GCSE Science (Chemistry) : Higher tier ppQs

from end of year 9/start of year 10 work

Name : _____

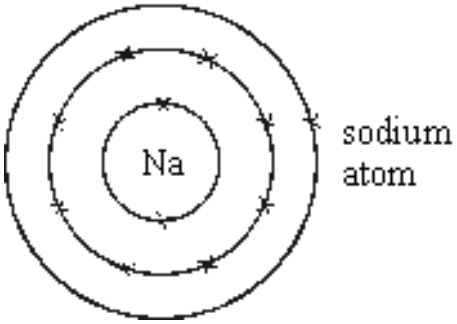
Total : **69 marks**

Q1. (a) The electronic structure of a sodium atom can be written 2,8,1.
Write the electronic structure of a potassium atom in the same way.

.....

(1)

(b) The electronic structure of a sodium atom can also be represented as in the diagram below.



(i) Draw a similar diagram for a fluorine atom.

(ii) Draw similar diagrams to show the electronic structure of the particles in sodium fluoride.

(4)
(Total 5 marks)

Q2.(a) Dmitri Mendeleev was one of the first chemists to classify the elements by arranging them in order of their atomic weights. His periodic table was published in 1869.

How did Mendeleev know that there must be undiscovered elements **and** how did he take this into account when he designed his periodic table?

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(2)

(b) By the early 20th century protons and electrons had been discovered.

Describe how knowledge of the numbers of protons and electrons in atoms allow chemists to place elements in their correct order and correct group.

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(3)

(c) The transition elements are a block of elements between Groups 2 and 3 of the periodic table.

(i) Transition elements have similar properties.

Explain why, in terms of electronic structure.

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(2)

(ii) There are **no** transition elements between the Group 2 element magnesium and the Group 3 element aluminium.

Give a reason why, in terms of electronic structure.

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(1)
(Total 8 marks)

Q3. Sodium and potassium are both in Group 1 of the Periodic Table.

(a) Explain, by reference to their electronic structures, why both elements are placed in Group 1.

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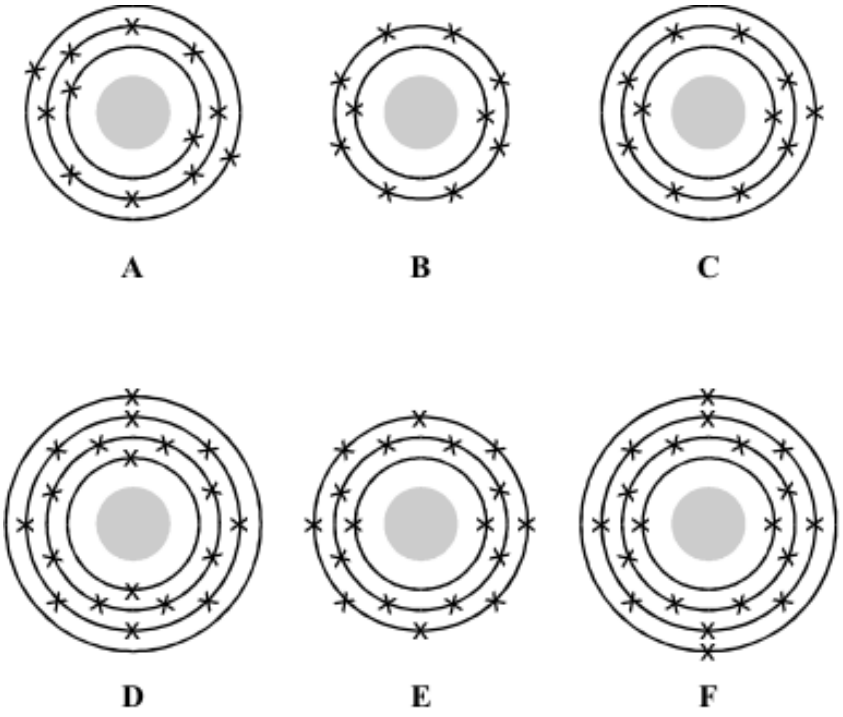
(1)

(b) Use the Data Sheet to help you to answer this question.
The diagrams below represent the electronic structures of some atoms and ions.



Which one of the structures, **A** - **F**

(i) represents a sodium **atom**, ...
(1)

(ii) represents a potassium **ion**? .....
(1)

(c) Sodium and potassium both react with cold water.

(i) The word equation represents the reaction of sodium with water.

sodium + water → sodium hydroxide + hydrogen

Complete and balance the symbol equation for this reaction.

..... + ... → 2NaOH + ...
(2)

(ii) How does the reactivity of potassium with water differ from that of sodium with water?

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Explain this difference in reactivity by reference to the electronic structures of the potassium and sodium atoms.

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(4)
(Total 9 marks)

Q4. This question is about potassium.

(a) Humphrey Davy was a professor of chemistry.

In 1807 Davy did an electrolysis experiment to produce potassium.

(i) Davy first tried to electrolyse a solid potassium salt to produce potassium.

Explain why this electrolysis did **not** work.

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.....

(2)

(ii) Humphrey Davy was the first person to produce potassium.

Humphrey Davy's experiment to produce this new element was quickly accepted by other scientists.

Suggest why.

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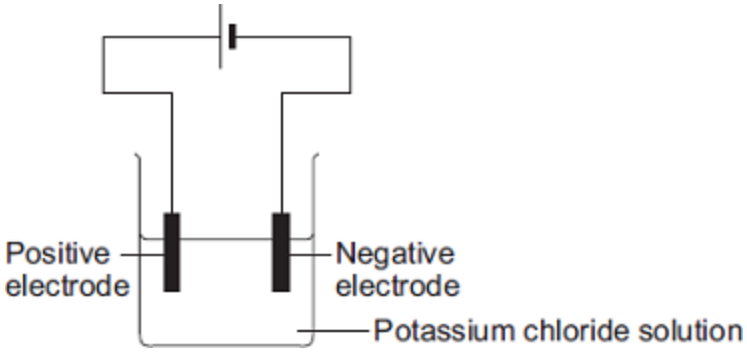
(1)

(b) A student dissolved some potassium chloride in water. The student tried to electrolyse the potassium chloride solution to produce potassium.

The apparatus the student used is shown in the diagram.



The student expected to see potassium metal at the negative electrode, but instead saw bubbles of a gas.

- Name the gas produced at the negative electrode.
- Explain why this gas was produced at the negative electrode **and** why potassium was not produced.

The reactivity series of metals on the Chemistry Data Sheet may help you to answer this question.

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(3)

(c) The student tried to electrolyse molten potassium chloride to produce potassium.

(i) Potassium metal was produced at the negative electrode.

Describe how potassium atoms are formed from potassium ions.

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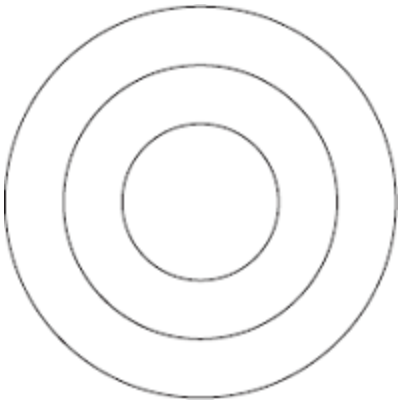
(2)

(ii) Complete and balance the equation for the reaction at the positive electrode.

.....Cl^- ⟶ Cl_2 + ...

(1)

(iii) Complete the diagram to show the electronic structure of a chloride ion (Cl^-).



(1)
(Total 10 marks)

Q5. Aluminium is extracted from aluminium oxide.

(a) The formula of aluminium oxide is Al_2O_3

The relative formula mass (M_r) of aluminium oxide is 102.

Calculate the percentage of aluminium in aluminium oxide.

Relative atomic masses (A_r): O = 16; Al = 27.

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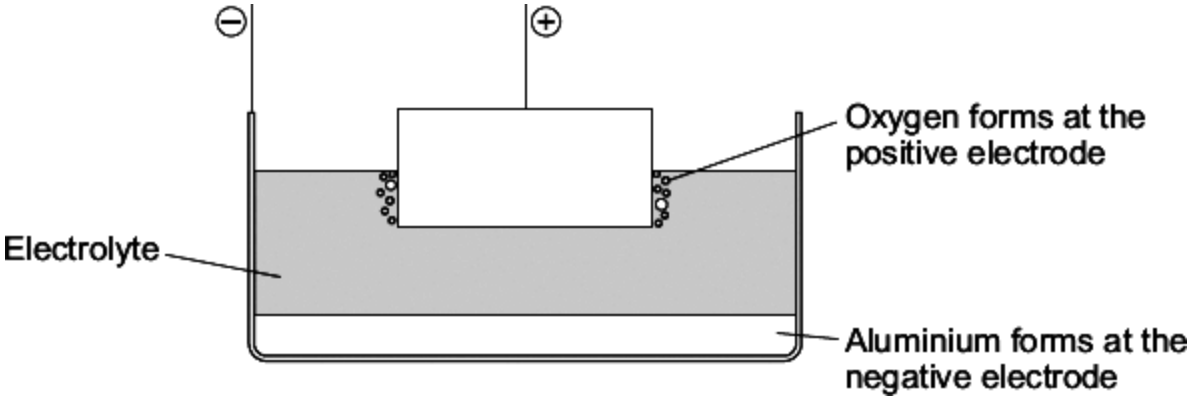
Percentage of aluminium = ... %

(2)

(b) Aluminium is extracted from aluminium oxide using electrolysis.

The diagram shows a cell used for the extraction of aluminium.



(i) The electrolyte contains cryolite.

Explain why.

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.....

(2)

(ii) Oxygen is formed at the positive electrode. Complete and balance the equation for this reaction.

... O^{2-} → O_2 + ...

(2)

(iii) The positive electrode in the cell is used up during the process.

Explain why.

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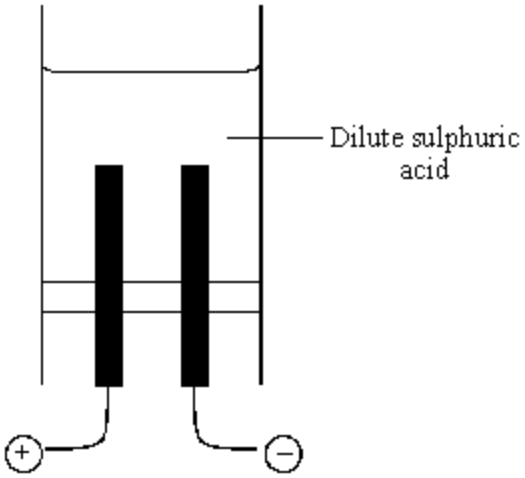
(2)

(Total 8 marks)

Q6. An electric current was passed through dilute sulphuric acid. The apparatus used is shown. Oxygen was formed at the anode.



(a) What name is given to solutions which decompose when electricity is passed through them?

.....

(1)

(b) The ionic equation for the reaction at the anode is:

$$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$$

Explain this type of reaction.

.....

.....

(2)

(c) Write a **balanced** ionic equation for the reaction at the cathode.

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(2)

(d) What happens to the concentration of the sulphuric acid as the electricity is passed through it? Explain your answer.

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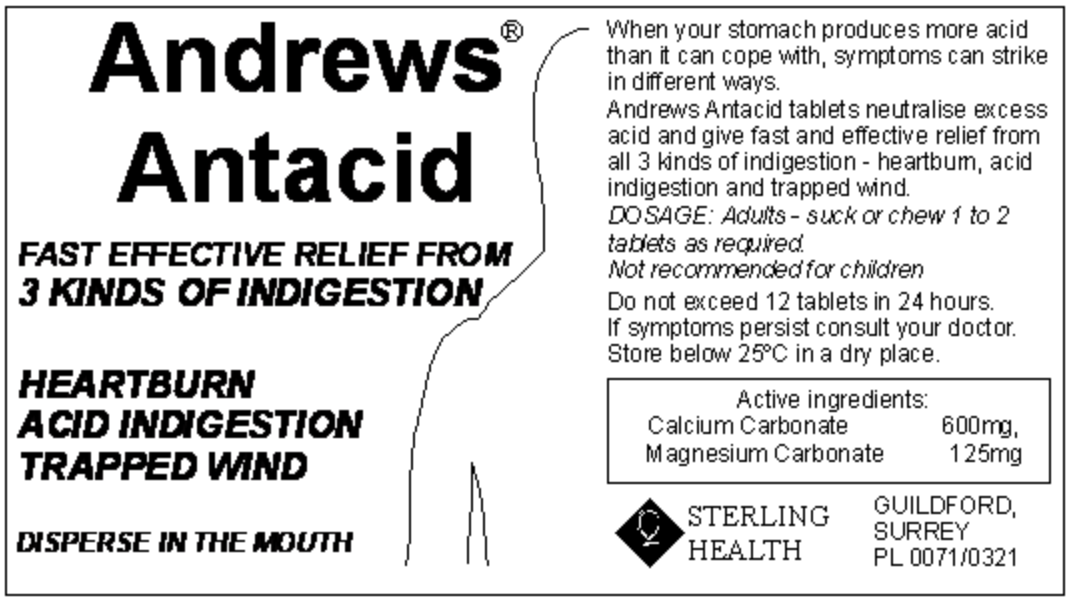
(3)

(Total 8 marks)

Q7. (a) This label has been taken from a packet of *Andrews Antacid*.



(i) Write the simplest ionic equation which represents a neutralisation reaction.

.....

(1)

(ii) Chewing the tablet cures indigestion faster than swallowing the tablet whole. Explain why.

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(1)

.....

.....

(1)

(b) The active ingredients in the *Antacid* react with hydrochloric acid in the stomach to give salts, water and carbon dioxide.

A student investigated how quickly the tablets react with **excess** hydrochloric acid.

40 cm^3 of dilute hydrochloric acid were placed in a conical flask. The flask was placed on a direct reading balance. Two *Antacid* tablets were quickly added to the flask. The apparatus was weighed immediately. At the same time, a stop clock was started. The mass was recorded every half minute for 5 minutes.

The results are shown in the table below.

Mass of flask + contents (g)	92.0	90.0	89.0	88.3	87.8	87.5	87.3	87.1	87.0	87.0	87.0
Time (minutes)	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0

The main active ingredient in *Andrews Antacid* is calcium carbonate.

(i) Balance the equation which represents the reaction between calcium carbonate and hydrochloric acid.

$$CaCO_{3(s)} + \ldots\ldots\ldots HCl_{(aq)} \rightarrow CaCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$$

(1)

(ii) State the meaning of the symbol "(aq)".

.....

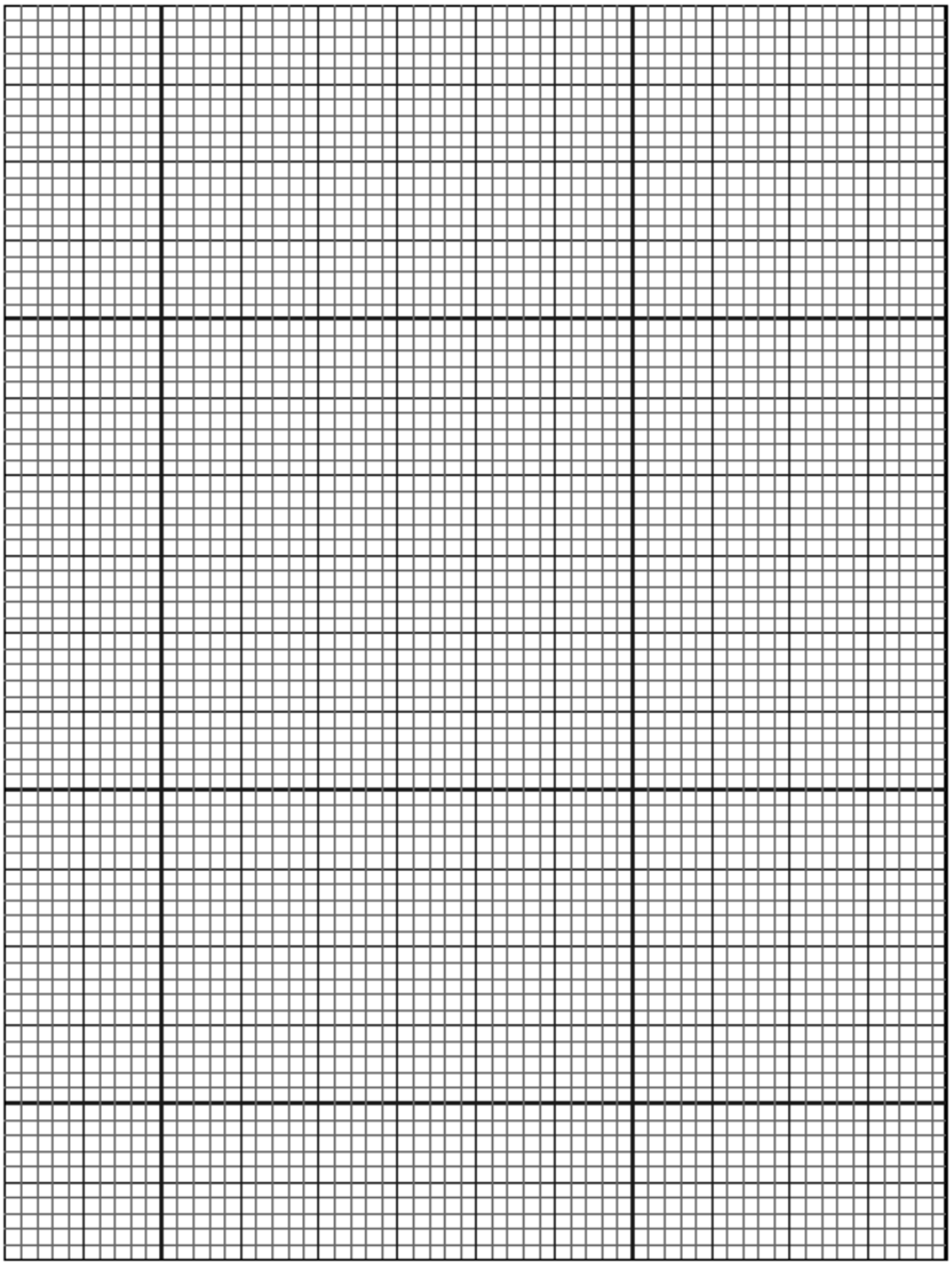
(1)

(iii) Why does the mass of the flask and contents decrease?

.....

(1)

(c) (i) Plot the results on the graph below and draw a smooth curve to show how the mass of the flask and its contents changes with time. Label this curve "A".



(3)

(ii) One of the results does not appear to fit the pattern. Circle this result on the graph.

(1)

(d) The student did a second experiment. The only change was that the acid was twice as concentrated.

On the graph, sketch a second curve to show a possible result for this experiment. Label this curve "B".

(2)

(Total 12 marks)

Q8. This is part of an article about food additives.

THE PERIL OF FOOD ADDITIVES

Some orange drinks contain the additives E102 (Tartrazine), E104 (Quinoline Yellow) and E110 (Sunset Yellow). These three coloured additives are thought to cause hyperactivity in children.

(a) State **two** reasons that a manufacturer might give to justify the use of these additives.

1 .....

.....

2 .....

.....

(2)

(b) Some scientists asked 4000 twelve-year-old children to help them investigate if there is a link between these three coloured additives and hyperactivity.

How would the scientists use these 4000 children to investigate if there is a link between these three coloured additives and hyperactivity in children?

.....

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.....

(4)

(c) A manufacturer used an independent scientist to show that their orange drink did not contain these three coloured additives.

(i) Suggest why the manufacturer would use a scientist who was independent instead of using their own scientist.

.....

.....

(1)

(ii) The scientist had samples of E102, E104 and E110 and the orange drink. The scientist used paper chromatography for the test.

Describe how the scientist could use the results to show if the orange drink contained any of these three coloured additives.

You may include a diagram of the paper chromatography results.

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(2)
(Total 9 marks)

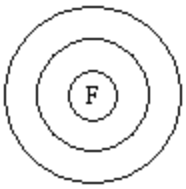
ANSWERS

M1. (a) 2, 8, 8, 1

for 1 mark

1

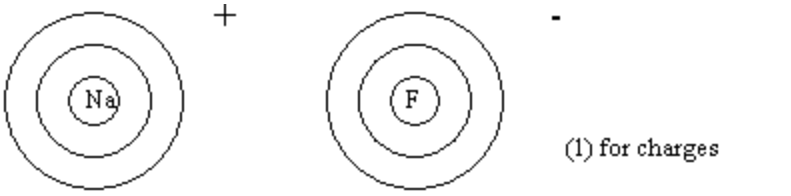
(b) (i)



for 1 mark

Ignore symbol in middle but structure must be drawn NOT 2,7

(ii)



(1) for charges

(1) for each structure

If covalent; can score mark for changes but not for diagram
Arrow showing electron transfer from metal atom to non-metal atom = 2 marks
If the ions are not identified then cannot score mark for changes

4

[5]

M2.(a) if placed consecutively, then elements would be in wrong group / have wrong properties

allow some elements didn't fit pattern

1

left gaps

1

(b) (elements placed in) atomic / proton number order

1

(elements in) same group have same number of outer electrons

1

any **one** from:

- number of protons = number of electrons
- reactions/(chemical) properties depend on the (outer) electrons
- number of shells gives the period

  allow number of shells increases down the group

1

(c) (i) (transition elements usually) have same / similar number of outer / 4th shell electrons

allow 2 electrons in outer shell

1

(because) inner (3rd) shell / energy level is being filled

ignore shells overlap

1

(ii) 2nd shell / energy level can (only) have maximum of 8 electrons

accept no d-orbitals

or 2nd shell / energy level cannot have 18 electrons

1

[8]

M3. (a) same number of electrons in outer shell / 1 / an electron in outer shell / lose one electron

for 1 mark

1

(b) (i) C

for 1 mark

1

(ii) E

for 1 mark

1

(c) (i) $2Na + 2H_2O \rightarrow 2NaOH + H_2$
symbols must be correct
correct multiples / fractions accepted
Balancing mark is independent
formulae gains 1 mark
balancing gains 1 mark

2

(ii) Assume 'it' means potassium
potassium more reactive / vigorous / faster reaction / violent (can be awarded in either section)
potassium atom larger than sodium / higher outer energy level / outer shell further from nucleus / more shells (not just more electrons)
electron in outer shell is less strongly attracted / greater shielding
outer electron more easily lost
for 1 mark each

4

[9]

M4.(a) (i) current / charge couldn't flow
allow could not conduct (electricity)

1

because the ions / particles couldn't move
*do **not** accept electrons/ molecules / atoms*

or

(salt) needs to be molten / (1) dissolved (to conduct electricity)

so that the ions / particles can move (1)
*do **not** accept electrons / molecules / atoms*

1

(ii) he had status
*accept he had authority **or** experience*

or

he had evidence / proof

accept the experiment could be repeated

1

(b) hydrogen / H_2

*do **not** allow hydrogen ions*

1

the ions are positive

accept because opposite (charges) attract

1

potassium is more reactive (than hydrogen)

accept potassium ions are less easily discharged (than hydrogen)

***or** potassium ions are less easily reduced (than hydrogen)*

1

(c) (i) gain electron(s)

*accept fully balanced correct equation for **2** marks*

1

one electron

*if no other marks awarded allow (potassium ions) reduced for **1** mark*

1

(ii) $2\ Cl^- \rightarrow Cl_2 + \mathbf{2e}^-$

must be completely correct, including charge on electron

accept correct multiples

1

(iii) 2, 8, 8

accept any combination of dots, crosses, "e" or any other relevant symbol

ignore any charges if given

1

[10]

M5. (a) 52.9(411765) / 53

correct answer with or without working = ***2*** *marks*

if answer incorrect allow 2 x 27= 54 ***or*** *27/102 x 100* ***or*** *26.5 for* ***1*** *mark*

2

(b) (i) because it lowers the melting point (of the aluminium oxide)

allow lowers the temperature <u>needed</u>

do ***not*** *accept lowers boiling point*

1

so less energy is needed (to melt it)

accept so that the cell / equipment does not melt

1

(ii) **2** O^{2-} on left hand side

accept correct multiples or fractions

1

$4e^-$ on right hand side

accept ***$-4e^-$*** *on left hand side*

1

(iii) because the electrode reacts with oxygen **or**

because the electrode burns

1

to form carbon dioxide **or**

electrode made from carbon / graphite

1

[8]

M6. (a) electrolytes

1

(b) oxidation

1

electrons lost

1

(c) $2H^+ + 2e^- \rightarrow H_2$

minus sign on e^- not needed

2

(d) concentration increases

1

OH^- discharged from water / water decomposes

1

H^+ concentration increases / H_2 and O_2 evolved

1

[8]

M7. (a) (i) $H^+ + OH^- \rightarrow H_2O / H_3O^+ + OH^- \rightarrow 2H_2O$

for 1 mark

1

(ii) 1 point from e.g.
smaller bits
bigger surface area
faster reaction
dissolve faster
more particles open to attack by acid

any 1 for 1 mark

1

(iii) $MgCO_3$ or $MG^{2+}CO_3^{2-}$ or CO_3Mg
for 1 mark

1

(b) (i) 2 HCl
for 1 mark

1

(ii) aqueous/<u>dissolved</u> in water (not in solution)
for 1 mark

1

(iii) CO_2/gas evolved/gas has mass
for 1 mark

1

(c) (i) plotting points
scales
curve
labelling axes including units
for 1 mark each

4

(d) faster
same final mass
for 1 mark each

2

[12]

M8.(a) any **two** from:

ignore reference to taste / shelf-life / sales etc

- improve the colour / appearance
- additives are permitted / not banned / listed on the label
- link between additives and hyperactivity not proved

- maintain the low cost of the drink **or** natural colours would make the drink cost more

  allow cheaper if qualified

2

(b) have a control group / placebo **or** test children before any drink given

1

give a drink to at least 3 groups **or** give a drink at least 3 times

1

give each additive to different group / children / at different times

1

observe / monitor / compare behaviour of group / children

1

(c) (i) so that there would be trust / respect / no bias

1

(ii) compare the colours / spots from the orange drink with those of the (three) additives

accept diagram of chromatogram(s) with spots for E102, 104, 110 and sample from the orange drink

1

there should be no matching colours / spots

1

[9]