Chemical Changes 2

Name: _____

Class: _____

Date: _____

Time: **54 minutes**

Marks: **54 marks**

Comments:

1. Iron is extracted from iron oxide in the blast furnace.

(a) The equation for one of the reactions in the blast furnace is:

$$Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$$

(i) Complete the word equation for this reaction.

iron oxide + carbon monoxide ⟶ _____ + _____

(2)

(ii) Oxygen is removed from iron oxide in the blast furnace.

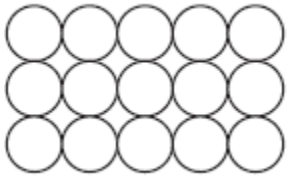
Draw a ring around the correct answer to complete the sentence.

The iron oxide is

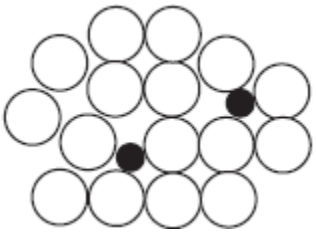
neutralised.
oxidised.
reduced.

(1)

(b) The diagrams represent pure iron and iron from the blast furnace.



Pure iron



Iron from the blast furnace

(i) Draw **one** line from each statement to the correct explanation.

Statement	Explanation
Pure iron is an element because	it is made of one sort of atom only.
	it contains two elements not chemically combined.
Iron from the blast furnace is a mixture because	every atom has the same number of neutrons.
	it contains two elements chemically combined.

(2)

(ii) Explain why iron from the blast furnace is harder than pure iron.

Use the diagrams on page 4 to help you.

_____

_____

_____

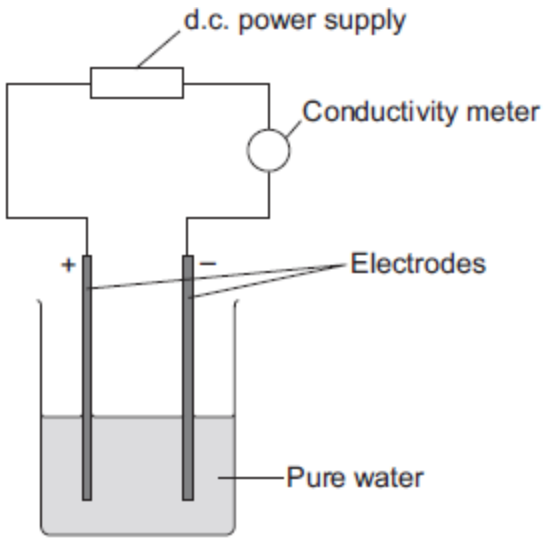
_____

(2)

(Total 7 marks)

2. 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.

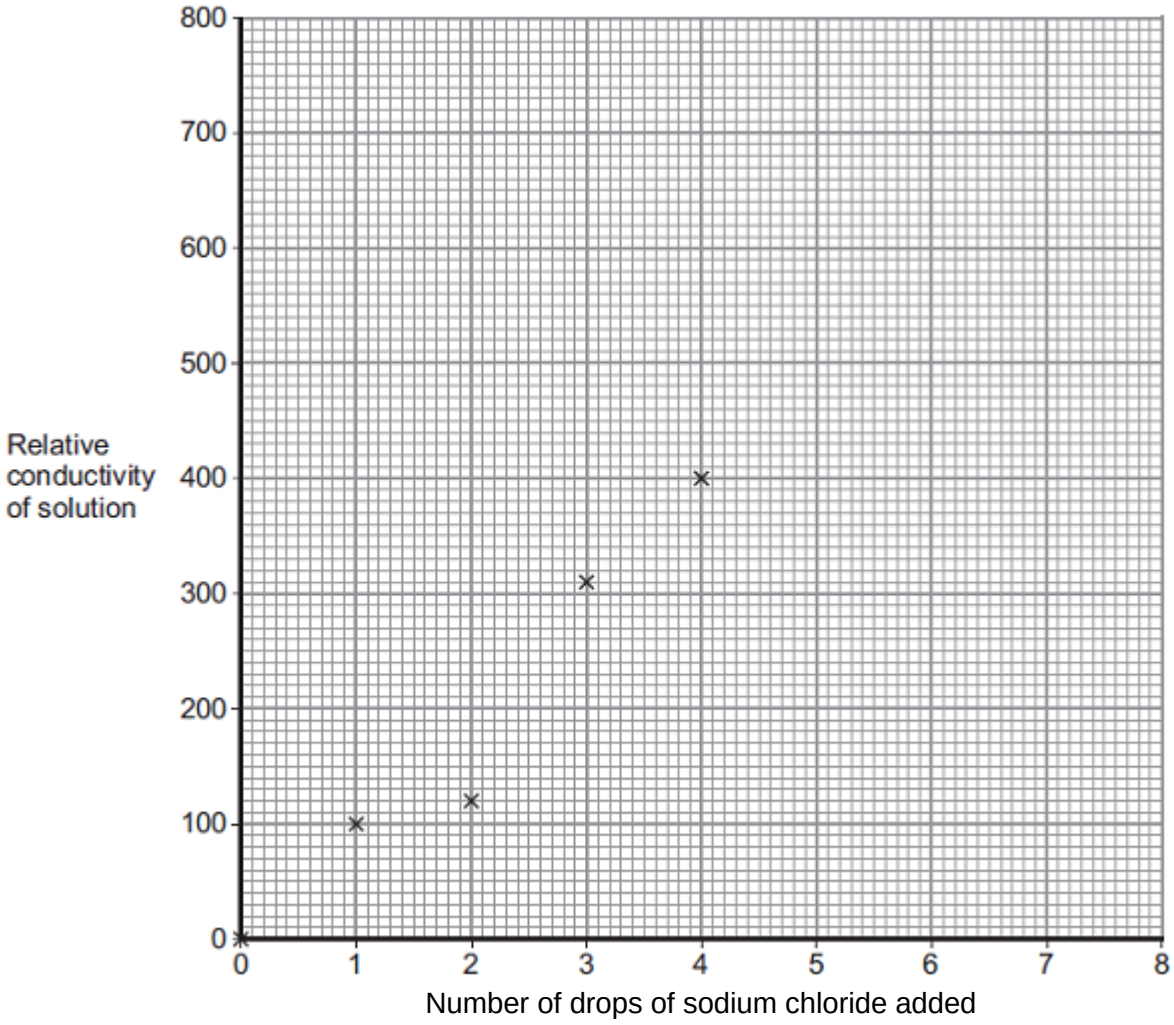
Number of drops of sodium chloride solution added	Relative conductivity of solution
0	0
1	100
2	120
3	310
4	400
5	510
6	590
7	710
8	800

(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.

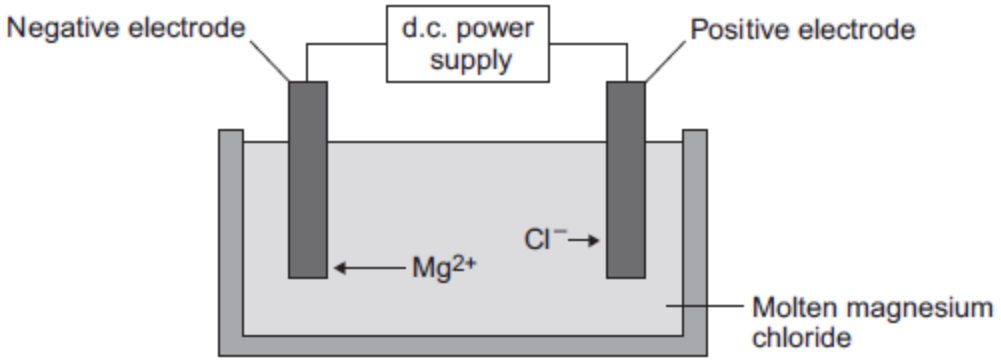
The gas produced at the negative electrode is _____

(1)

(Total 10 marks)

3. Some students investigated reactions to produce magnesium.

(a) The students used electrolysis to produce magnesium from magnesium chloride, as shown in the figure below.



(i) Magnesium chloride contains magnesium ions and chloride ions.

Why does solid magnesium chloride **not** conduct electricity?

_____

_____

(1)

(ii) One of the products of the electrolysis of molten magnesium chloride is magnesium.

Name the other product.

_____

(1)

(iii) Why do magnesium ions (Mg^{2+}) move to the negative electrode?

_____

_____

(1)

(iv) At the negative electrode, the magnesium ions (Mg^{2+}) gain electrons to become magnesium atoms.

How many electrons does each magnesium ion gain?

_____

(1)

(b) The students did the experiment four times and weighed the magnesium produced.

The table below shows their results.

Experiment	Mass of magnesium produced in grams
1	1.13
2	0.63
3	1.11
4	1.09

(i) There is an anomalous result.

Suggest **one** possible reason for the anomalous result.

_____

_____

(1)

(ii) Calculate the mean mass of magnesium produced, taking account of the anomalous result.

_____

_____

_____

Mean mass = _____ g

(2)

(c) The formula of magnesium chloride is $MgCl_2$

The relative formula mass of magnesium chloride is 95.

The relative atomic mass of magnesium is 24.

(i) Use the equation to calculate the percentage mass of magnesium in magnesium chloride.

$$\text{Percentage mass of magnesium} = \frac{\text{mass of magnesium}}{\text{mass of magnesium chloride}} \times 100\%$$

_____

_____

_____

Percentage mass of magnesium in magnesium chloride = _____ %

(2)

(ii) Draw a ring around the relative mass of chlorine in $MgCl_2$

71 **95** **119**

(1)

(d) Magnesium is also produced from the reaction of magnesium oxide with silicon.

(i) The equation for the reaction is:

$$2\,MgO(s) + Si(s) \rightleftharpoons SiO_2(s) + 2\,Mg(s)$$

What is the meaning of this symbol $\rightleftharpoons$?

Draw a ring around the correct answer.

neutralisation reaction **precipitation reaction** **reversible reaction**

(1)

(ii) The forward reaction is endothermic.

Draw a ring around the correct answer to complete the sentence.

In an endothermic reaction the temperature of the surroundings

decreases.
increases.
stays the same.

(1)

(Total 12 marks)

4. Kelp is a seaweed.

Kelp can be used in foods and as a renewable energy source.

© Ethan Daniels/Shutterstock

(a) Scientific experiments, on their own, **cannot** fully answer one of the following questions. Which one?

Tick (✓) **one** box.

Questions	Tick (✓)
How much carbon dioxide is produced when 100 g of kelp is burned?	
Does kelp give out more heat energy than coal?	
Will kelp last longer than coal as an energy source?	
Which fuel, kelp or coal, produces the most ash when burned?	

(1)

(b) Scientists cannot answer the question 'should people use kelp instead of coal as an energy source?'

Give **two** reasons why.

_____

_____

_____

_____

(2)

(c) Sodium iodide can be produced from kelp.

(i) How many electrons are in the outer shell of an iodine atom?

(1)

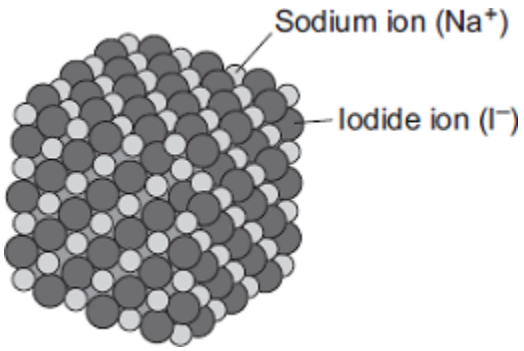
(ii) Sodium iodide contains sodium ions (Na^+) and iodide ions (I^-).

Describe, as fully as you can, what happens when sodium atoms react with iodine atoms to produce sodium iodide.

You may use a diagram in your answer

(3)

(iii) The diagram shows the structure of sodium iodide.



Solid sodium iodide does not conduct electricity.

Why does sodium iodide solution conduct electricity?

_____

_____

(1)

(iv) When sodium iodide solution is electrolysed, iodine is formed at the positive electrode.

Complete and balance the half equation for the formation of iodine.

$$\_\_\_\_\_I^- \rightarrow I_2 + \_\_\_\_\_e^-$$

(1)

(v) What is formed at the negative electrode when sodium iodide solution is electrolysed?

Explain why.

_____

_____

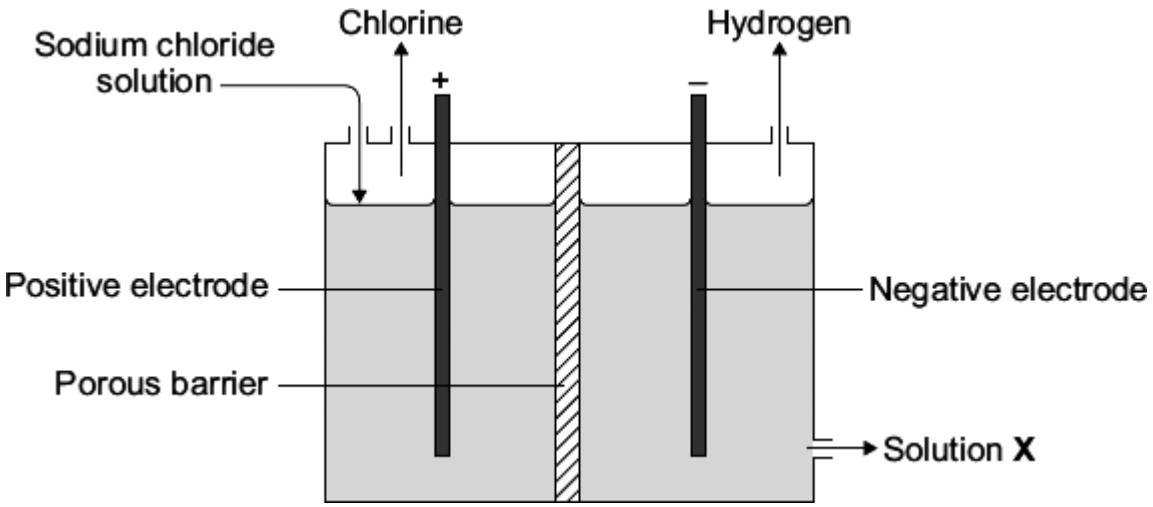
_____

_____

(2)

(Total 11 marks)

5. The electrolysis of sodium chloride solution is an industrial process.



(a) Why do chloride ions move to the positive electrode?

_____

(1)

(b) Sodium chloride solution contains two types of positive ions, sodium ions (Na^+) and hydrogen ions (H^+).

Tick (✓) the reason why hydrogen is produced at the negative electrode and **not** sodium.

Reason	Tick (✓)
Hydrogen is a gas.	
Hydrogen is less reactive than sodium.	
Hydrogen is a non-metal.	
Hydrogen ions travel faster than sodium ions.	

(1)

(c) Solution **X** is alkaline.

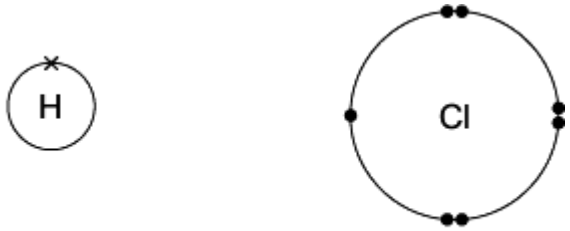
Which ion makes solution **X** alkaline?

_____

(1)

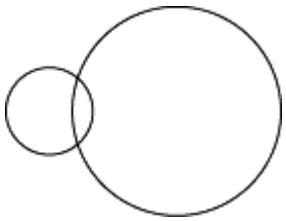
(d) Electrolysis of sodium chloride solution produces hydrogen and chlorine.
The hydrogen and chlorine can be used to make hydrogen chloride.

(i) The diagrams show how the outer electrons are arranged in atoms of hydrogen and chlorine.



Hydrogen atom Chlorine atom

Complete the diagram to show how the electrons are arranged in a molecule of hydrogen chloride (HCl).



(1)

(ii) Name the type of bond between the hydrogen and the chlorine atoms in a molecule of hydrogen chloride.

_____

(1)

(iii) Some hydrogen chloride was bubbled into water. This made a solution with a pH of 1.

Which ion gave the solution a pH of 1?

_____

(1)

(Total 6 marks)

6. An ore contains zinc carbonate ($ZnCO_3$).

(a) Complete the table to show the number of atoms of each element in the formula of zinc carbonate.

Zinc has been done for you.

Element	**Number of atoms in the formula $ZnCO_3$**
Zinc, Zn	1
Carbon, C	
Oxygen, O	

(2)

(b) Draw a ring around the correct answer to complete the sentence and the word equation.

(i) Zinc carbonate decomposes in a similar way to calcium carbonate

when

- water is added.
- cooled.
- heated.

(1)

(ii) zinc carbonate → zinc oxide +

- carbon dioxide
- hydrogen
- oxygen

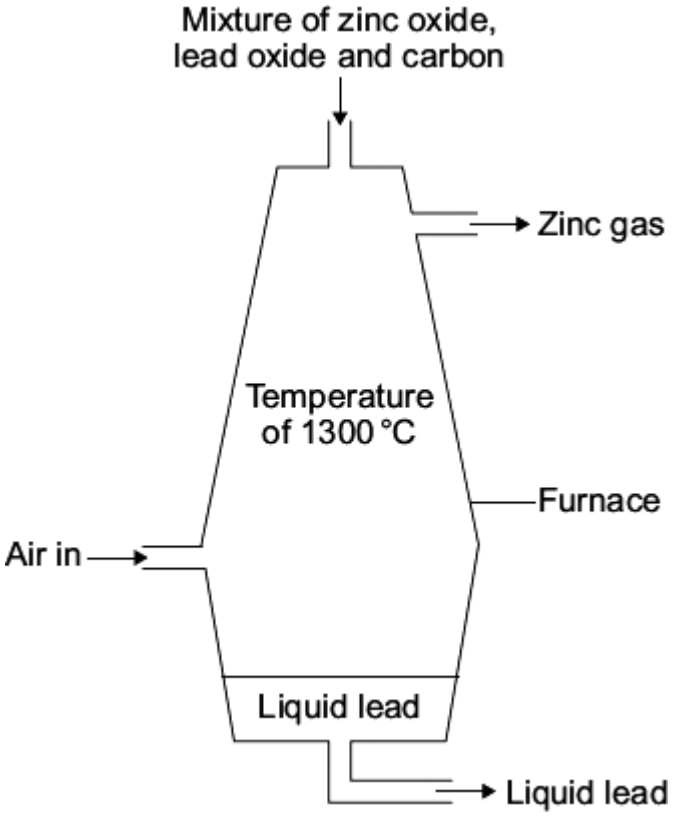
(1)

(c) Another ore contains a mixture of zinc carbonate and lead carbonate.

The metals zinc and lead are produced from this ore in two stages:

Stage 1 decomposing the carbonates to produce a mixture of zinc oxide and lead oxide.

Stage 2 mixing the oxides with carbon and heating in a furnace.



Some of the reactions in the furnace are:

zinc oxide + carbon → zinc + carbon dioxide

lead oxide + carbon → lead + carbon dioxide

carbon + oxygen → carbon dioxide

Use the information given to help you to answer these questions.

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

The reaction between carbon and oxygen that heats the

furnace is called

combustion.
decomposition.

evaporation.

(1)

(ii) Tick (✓) **one** reason why carbon reacts with zinc oxide to produce zinc.

Reason	**Tick (✓)**
carbon is less reactive than zinc	
carbon is more reactive than zinc	
carbon is similar in reactivity to zinc	

(1)

(iii) In the furnace zinc is a gas but lead is a liquid.

Suggest why.

_____

_____

_____

_____

(2)

(Total 8 marks)

1. (a) (i) iron

either order

1

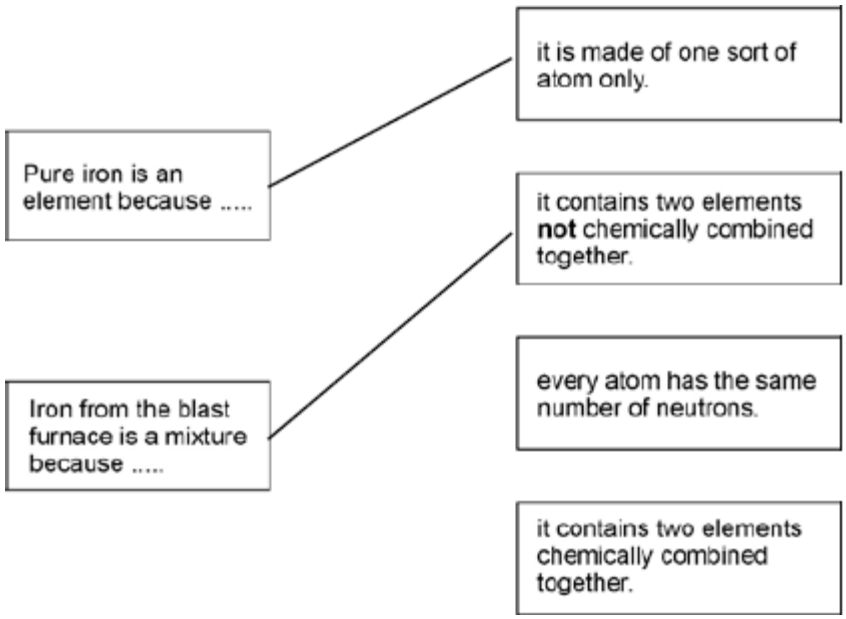
carbon dioxide

1

(ii) reduced

1

(b) (i)



*each correct line gains **1** mark*

extra lines from statement negate the mark

max. 2

(ii) the layers / rows are distorted / disrupted **or** it doesn't occur in layers **or** the atoms are different

1

so cannot **slide** over one another **or slide** less easily

1

[7]

2. (a) (i) points correctly plotted (± ½ small square)

*four points = **2** marks*

*three points = **1** mark*

Max 2

straight line of best fit using full range of points from 0,0

1

(ii) any **one** from:

must explain why the point is below the line

- the solution may not have been properly stirred
- the electrodes may have been a larger distance apart
- the drop of sodium chloride may have been a smaller volume / smaller

allow not enough sodium chloride added

allow smaller amount of sodium chloride

*do **not** allow too few drops added*

ignore the student may have misread the conductivity meter

1

(iii) any **one** from:

- the volume of pure water

allow amount

- the concentration (of the solutions added)
- the volume (of the drops) of solution added

ignore number of drops

- the distance between the electrodes
- the same electrodes **or** electrodes made of the same material
- same depth **or** surface area of electrodes in the water
- constant power supply

ignore current

- stirred

1

(b) (i) because (pure) water is covalent / molecular (simple) **or** contains molecules

1

therefore (pure) water has no free / mobile electrons **or** ions

*molecules do not have a charge **or** molecules do not contain ions*
*gains **2** marks*

1

(ii) because there are ions in sodium chloride

*allow Na^+ and / or Cl^-(ions) **or** ionic bonding.*

Ignore particles other than ions for MP1.

1

which can move **or** carry the current / charge

MP2 must be linked to ions only.

1

(iii) Hydrogen

allow H_2 / H

1

[10]

3. (a) (i) ions cannot move

allow only conducts as a liquid

1

(ii) chlorine

1

(iii) they are positively / oppositely charged

or

they are attracted

1

(iv) 2

1

(b) (i) any **one** from:

- not all the magnesium was collected

  allow some magnesium was lost
- *used less time **or** lower current **or** different battery / power pack **or** different balance **or** lower voltage*
- error in reading balance
- error in recording result

1

(ii) 1.11

*correct answer with or without working gains **2** marks.*

*if answer incorrect, allow **1** mark for 0.99*

***or** for 1.13 + 1.11 + 1.09*

2

(c) (i) *25 – 25.3*

*correct answer with or without working gains **2** marks.*

*If answer incorrect, allow **1** mark for 24 / 95*

2

(ii) 71

1

(d) (i) reversible reaction

1

(ii) decreases

1

[12]

4. (a) Will kelp last longer than coal as an energy source?

1

(b) any **two** from:

- cannot be determined by experiment
  allow can't predict how long kelp / coal will last
  allow more testing needed
- based on opinion
- ethical **or** environmental **or** economic reason
  allow could damage ecosystem allow reference to cost

2

(c) (i) 7

1

(ii) sodium (atom) loses (electron) **and** iodine (atom) gains (an electron)
*reference to incorrect bonding **or** incorrectly named particle = max **2***
any or all marks can be obtained from a labelled diagram
ignore inner shell electrons if shown

1

1 electron

1

(electrostatic) attraction **or** forms ionic bond(s)

1

(iii) ions can move (in the solution)

1

(iv) $2\ I^- \rightarrow \mathbf{I_2} + \mathbf{2}\ e^-$

1

(v) hydrogen is formed

1

because sodium is more reactive (than hydrogen)

1

[11]

5. (a) any **one** from:

- they are negative / anions
  allow Cl^-
  ignore atoms / chlorine
  *do **not** accept chloride ions are negative electrodes*
- they are attracted
- they are oppositely charged

1

(b) hydrogen is less reactive than sodium

1

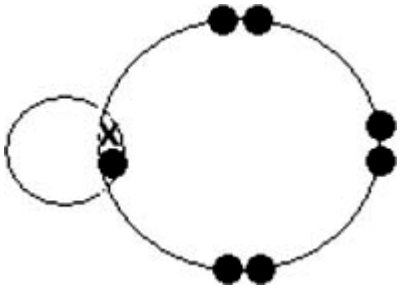
(c) hydroxide (ions) / OH^-

ignore OH

*do **not** accept NaOH / sodium hydroxide*

1

(d) (i)



allow any combination of dots or crosses

ignore chemical symbols

1

(ii) covalent

allow close spelling errors

apply list principle

1

(iii) hydrogen (ion) / H^+

ignore (aq) / H

do not accept hydrochloric acid / HCl

apply list principle

1

[6]

6. (a) (carbon =) 1

1

(oxygen =) 3

1

(b) (i) heated

1

(ii) carbon dioxide

1

(c) (i) combustion

1

(ii) carbon is more reactive than zinc

1

(iii) zinc boils (in the furnace / below 1300°C)

ignore melting point / changes of state

1

lead does not boil / (only) melts in the furnace / boils above 1300°C

*if no other mark awarded allow zinc has a lower boiling point **or** lead has a higher boiling point*

***or** they / zinc **and** lead have different boiling points for **1** mark*

1

[8]