fe^{2+}		
Iron(III)	Fe^{3+}		
Aluminium	Al^{3+}		

Unlike GCSE these are not given on any data sheet and therefore important to learn and the best way of learning them is using them.
You can though use the periodic table and this can be helpful, particular with the metal ions; try to spot the connection between the metals and their position in the Periodic table.

Complete the table for the formula making sure the charges balance;-

	Na^+	K^+	Mg^{2+}	Ca^{2+}	Al^{3+}	Cu^{2+}(III)
Cl^-	NaCl					
O^{2-}		K_2O				
OH^-			$Mg(OH)_2$			
CO_3^{2-}				$CaCO_3$		
SO_4^{2-}					$Al_2(SO_4)_3$	

Name the five compounds formed in the grey highlighted boxes above.

1.

2.

3.

4.

5.

Using the ion table and your own research give the formulae of the following ionic compounds:

1. Potassium nitrate

2. Lithium hydroxide

3. Barium fluoride

4. Ammonium nitrate

5. Sodium hydrogen carbonate

6. Iron (II) chloride

7. Iron (III) chloride

8. Zinc nitrate

9. Hydrochloric acid

10. Ammonium hydroxide

11. Sodium sulfate

12. Sodium sulphide

13. Sulphuric acid

14. Potassium phosphate

15. Potassium dichromate (VI)

Task 3 - Dot cross diagrams

You have covered ionic and covalent bonding in your GCSE. Using your knowledge, draw the dot cross diagrams for the following compounds, showing only outer electrons.
You will need to decide what type of bonding is present within these compounds, before you start remember **ionic compounds** contain ions and must contain **both a metal and a non-metal**; **covalent molecules** share electrons and contain **non-metals**.

Chlorine gas	**Sodium chloride**
Magnesium oxide	**Water**
Carbon dioxide	**Calcium chloride**
Methane (CH_4)	**Nitrogen gas**

Task 4 - Rearranging Formulae

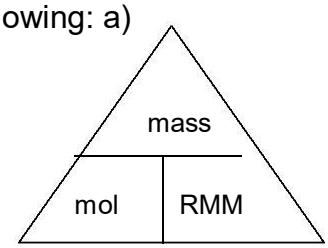
When solving chemistry problems you will often be required to rearrange an equation to solve for an unknown. You would have seen this in Physics when trying to solve speed.

Speed (m/s) = distance (m) / time (s)

We can write this to show distance and time as follows:

Distance (m) = speed (m/s) x time (s) Time (s) = distance (m) / speed (m/s)

Rearrange the following: a)

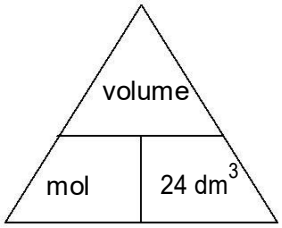


mass =

mol =

RMM =

b)



Volume =

mol =

c)

$n = c\ v$

c =

v =

The units of *n* is mol and the unit for *v* is dm^3. Write down the units for *c*.

d) There are $1000cm^3$ in $1dm^3$. Convert the following:

1.	250 cm^3 is	dm^3	4.	0.8 dm^3 is	cm^3
2.	30 cm^3 is	dm^3	5.	10 dm^3 is	cm^3
3.	500 cm^3 is	dm^3	6.	0.0065 dm^3 is	cm^3

Task 5 - Balancing equations

Look at the following equations – some need balancing, others do not. Balance the equations that need it.

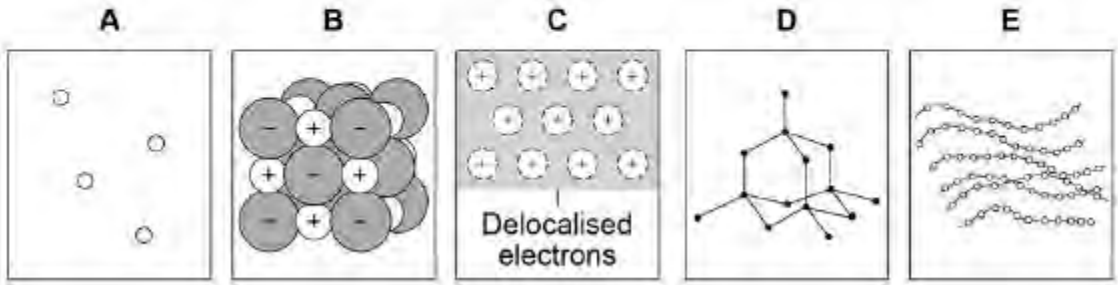
1)	C	+	O_2	→	CO			
2)	Na	+	O_2	→	Na_2O			
3)	H_2	+	O_2	→	H_2O			
4)	Na	+	I_2	→	NaI			
5)	CH_4	+	O_2	→	CO_2	+	H_2O	
6)	SO_2	+	O_2	→	SO_3			
7)	Fe_2O_3	+	C	→	Fe	+	CO	
8)	Fe_2O_3	+	CO	→	Fe	+	CO_2	
9)	NH_3	+	O_2	→	NO	+	H_2O	
10)	Fe_3O_4	+	H_2	→	Fe	+	H_2O	
11)	C	+	CO_2	→	CO			
12)	Fe	+	S	→	FeS			
13)	Ca	+	H_2O	→	$Ca(OH)_2$	+	H_2	
14)	Al	+	Cl_2	→	$AlCl_3$			
15)	Fe	+	HCl	→	$FeCl_2$	+	H_2	

Task 6 – Exam style questions (7 Sections; A-G)

A. Structure and Bonding

Q1. **Figure 1** shows the structure of five substances.

Figure 1



(a) Which diagram shows a gas?

Tick (✔) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(b) Which diagram shows the structure of diamond?

Tick (✔) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(c) Which diagram shows a metallic structure?

Tick (✔) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(d) Which diagram shows a polymer?

Tick (✔) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(e) A chlorine atom has 7 electrons in the outer shell.

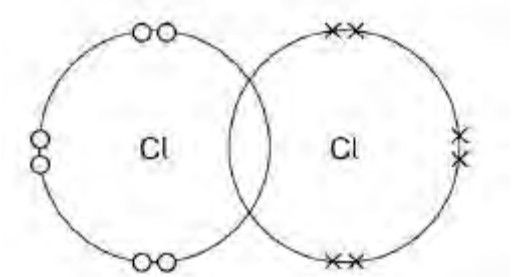
Two chlorine atoms covalently bond to form a chlorine molecule, Cl_2

Figure 2 is a dot and cross diagram showing the outer shells and some electrons in a chlorine molecule.

Complete the dot and cross diagram.

Show only the electrons in the outer shell.

Figure 2



(1)

(f) What is the reason for chlorine's low boiling point?

Tick (✔) **one** box.

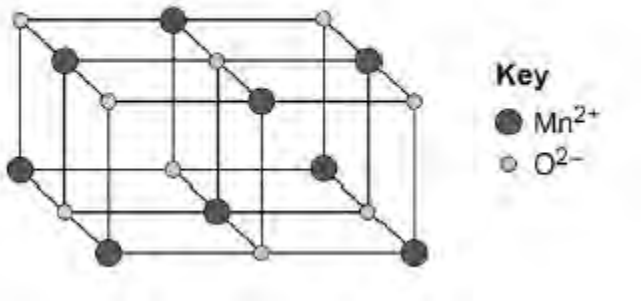
- Strong covalent bonds ☐
- Strong forces between molecules ☐
- Weak covalent bonds ☐
- Weak forces between molecules ☐

(1)

Figure 3 represents the structure of manganese oxide.

Manganese oxide is an ionic compound.

Figure 3



(g) Determine the empirical formula of manganese oxide.

Use **Figure 3**.

_____

_____

Empirical formula = _____

(1)

(h) Why does manganese oxide conduct electricity as a liquid?

Tick (✔) **one** box.

Atoms move around in the liquid	☐
Electrons move around in the liquid	☐
Ions move around in the liquid	☐
Molecules move around in the liquid	☐

(1)

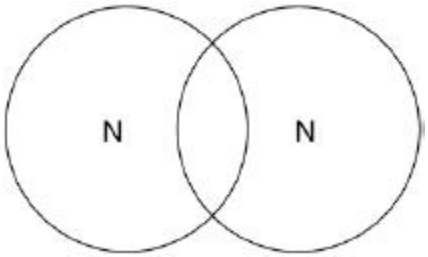
(Total 8 marks)

Q2.

This question is about structure and bonding.

(a) Complete the dot and cross diagram to show the covalent bonding in a nitrogen molecule, N_2

Show only the electrons in the outer shell.



(2)

(b) Explain why nitrogen is a gas at room temperature.

Answer in terms of nitrogen's structure.

_____

_____

_____

_____

_____

_____

(3)

(c) Graphite and fullerenes are forms of carbon.

Graphite is soft and is a good conductor of electricity.

Explain why graphite has these properties.

Answer in terms of structure and bonding.

_____

_____

_____

_____

_____

_____

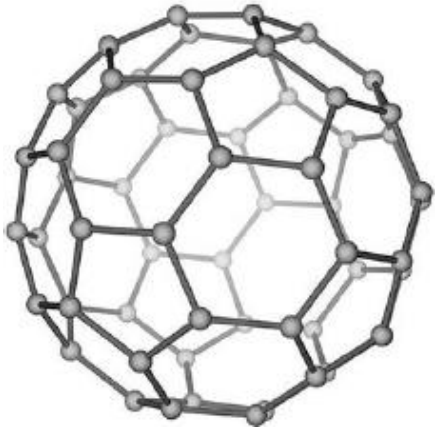
_____

_____

(4)

(d) **Figure 1** shows a model of a Buckminsterfullerene molecule.

Figure 1



A lubricant is a substance that allows materials to move over each other easily.

Suggest why Buckminsterfullerene is a good lubricant. Use **Figure 1**.

_____

_____

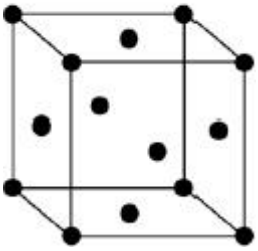
_____

_____

(2)

Silver can form cubic nanocrystals. **Figure 2** represents a silver nanocrystal.

Figure 2



(e) A silver nanocrystal is a cube of side 20 nm

Calculate the surface area to volume ratio of the nanocrystal.

_____

_____

_____

_____

_____

Surface area to volume ratio = _____

(3)

(f) Silver nanoparticles are sometimes used in socks to prevent foot odour.

Suggest why it is cheaper to use nanoparticles of silver rather than coarse particles of silver.

_____

_____

_____

_____

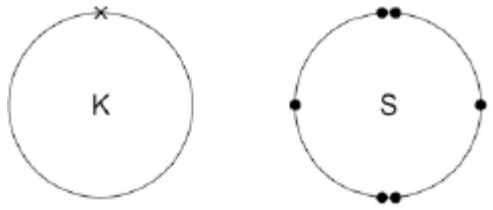
(2)

(Total 16 marks)

Q3.

Figure 1 shows the outer electrons in an atom of the Group 1 element potassium and in an atom of the Group 6 element sulfur.

Figure 1



(a) Potassium forms an ionic compound with sulfur.

Describe what happens when **two** atoms of potassium react with **one** atom of sulfur.

Give your answer in terms of electron transfer.

Give the formulae of the ions formed.

_____

_____

_____

_____

_____

_____

_____

_____

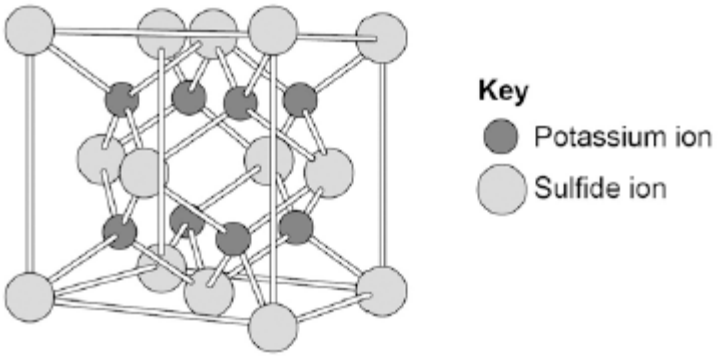
_____

_____

(5)

(b) The structure of potassium sulfide can be represented using the ball and stick model in **Figure 2**.

Figure 2



The ball and stick model is **not** a true representation of the structure of potassium sulfide.

Give **one** reason why.

_____

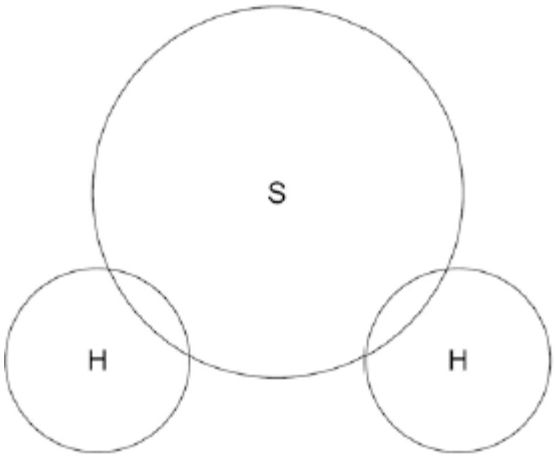
_____

(1)

(c) Sulfur can also form covalent bonds.

Complete the dot and cross diagram to show the covalent bonding in a molecule of hydrogen sulfide.

Show the outer shell electrons only.



(2)

(d) Calculate the relative formula mass (M_r) of aluminium sulfate $Al_2(SO_4)_3$

Relative atomic masses (A_r): oxygen = 16; aluminium = 27; sulfur = 32

_____

_____

_____

Relative formula mass = _____

(2)

(e) Covalent compounds such as hydrogen sulfide have low melting points and do **not** conduct electricity when molten.

Draw **one** line from each property to the explanation of the property.

Property	**Explanation of property**
	Electrons are free to move
	There are no charged particles free to move
Low melting point	
	Ions are free to move
	Weak intermolecular forces of attraction
Does not conduct electricity when molten	
	Bonds are weak
	Bonds are strong

(2)

(f) Ionic compounds such as potassium sulfide have high boiling points and conduct electricity when dissolved in water.

Draw **one** line from each property to the explanation of the property.

Property	**Explanation of property**
High boiling point	There are no charged particles free to move
Conduct electricity when molten	Ions are free to move
	Weak intermolecular forces of attraction
	Bonds are weak
	Bonds are strong
	Electrons are free to move

(2)

(Total 14 marks)

B. Calculations

Q1.

Titanium is a transition metal.

Titanium is extracted from titanium dioxide in a two-stage industrial process.

Stage 1 $TiO_2 + 2\ C + 2\ Cl_2 \longrightarrow TiCl_4 + 2\ CO$

Stage 2 $TiCl_4 + 4\ Na \longrightarrow Ti + 4\ NaCl$

(a) Suggest **one** hazard associated with **Stage 1**.

_____

_____ **(1)**

(b) Water must be kept away from the reaction in **Stage 2**.

Give **one** reason why it would be hazardous if water came into contact with sodium.

_____

_____ **(1)**

(c) Suggest why the reaction in **Stage 2** is carried out in an atmosphere of argon and **not** in air.

_____

_____

_____

_____

(2)

(d) Titanium chloride is a liquid at room temperature.

Explain why you would **not** expect titanium chloride to be a liquid at room temperature.

_____

_____

_____

_____

_____

_____

_____

(3)

In **Stage 2**, sodium displaces titanium from titanium chloride.

(e) Sodium atoms are oxidised to sodium ions in this reaction.

Why is this an oxidation reaction?

_____

_____ **(1)**

(f) Complete the half equation for the oxidation reaction.

$$Na \longrightarrow \_\_\_\_\_ + \_\_\_\_\_$$

(1)

(g) In Stage 2, 40 kg of titanium chloride was added to 20 kg of sodium.

The equation for the reaction is:

$$TiCl_4 + 4\ Na \longrightarrow Ti + 4\ NaCl$$

Relative atomic masses (A_r): Na = 23 Cl = 35.5 Ti = 48

Explain why titanium chloride is the limiting reactant. You **must** show your working.

_____

_____

_____

_____

_____

_____

_____

(4)

(h) For a **Stage 2** reaction the percentage yield was 92.3%

The theoretical maximum mass of titanium produced in this batch was 13.5 kg.

Calculate the actual mass of titanium produced.

_____

_____

_____

Mass of titanium = _____ kg

(2)

(Total 15 marks)

Q2.

Sodium hydroxide neutralises sulfuric acid.

The equation for the reaction is:

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

(a) Sulfuric acid is a strong acid.

What is meant by a strong acid?

_____

_____

_____

(2)

(b) Write the ionic equation for this neutralisation reaction. Include state symbols.

_____

(2)

(c) A student used a pipette to add 25.0 cm^3 of sodium hydroxide of unknown concentration to a conical flask.

The student carried out a titration to find out the volume of 0.100 mol / dm^3 sulfuric acid needed to neutralise the sodium hydroxide.

Describe how the student would complete the titration.

You should name a suitable indicator and give the colour change that would be seen.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(d) The student carried out five titrations. Her results are shown in the table below.

	Titration 1	Titration 2	Titration 3	Titration 4	Titration 5
Volume of 0.100 mol / dm^3 sulfuric acid in cm^3	27.40	28.15	27.05	27.15	27.15

Concordant results are within 0.10 cm^3 of each other.

Use the student's concordant results to work out the mean volume of 0.100 mol / dm^3 sulfuric acid added.

Mean volume = _____ cm^3

(2)

(e) The equation for the reaction is:

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the concentration of the sodium hydroxide.

Give your answer to three significant figures.

Concentration = _____ mol / dm^3

(4)

(f) The student did another experiment using 20 cm^3 of sodium hydroxide solution with a concentration of 0.18 mol / dm^3.

Relative formula mass (M_r) of NaOH = 40

Calculate the mass of sodium hydroxide in 20 cm^3 of this solution.

_____

_____

_____

_____

Mass = _____ g

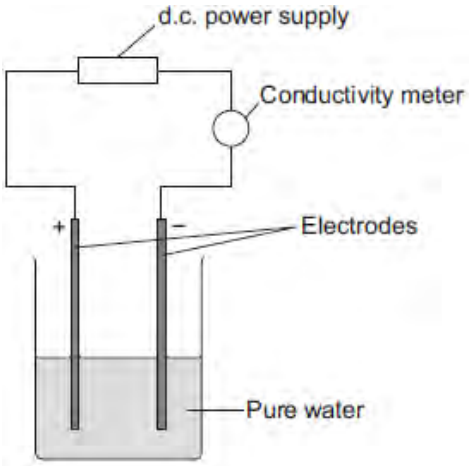
(2)

(Total 16 marks)

C. Electrolysis

Q1. A student investigated the conductivity of different concentrations of sodium chloride solution. The student set the apparatus up as shown in **Figure 1**.

Figure 1



The student measured the conductivity of the pure water with a conductivity meter.

The reading on the conductivity meter was zero.

(a) The student:

- added sodium chloride solution one drop at a time
- stirred the solution
- recorded the reading on the conductivity meter.

The student's results are shown in the table below.

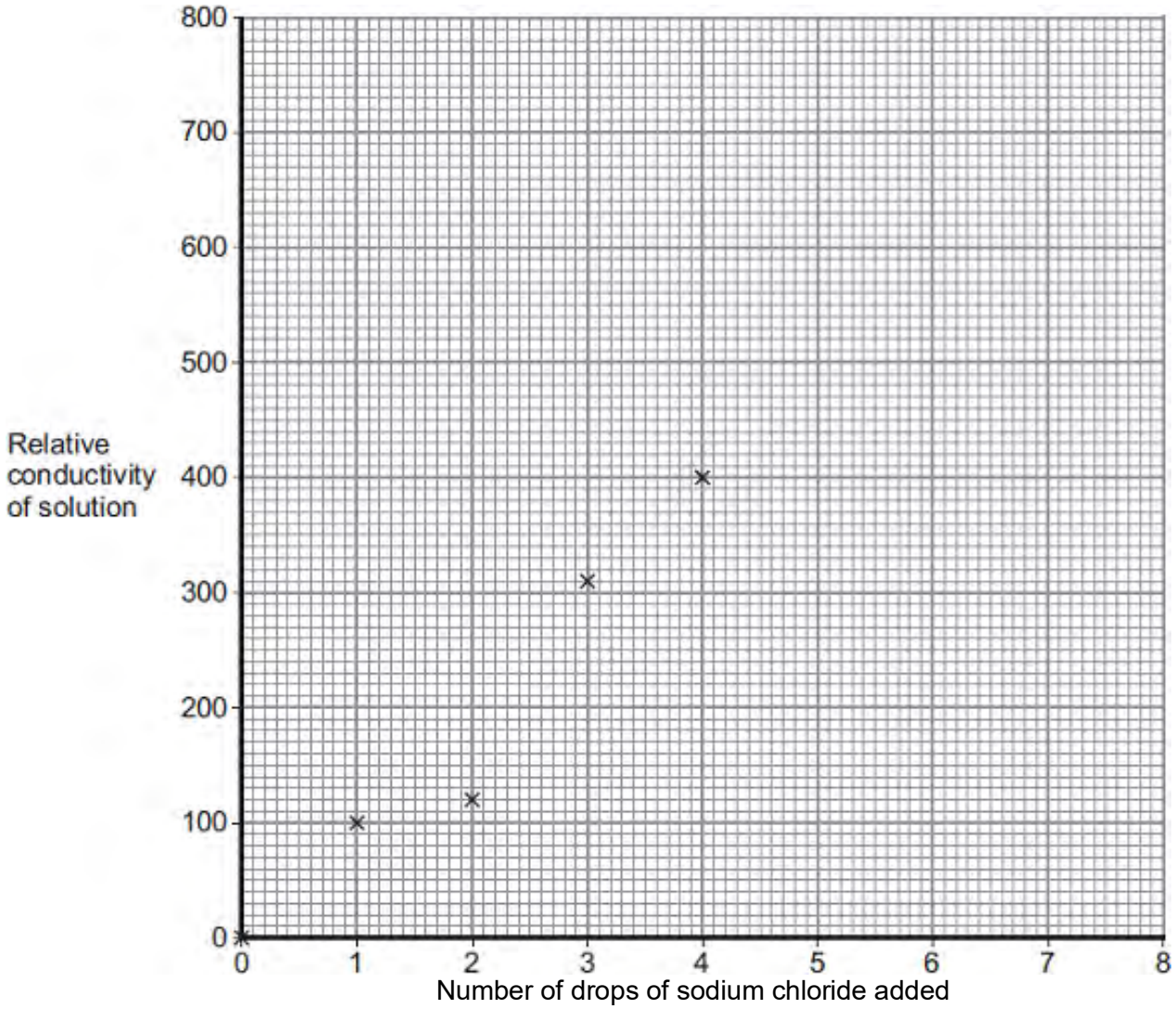
Number of drops of sodium chloride solution added	Relative conductivity of solution
0	0
1	100
2	120
3	310
4	400
5	510
6	590
7	710
8	800

(i) The student plotted the results on the grid shown in **Figure 2**.

Plot the four remaining results.

Draw a line of best fit, ignoring the anomalous result.

Figure 2



(3)

(ii) One of the points is anomalous.

Suggest **one** error that the student may have made to cause the anomalous result.

_____

_____

(1)

(iii) The student wanted to compare the conductivity of sodium chloride solution with the conductivity of potassium chloride solution.

State **one** variable he should keep constant when measuring the conductivity of the two solutions.

_____

(1)

(b) (i) Explain, in terms of bonding, why pure water does **not** conduct electricity.

_____

_____

_____

_____

(2)

(ii) Explain why sodium chloride solution conducts electricity.

_____

_____

_____

_____

(2)

(iii) After he had added sodium chloride solution, the student noticed bubbles of gas at the negative electrode.

Complete the sentence.

The gas produced at the negative electrode is _____ **(1)**

(Total 10 marks)

Q2.

Many everyday substances can be classified as acids, bases or salts. For example, car batteries contain sulphuric acid, oven cleaners contain sodium hydroxide and table salt contains sodium chloride.

(a) A solution of each of these substances was tested with universal indicator.

Solution	Colour of universal indicator
Sulphuric acid (H_2SO_4)	red
Sodium hydroxide (NaOH)	purple
Sodium chloride (NaCl)	green

(i) Explain how these universal indicator colours and the corresponding pH values could be used to identify each of these solutions.

_____

_____

_____

_____

_____

(3)

(ii) Name and give the formula of the ion which causes the solution to be acidic.

Name of ion _____

Formula of ion

_____

(2)

(b) Sodium chloride can be made by reacting sodium hydroxide with hydrochloric acid in the presence of an indicator.

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

_____

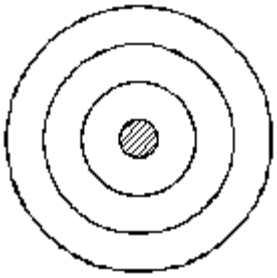
(1)

(ii) Write a balanced chemical equation for this reaction.

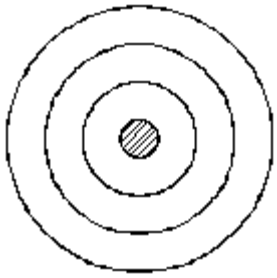
_____(aq) + _____(aq) → _____(aq) + _____(l)

(2)

(c) The atomic number for sodium is 11 and for chlorine is 17.



Sodium atom



Chlorine atom

(i) Complete the diagrams to show the electron arrangements for a sodium atom and a chlorine atom.

(2)

(ii) These atoms form different particles by one electron transferring from the sodium atom to the chlorine atom. What is the name given to the particles formed?

_____

(1)

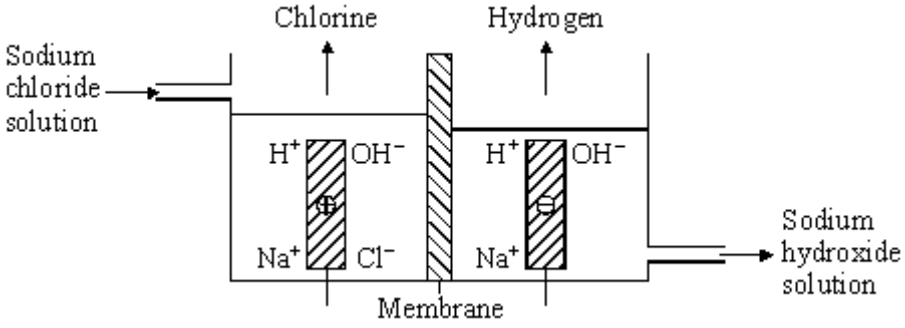
(iii) Why do these sodium and chloride particles bond?

_____

_____

(1)

(d) Sodium chloride solution is electrolysed to form three products, hydrogen, chlorine and sodium hydroxide.



Describe how each of these products are formed.

_____

_____

_____

_____

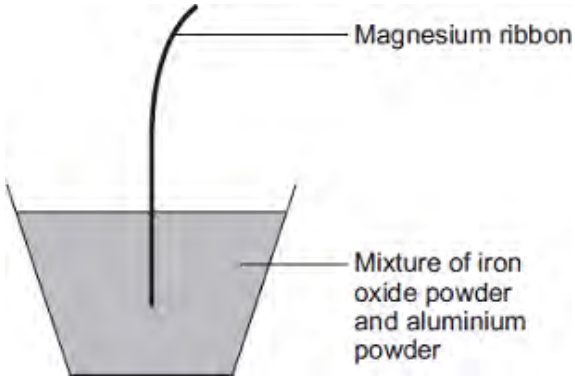
_____

_____ **(3)**

(Total 15 marks)

Q3.

The diagram shows one way of producing iron.



Iron oxide reacts with aluminium to produce iron.

The symbol equation for the reaction is: $Fe_2O_3 + 2\ Al \longrightarrow 2\ Fe + Al_2O_3$

(a) (i) Complete the word equation for this reaction.

iron oxide + aluminium ⟶ iron + _____ **(1)**

(ii) The magnesium ribbon is lit to start the reaction.

Why does the burning magnesium ribbon start the reaction?

_____

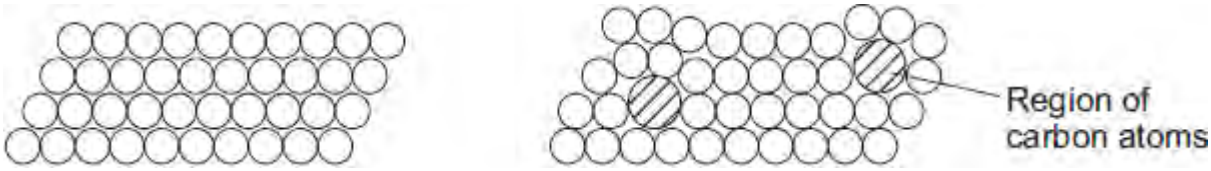
_____ **(1)**

(b) In industry, iron is produced in the blast furnace when iron oxide is heated with carbon.

The iron from the blast furnace is called cast iron.

Cast iron contains carbon.

The diagrams show the structure of pure iron and cast iron.



Pure iron Cast iron

Use the diagrams to help you answer the questions.

(i) Draw a ring around the correct answer to complete the sentence.

Pure iron is an element because pure iron

contains only one sort of atom.
is magnetic.
is a metal.

(1)

(ii) Suggest why cast iron is harder than pure iron.

_____

_____

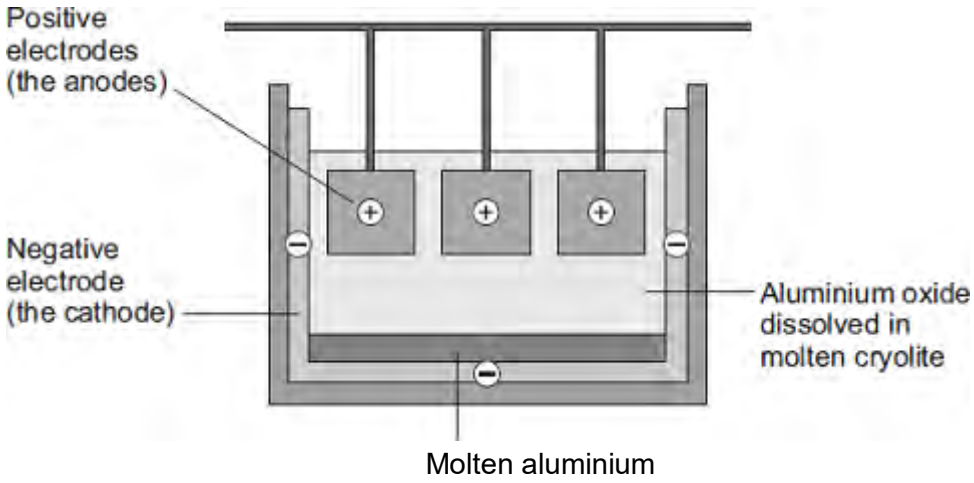
_____

_____

_____

(2)

(c) Aluminium is extracted by electrolysis using the ionic compound aluminium oxide.



(i) Aluminium **cannot** be extracted by heating aluminium oxide with carbon.

Suggest why.

_____

_____

(1)

(ii) Why is aluminium oxide dissolved in molten cryolite?

_____

_____

(1)

(iii) Aluminium metal is produced at the negative electrode (cathode).

Complete the half equation for the process.

Al^{3+} + _____ e^- $\longrightarrow$ Al

(1)

(iv) Use the half equation to state why Al^{3+} ions are reduced.

_____

_____

(1)

(v) Explain why the positive electrodes (anodes) burn away.

Use your knowledge of the products of electrolysis to help you.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 13 marks)

D. Acids and Bases

Q1. This question is about metal oxides.

When sodium is heated in oxygen, sodium oxide is produced.

(a) Balance the equation for the reaction.

_____ Na + O_2 → 2 Na_2O

(1)

(b) Why is this an oxidation reaction?

_____

_____

(1)

(c) Sodium oxide is added to water and shaken.

Universal indicator is added.

The pH of the solution is 14

What is the colour of the universal indicator?

Tick (✔) **one** box.

Green ☐

Purple ☐

Red ☐

Yellow ☐

(1)

(d) Aluminium oxide reacts with hydrochloric acid to produce a salt.

What is the name of the salt produced?

Tick (✔) **one** box.

Aluminium chloride ☐

Aluminium nitrate ☐

Aluminium sulfate ☐

Aluminium sulfide ☐

(1)

A student investigates the solubility of four metal oxides and four non-metal oxides in water.

The student tests the pH of the solutions formed.

The table shows the student's results.

Type of oxide	Oxide	Solubility in water	pH of solution
Metal oxides	Sodium oxide	Soluble	14
	Calcium oxide	Soluble	10
	Magnesium oxide	Slightly soluble	9
	Zinc oxide	Insoluble	No solution formed
Non-metal oxides	Carbon dioxide	Soluble	5
	Sulfur dioxide	Soluble	2
	Phosphorus oxide	Soluble	1
	Silicon dioxide	Insoluble	No solution formed

The student makes two conclusions.

Conclusion 1: 'All metal oxides produce alkaline solutions.'

Conclusion 2: 'All non-metal oxides produce acidic solutions.'

(e) Explain why the student's conclusions are only partly correct.

Use information from the table above.

(4)

(f) Give an improved conclusion for metal oxides.

Use the table above.

(2)

(Total 9 marks)

Q2.

(a) A student had a colourless solution.

The student thought the solution was dilute hydrochloric acid.

(i) The student added universal indicator to this solution.

What colour would the universal indicator change to if the solution is hydrochloric acid?

_____

(1)

(ii) Describe how the student could show that there are chloride ions in this solution.

_____

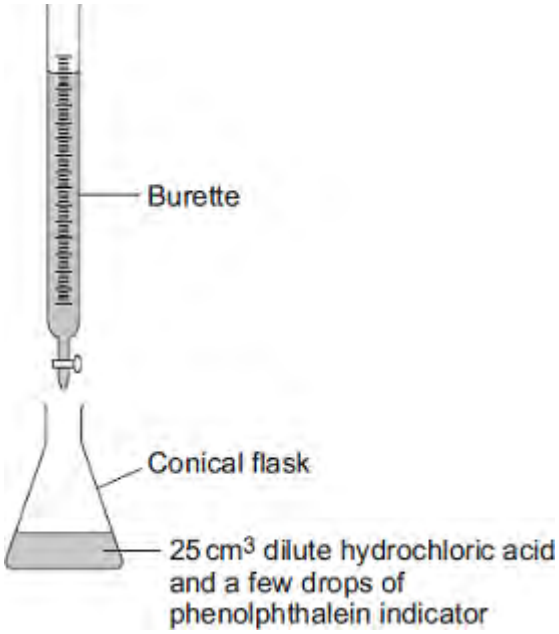
_____

_____

_____

(2)

(b) The results of a titration can be used to find the concentration of an acid.



Describe how to use the apparatus to do a titration using 25 cm^3 of dilute hydrochloric acid.

In your answer you should include:

- how you will determine the end point of the titration
- how you will make sure the result obtained is accurate.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) Hydrochloric acid is a strong acid. Ethanoic acid is a *weak acid*.

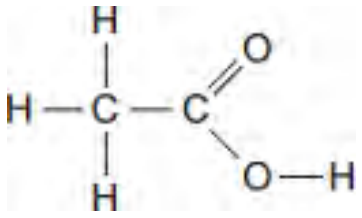
What is meant by the term *weak acid*?

_____

_____

(1)

(d) The displayed formula of ethanoic acid is:



(i) On the formula, draw a circle around the functional group in ethanoic acid.

(1)

(ii) Ethanoic acid and ethanol react together to make the ester ethyl ethanoate. Draw the **displayed** formula of ethyl ethanoate.

(2)

(Total 11 marks)

Q3.

This question is about compounds.

(a) The table gives information about the solubility of some compounds.

Soluble compounds
All potassium and sodium salts
All nitrates
Chlorides, bromides and iodides, except those of silver and lead

Use information from the table to answer these questions.

(i) Name a soluble compound that contains silver ions.

_____

(1)

(ii) Name a soluble compound that contains carbonate ions.

_____

(1)

(b) Metal oxides react with acids to make salts.

What type of compound is a metal oxide?

_____

(1)

(c) Lead nitrate solution is produced by reacting lead oxide with nitric acid.

(i) State how solid lead nitrate can be obtained from lead nitrate solution.

_____

_____

(1)

(ii) Balance the equation for the reaction.

$$PbO + HNO_3 \longrightarrow Pb(NO_3)_2 + H_2O$$

(1)

(iii) Give the total number of atoms in the formula $Pb(NO_3)_2$

_____

(1)

(d) An oxide of lead that does **not** have the formula PbO contains 6.21 g of lead and 0.72 g of oxygen.

Calculate the empirical formula of this lead oxide.

Relative atomic masses (A_r): O = 16; Pb = 207

You must show your working to gain full marks.

_____

_____

_____

_____

_____

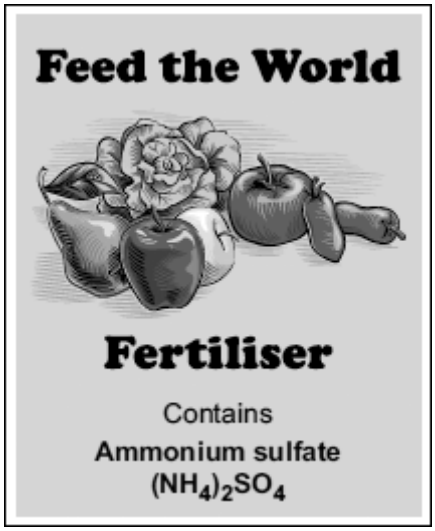
_____

Empirical formula = _____

(4)

(Total 10 marks)

Q4. Ammonium sulfate is an artificial fertiliser.



(a) (i) When this fertiliser is warmed with sodium hydroxide solution, ammonia gas is given off.
Describe and give the result of a test for ammonia gas.

Test _____

_____

Result _____

_____ **(2)**

(ii) Describe and give the result of a chemical test to show that this fertiliser contains sulfate ions (SO_4^{2-}).

Test _____

_____

Result _____

_____ **(2)**

(b) Ammonium sulfate is made by reacting sulfuric acid (a *strong* acid) with ammonia solution (a *weak* alkali).

(i) Explain the meaning of *strong* in terms of ionisation.

_____ **(1)**

(ii) A student made some ammonium sulfate in a school laboratory.

The student carried out a titration, using a suitable indicator, to find the volumes of sulfuric acid and ammonia solution that should be reacted together.

Name a suitable indicator for strong acid-weak alkali titrations.

_____

(1)

(iii) The student found that 25.0 cm^3 of ammonia solution reacted completely with
32.0 cm^3 of sulfuric acid of concentration 0.050 moles per cubic decimetre.

The equation that represents this reaction is:

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

Calculate the concentration of this ammonia solution in moles per cubic decimetre.

_____

_____

_____

_____

_____

Concentration = _____ moles per cubic decimetre

(3)

(iv) Use your answer to (b)(iii) to calculate the concentration of ammonia in grams per cubic decimetre.

(If you did not answer part (b)(iii), assume that the concentration of the ammonia solution is 0.15 moles per cubic decimetre. This is **not** the correct answer to part (b)(iii).)

Relative formula mass of ammonia (NH_3) = 17.

_____

_____

_____

Concentration = _____ grams per cubic decimetre

(2)

(Total 11 marks)

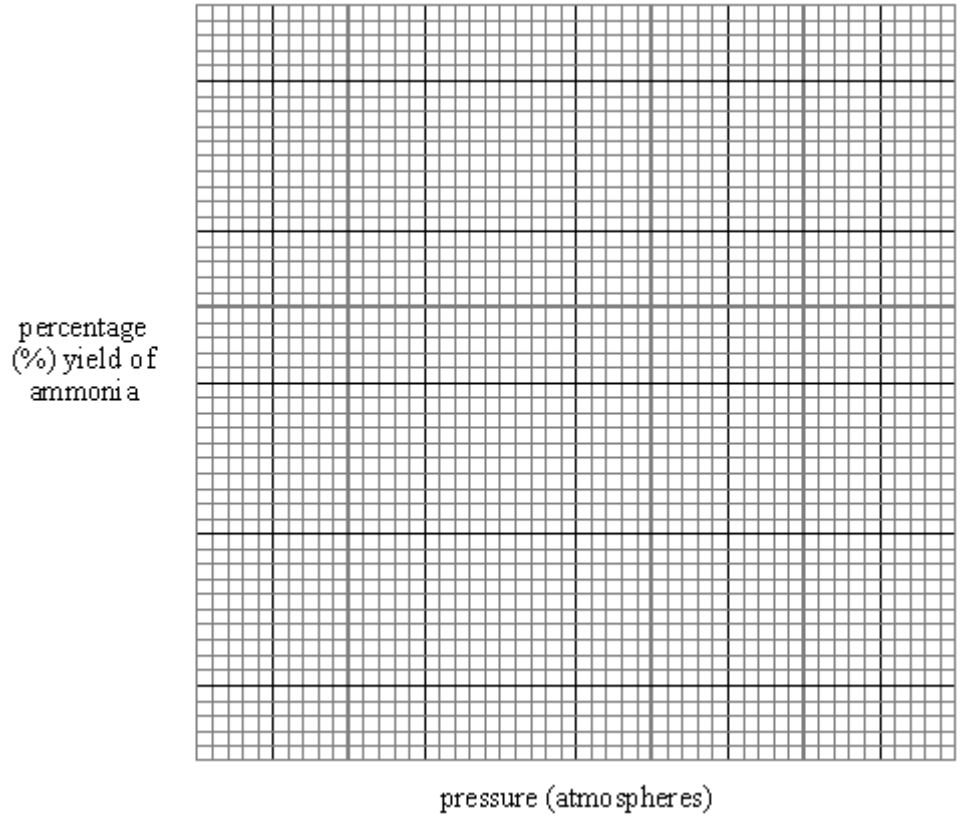
E. Equilibrium

Q1.

The Haber process is used to make ammonia NH_3.
The table shows the percentage yield of ammonia at different temperatures and pressures.

PRESSURE (ATMOSPHERES)	PERCENTAGE (%) YIELD OF AMMONIA AT 350°C	PERCENTAGE (%) YIELD OF AMMONIA AT 500°C
50	25	5
100	37	9
200	52	15
300	63	20
400	70	23
500	74	25

(a) (i) Use the data in the table to draw two graphs on the grid below. Draw one graph for a temperature of 350°C and the second graph for a temperature of 500°C.
Label each graph with its temperature.



(4)

(ii) Use your graphs to find the conditions needed to give a yield of 30% ammonia.

_____ °C and _____ atmospheres

(1)

(iii) On the grid sketch the graph you would expect for a temperature of 450°C.

(1)

(b) (i) This equation represents the reaction in which ammonia is formed.

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} + \text{heat}$

What does the symbol $\rightleftharpoons$ in this equation tell you about the reaction?

_____

(1)

(ii) Use your graphs and your knowledge of the Haber process to explain why a temperature of 450°C and a pressure of 200 atmospheres are used in industry.

_____

_____

_____

_____

_____

_____

(5)

(c) (i) Ammonium nitrate is one type of artificial fertiliser.
Calculate the relative formula mass of ammonium nitrate NH_4NO_3.
(Relative atomic masses: H = 1, N = 14, O = 16.)

_____

_____

(1)

(ii) Use your answer to part (c)(i) to help you calculate the percentage by mass of nitrogen present in ammonium nitrate NH_4NO_3.

_____

_____

(2)

(Total 15 marks)

Q2. The equation for a reaction to produce hydrogen is:

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

(a) Explain why changing the pressure does **not** affect the yield of hydrogen at equilibrium.

_____

_____

(1)

(b) Suggest why the best yield of hydrogen at equilibrium is obtained at **low** temperatures.

_____

_____

(1)

(c) The temperature used in industry needs to be high enough for the reaction to take place quickly. Explain, in terms of particles, why the rate of reaction increases when the temperature is increased.

_____

_____

_____

_____

_____

_____

(3)

(d) Scientists have developed catalysts which allow the reaction to take place quickly at lower temperatures. How could this be good for the manufacturer and for the environment?

_____

_____

_____

_____

(2)

(Total 7 marks)

Q3.

Ammonia is manufactured by the Haber Process, where nitrogen and hydrogen react together as follows:

$N_2 + 3H_2 \Leftrightarrow 2NH_3$

The reaction is reversible. A balance is eventually reached when ammonia is being formed at the same rate at which it is decomposing.

This point is called 'equilibrium'.

	PERCENTAGE OF AMMONIA AT EQUILIBRIUM		
PRESSURE (ATM)	100° C	300° C	500° C
25	91.7	27.4	2.9
100	96.7	52.5	10.6
400	99.4	79,7	31.9

(a) (i) What is meant by a 'reversible reaction'?

_____

_____ **(1)**

(ii) Which substances are present in the mixture at equilibrium?

_____ **(1)**

(b) (i) Under what conditions shown in the table is the maximum yield of ammonia obtained?

_____

_____ **(2)**

(ii) The Haber Process is usually carried out at a higher temperature than that which would produce the maximum yield. Suggest why.

_____

_____

_____

_____ **(2)**

(c) Ammonia can be converted into nitric acid in three stages:

Stage 1 Ammonia reacts with oxygen from the air to form nitrogen monoxide and water

$4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$

Stage 2 On cooling, nitrogen monoxide reacts with oxygen from the air to form nitrogen dioxide.

Stage 3 Nitrogen dioxide reacts with water to form nitric acid and nitrogen monoxide.

(i) Describe the conditions under which the reaction in Stage 1 takes place.

_____

_____

_____

_____

(3)

(ii) Balance the equation for the reaction at Stage 2.

$NO + O_2 \longrightarrow NO_2$

(1)

(iii) Balance the equation for the reaction at Stage 3.

$NO_2 + H_2O \longrightarrow HNO_3 + NO$

(1)

(d) The chemical plant for manufacturing ammonia is often on the same site as plants manufacturing nitric acid and fertilisers.

(i) What advantages will this have for the manufacturing company?

_____

_____

_____

_____

(2)

(ii) Briefly describe **two** important ways in which it is possible to reduce the environmental impact of such plants on the surrounding area.

1.

_____

_____

2.

_____

_____

(2)

(Total 15 marks)

Q4.

The reaction of methane with steam is used in industry to make hydrogen.

(a) One of the reactions in this process is represented by this equation.

CH_4 (g) + H_2O ⇌ CO (g) + $3H_2$ (g)

The forward reaction is endothermic.

State the conditions of temperature and pressure that would give the maximum yield of hydrogen.

Explain your answers.

(i) Temperature

_____

_____

_____

_____

(2)

(ii) Pressure

_____

_____

_____

_____

(2)

(iii) Which one of the following metals is most likely to be a catalyst for this process? Draw a ring around your answer.

aluminium lead magnesium nickel sodium

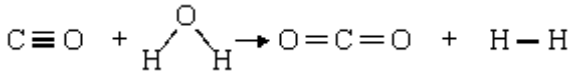
Give a reason for your choice.

_____

_____

(1)

(b) A second stage in this process is represented by this equation.



(i) Use the bond energies given in the table to help you to calculate the nett energy transfer (energy change) for this reaction.

Bond	Bond energy in kJ/mol
C ≡ O	1077
C = O	805
H – H	436
O – H	464

Nett energy transfer = _____ kJ/mol

(3)

(ii) State whether this reaction is exothermic or endothermic.

_____

Explain, by reference to your calculation, how you know.

(2)

(Total 10 marks)

F. Organic Chemistry

Q1. Crude oil is a complex mixture of hydrocarbons, mainly alkanes. The number of carbon atoms in the molecules ranges from 1 to over 100.

(a) How does the boiling point change as the number of carbon atoms in the molecules increases?

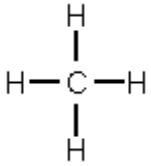
_____

_____ **(1)**

(b) Name the method used to separate petroleum into fractions.

_____ **(1)**

(c) The simplest hydrocarbon is methane, CH_4. Its structure can be represented:



Draw the structure of ethane, C_2H_6.

(1)

(Total 3 marks)

Q2. Crude oil is separated into fractions by fractional distillation.

The table gives information about some of the fractions.

Fraction	Boiling point range in °C	Number of carbon atoms per molecule
Gas	Below 20	1 – 4
Petrol	20 – 100	5 – 10
Paraffin	100 – 250	11 – 15
Diesel	250 – 350	16 – 20
Lubricant	350 – 500	21 – 35
Bitumen	Above 500	Above 35

(a) What is the relationship between the boiling point of a fraction and the number of carbon atoms in its molecules?

_____

_____

(1)

(b) Give **one** further difference, other than boiling point, between diesel and paraffin that also depends on the number of carbon atoms in their molecules.

_____

_____

(1)

(c) All the fractions contain hydrocarbons.

Name the **two** elements in a hydrocarbon.

_____ and _____

(1)

(Total 3 marks)

Q3.

Modem window frames are often made from uPVC which contains the plastic poly(chloroethene).

(a) State why plastic window frames need no painting or maintenance.

_____

_____

(1)

(b) Poly(chloroethene) is a polymer formed by the *addition polymerisation* of chloroethene.

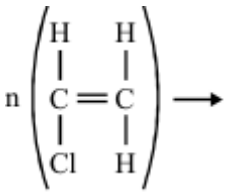
(i) Chloroethene is an unsaturated molecule. Why is this molecule said to be unsaturated?

_____

_____

(1)

(ii) Complete the diagram to represent how poly(chloroethene) is formed from chloroethene.



(3)

(iii) Explain what is meant by the term *polymerisation*.

_____

_____

_____

_____

(2)

(iv) Why is this an *addition polymerisation*?

_____

_____

(1)

(Total 8 marks)

Q4.

This question is about polymers.

(a) Name the monomer used to form poly(chloroethene).

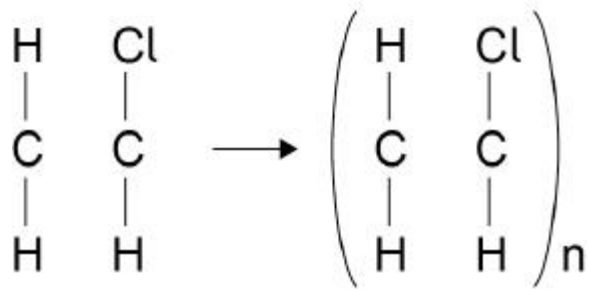
_____

(1)

(b) **Figure 1** shows the equation for the formation of poly(chloroethene).

Complete **Figure 1**.

Figure 1



(3)

(c) Poly(chloroethene) is the only product.

What type of polymer is poly(chloroethene)?

_____

(1)

Ethanediol reacts with butanedioic acid to produce a polyester and a small molecule.

(d) **Figure 2** shows the structural formula of ethanediol.

Figure 2

$HO–CH_2–CH_2–OH$

Name the functional group present in ethanediol.

_____

(1)

(e) **Figure 3** shows the structural formula of butanedioic acid.

Figure 3

$HOOC–CH_2–CH_2–COOH$

Which formula represents the carboxylic acid functional group?

Tick (✔) **one** box.

$–CH_2–$ ☐

$–CH_2–CH_2–$ ☐

$–CH_2–COOH$ ☐

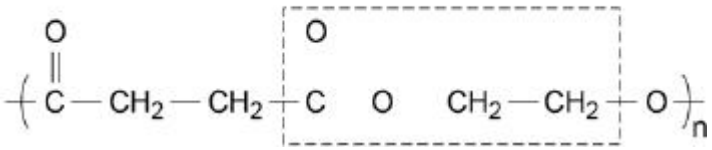
$–COOH$ ☐

(1)

(f) **Figure 4** shows part of the structure of the polyester.

Complete the box in **Figure 4**.

Figure 4



(2)

(g) Name the small molecule produced when ethanediol reacts with butanedioic acid.

_____

(1)

Starch, proteins and DNA are naturally occurring polymers.

(h) Name the monomers from which starch and proteins are produced.

Starch _____

Proteins _____

(2)

(i) Describe the structure of DNA.

_____

_____

_____

_____

(2)

(Total 14 marks)

G. Analysis

Q1.

This question is about chemicals in fireworks.

Coloured flames are produced because of the metal ions in the fireworks.

(a) What colour flame would sodium ions produce?

_____

(1)

(b) Name a metal ion that would produce a green flame.

_____

(1)

(c) Some fireworks contain a mixture of metal ions.

Why is it difficult to identify the metal ions from the colour of the flame?

_____

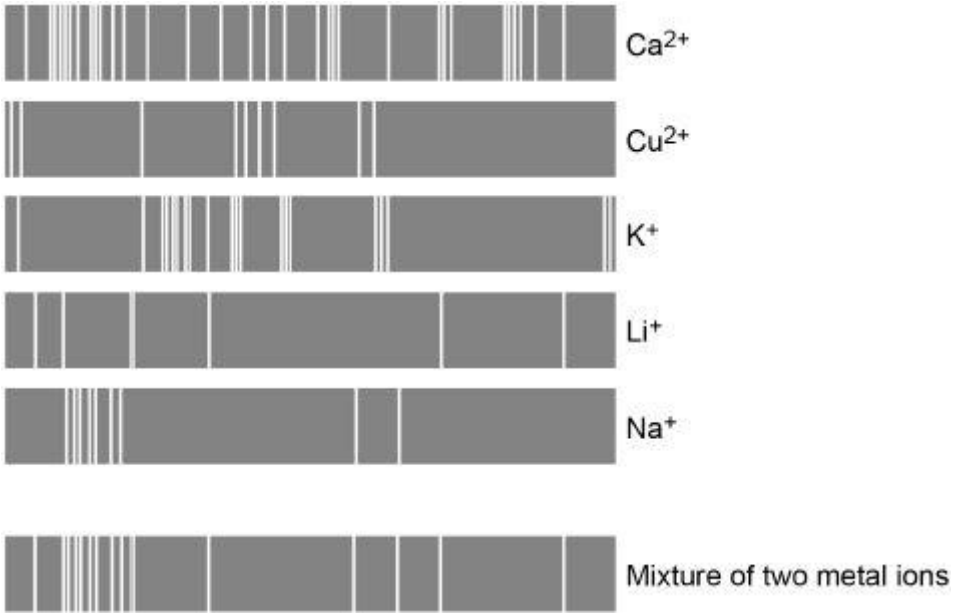
_____

(1)

(d) Flame emission spectroscopy is used to identify metal ions in a firework.

The diagram below shows:

- the flame emission spectra of five individual metal ions
- a flame emission spectrum for a mixture of two metal ions.



Which **two** metal ions are in the mixture?

Tick **two** boxes.

Ca^{2+} ☐

Cu^{2+} ☐

K^+ ☐

Li^+ ☐

Na^+ ☐

(2)

The compounds in fireworks also contain non-metal ions.

A scientist tests a solution of the chemicals used in a firework.

(e) Silver nitrate solution and dilute nitric acid are added to the solution.

A cream precipitate forms

Which ion is shown to be present by the cream precipitate?

_____

(1)

(f) Describe a test to show the presence of sulfate ions in the solution.

Give the result of the test if there are sulfate ions in the solution.

Test

_____

_____

_____

_____

Result

_____

_____

(3)

(Total 9 marks)

Q2. A student investigated an egg shell.

Trish Steel [CC-BY-SA-2.0], via Wikimedia Commons

(a) The student did some tests on the egg shell.

The student's results are shown in the table below.

	Test	Observation
1	Dilute hydrochloric acid was added to the egg shell.	A gas was produced. The egg shell dissolved, forming a colourless solution.
2	A flame test was done on the colourless solution from test **1**.	The flame turned red.
3	Sodium hydroxide solution was added to the colourless solution from test **1**.	A white precipitate formed that did not dissolve in excess sodium hydroxide solution.
4	Silver nitrate solution was added to the colourless solution from test **1**.	A white precipitate formed.

(i) The student concluded that the egg shell contains carbonate ions.

Describe how the student could identify the gas produced in test **1**.

_____

_____

_____

_____

(2)

(ii) The student concluded that the egg shell contains aluminium ions.

Is the student's conclusion correct? Use the student's results to justify your answer.

_____

_____

_____

_____

(2)

(iii) The student concluded that the egg shell contains chloride ions.

Is the student's conclusion correct? Use the student's results to justify your answer.

_____

_____

_____

_____

(2)

(b) Some scientists wanted to investigate the amount of lead found in egg shells. They used a modern instrumental method which was *more sensitive* than older methods.

(i) Name **one** modern instrumental method used to identify elements.

_____

_____

(1)

(ii) What is the meaning of *more sensitive*?

_____

_____

(1)

(Total 8 marks)

Q3.

Four bottles of chemicals made in the 1880s were found recently in a cupboard during a Health and Safety inspection at Lovell Laboratories.

Sodium carbonate

Sodium chloride

Sodium nitrate

Sodium sulfate

The chemical names are shown below each bottle.

(a) You are provided with the following reagents:

- aluminium powder
- barium chloride solution acidified with dilute hydrochloric acid
- dilute hydrochloric acid
- silver nitrate solution acidified with dilute nitric acid
- sodium hydroxide solution.
- limewater
- red litmus paper

(i) Describe tests that you could use to show that these chemicals are correctly named.

In each case give the reagent(s) you would use **and** state the result.

Test and result for carbonate ions:

_____

_____

_____

Test and result for chloride ions:

_____

_____

_____

Test and result for nitrate ions:

_____

_____

_____

Test and result for sulfate ions:

_____

_____

_____

(4)

(ii) Suggest why a flame test would **not** distinguish between these four chemicals.

_____

(1)

(b) Instrumental methods of analysis linked to computers can be used to identify chemicals.

Give **two** advantages of using instrumental methods of analysis.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q4.

A student investigated the colours in three different flowers, **A**, **B** and **C**.

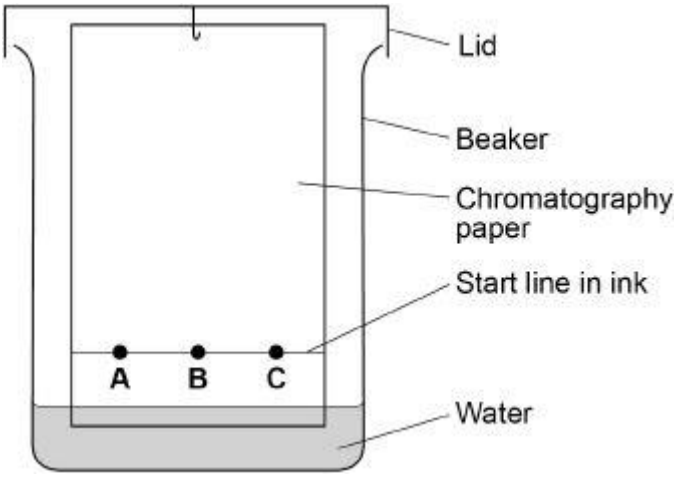
The colours are soluble in ethanol but are insoluble in water.

This is the method used.

1. Crush flower **A**.
2. Add ethanol to flower **A**.
3. Filter the mixture.
4. Put spots of the coloured filtrate on to the chromatography paper.
5. Repeat steps 1-4 with flowers **B** and **C**.

Figure 1 shows the apparatus used.

Figure 1



(a) The student made **two** mistakes in setting up the apparatus.

Give **one** problem caused by each mistake.

Mistake 1_____

Problem caused _____

_____

Mistake 2

_____

Problem caused_____

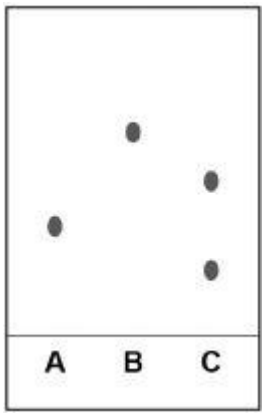
_____

(4)

(b) Another student set up the apparatus correctly.

Figure 2 represents the student's results.

Figure 2



Give **two** conclusions you can make from **Figure 2**.

1. _____

_____

2. _____

_____

(2)

(c) Colour **A** has an R_f value of 0.65

Colour **A** moves 3.2 cm

Calculate the distance moved by the solvent.

_____

_____

Distance moved by the solvent = _____ cm

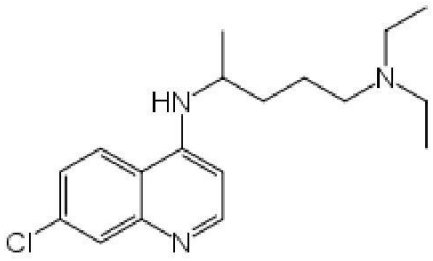
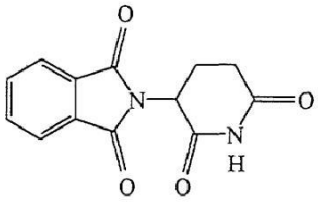
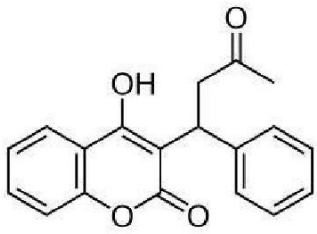
(2)

(Total 8 marks)

Task 7 – Research

Choose one (or more) of the following medicines/drugs and find out:

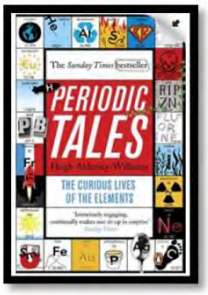
1. Common brand names
2. Class of drug
3. Brief history of discovery
4. State the chemical functional group found in the compound
5. Uses
6. List any side effects

Chloroquine	Thalidomide	Warfarin
		

Book Recommendations

We recommend the first three texts as interesting texts for Chemistry / Science students, the final text will be of use to those who are not studying A-level maths as it covers the various different types of calculations encountered throughout the A-level course. This book contains many worked through examples. We are hoping to obtain a class set for September 2017.

Periodic Tales: The Curious Lives of the Elements (Paperback) Hugh Aldersey-Williams

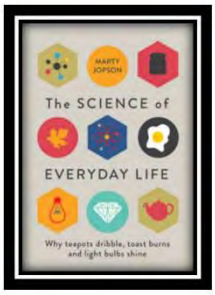


ISBN-10: 0141041455

http://bit.ly/pixlchembook1

This book covers the chemical elements, where they come from and how they are used. There are loads of fascinating insights into uses for chemicals you would have never even thought about.

The Science of Everyday Life: Why Teapots Dribble, Toast Burns and Light Bulbs Shine (Hardback) Marty Jopson

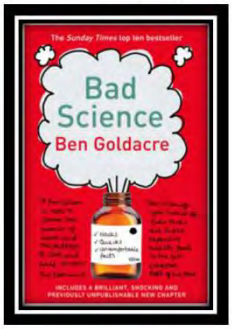


ISBN-10: 1782434186

http://bit.ly/pixlchembook2

The title says it all really, lots of interesting stuff about the things around you home!

Bad Science (Paperback) Ben Goldacre

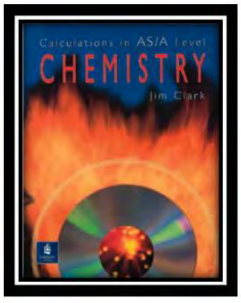


ISBN-10: 000728487X

http://bit.ly/pixlchembook3

Here Ben Goldacre takes apart anyone who published bad / misleading or dodgy science – this book will make you think about everything the advertising industry tries to sell you by making it sound 'sciency'.

Calculations in AS/A Level Chemistry (Paperback) Jim Clark



ISBN-10: 0582411270

http://bit.ly/pixlchembook4

If you struggle with the calculations side of chemistry, this is the book for you. Covers all the possible calculations you are ever likely to come across. Brought to you by the same guy who wrote the excellent **chemguide.co.uk** website.

Note these links are to Waterstones, should you wish to acquire any of these books you may find them cheaper elsewhere.