AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.1.2 THE PERIODIC TABLE (PACK 5)

SCORE	PERCENTAGE
/271	%

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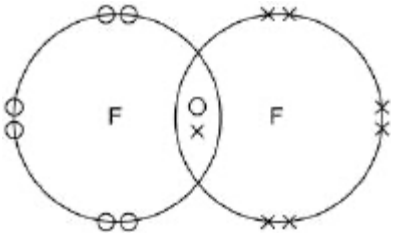
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Q1.

(a) group 7

1

(b)



*one shared pair anywhere in overlap between two circles **or** on intersection*

6 other electrons on each atom

*allow dots **or** crosses **or** mixture for all marks*

ignore any inner shell electrons

1
1

(c) bromine

1

potassium chloride

1

either order

allow correct chemical formulae

(d) displacement

1

(e) (an) electron

1

(f) smaller than

1

(g) (chlorine has) fewer levels / shells (of electrons)

allow converse for bromine

allow (chlorine has) fewer electrons

allow Cl has 3 levels / shells and Br has 4 levels / shells

ignore atomic number
***or** mass number*
***or** number of protons*

1

*mark independent of answer to part **(f)***

(h) 3

allow multiples

1

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(i) there are weak forces

*do **not** accept weak bonds*

1

between molecules

1

*allow weak intermolecular forces for the first **2** marks*

which require little energy to overcome / break

allow does not need much energy to boil

1

[13]

Q2.

(a) H^+

1

(b) nitric (acid) **or** HNO_3

1

zinc (oxide) or ZnO

1

this order only

(c) dissolved in water

1

(d) any value from 0 to less than 8

1

(e) **Level 2:** The method would lead to the production of a valid outcome. Key steps are identified and logically sequenced.

3–4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- add universal indicator **or** wide range indicator

indicator turns blue / purple / violet (because pH = 14)
or has highest pH or is an alkali
so A is sodium hydroxide

indicator turns red (because pH = 2)
or has lowest pH **or** is an acid
so B is phosphorus oxide

indicator turns green (because pH = 7)
or neutral
so C is silicon dioxide

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- add solid to water

A and B dissolve; C does not
so C is silicon dioxide

[9]

Q3.

(a) (difference)
sodium has one and chlorine has seven electrons in outer level / shell
or
number of electrons

number of electrons must be correct if quoted

1

(similarity)
both have three / same number of levels / shells
or
have electrons in third level / shell
or
both have incomplete (outer) levels / shells

allow both have 2 electrons in inner shell
or
both have 8 electrons in second shell
or
both are one electron away from full outer level / shell

1

(b) sodium (atom) loses

allow moves / transfers for loses

*do **not** accept sodium ion loses*

1

one (outer shell electron)

1

chlorine (atom) gains

*do **not** accept chloride*

1

one (electron)

1

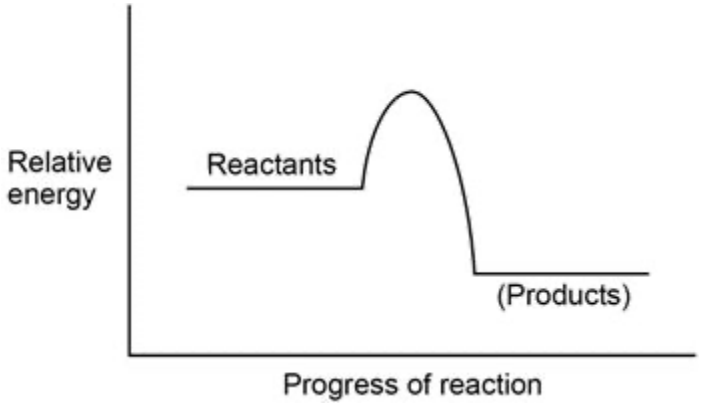
transfer of 1 electron from chlorine to sodium
***max 2** marks*

*reference to sharing or covalent bonding **max 3** marks*

allow marks from suitable diagram(s)

(c)

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ignore labels

any curve / line going up and then down

products <u>line</u> below reactants

allow curve to start / finish anywhere along reactant / product lines

1
1

[8]

Q4.

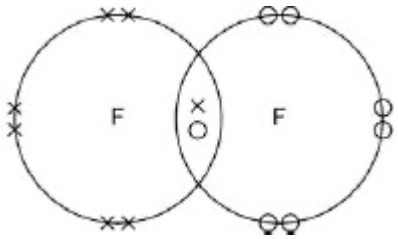
(a) g

*do **not** accept upper case (G)*

*do **not** accept gas*

1

(b)



*one shared pair anywhere in overlap between two circles **or** on intersection*

1

6 other electrons on each atom

1

*allow dots **or** crosses **or** mixture for all marks*

ignore any inner shell electrons

(c) 18

1

(d) $AlBr_3$

1

2 $Al + 3\ Br_2 (\longrightarrow 2\ AlBr_2)$

1

*allow **1** mark for balancing their equation with an incorrect product*

(e) chlorine is a smaller atom

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or has fewer energy levels
or outer shell closer to nucleus

ignore chlorine has fewer electrons

1

chlorine has less shielding
or
has the greater attraction between the nucleus and the outer shell **or** incoming electron

1

therefore chlorine can gain an electron (into the outer shell) more easily

1

*if no other marks awarded allow **1** mark for correct trend in reactivity in Group 7*

*do **not** accept reference to incorrect particles e.g. chloride atom*

***max 2** if outer shell / level not mentioned*
'it' refers to chlorine
allow converse reasons for bromine being less reactive

[9]

Q5.

(a) **Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

5–6

Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

A is sodium oxide
B is phosphorus oxide
C is magnesium oxide
D is silicon dioxide

linked statements:

A is sodium oxide
because it has highest pH **or** pH = 14 **or** is a strong alkali

B is phosphorus oxide
because it has lowest pH **or** pH = 3 **or** is an acid

C is magnesium oxide
because it has 2nd highest pH **or** pH = 9 **or** is a (weak) alkali

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D is silicon dioxide
because it is neutral **or** pH = 7

or

A and B are sodium oxide **or** phosphorus oxide
because both soluble **or** no solid remains

C is magnesium oxide
because it will be the colourless solution with solid remaining

D is silicon dioxide
because it will be the colourless liquid with solid remaining

for **level 3** the solids must be correctly identified

(b) dilution by a factor of 100

allow pH changes by 1 when solution is diluted by factor of 10
or
allow pH changes by 2

1

(pH =) 5

1

*an answer of (pH=) 5 gains **2** marks*

[8]

Q6.

(a) melting points decrease (as the atomic number increases)

allow negative correlation

1

(b) 55
and
29 (°C)

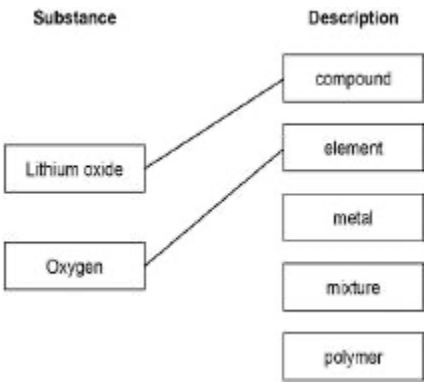
allow values in range 28−32 (°C)

1

(c) 1

1

(d)



1
1

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(e) $4\ Li + O_2 \longrightarrow 2\ Li_2O$

allow correct multiples

1

(f) ionic

1

(g) $(M_r) = (2 \times 7) + 16$

1

$= 30$

1

*an answer of 30 scores **2** marks*

[9]

Q7.

(a) alkali metals

1

(b) any **one** from:

- small piece of metal
- large volume of water
- use a (safety) screen
- keep a safe distance (between teacher / students and apparatus)

1

(c) reactivity increases down the group

1

any **two** from:

- speed increases (down the group)
- sodium / potassium melts but lithium does not
- flame is seen with potassium, but no flame with lithium / sodium

2

(d) rubidium is too reactive

allow reaction would be violent

1

(e) $2Na + 2H_2O \longrightarrow 2NaOH + H_2$

allow correct multiples

1

(f) sodium hydroxide

1

(g) an answer in the range 0.373−0.495 (nanometres)

1

(h) 3.04×10^{-10} m

1

(i) batteries increased from 10 to 28

or

batteries increased by 18

allow batteries increased approximately ×3

1

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producing ceramics and / or glass increased from 10 to 22
or
producing ceramics and / or glass increased by 12

allow ceramics and / or glass increased by approximately ×2

1

lubricants decreased from 8 to 6
or
lubricants decreased by 2

allow lubricants decreased by a quarter

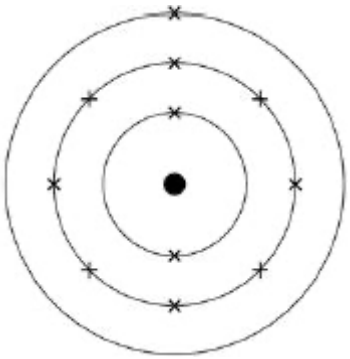
1

*if no other marks awarded allow **1** mark for batteries and glass / ceramics increased, lubricants decreased, with no or incorrect data*

[13]

Q8.

(a)



allow dot, cross, or e to show electrons

1

(b) any **two** from:
- use tongs / tweezers to handle metal
- use a (safety) screen
- use a small piece of metal
- use a large volume of water
- keep a safe distance between teacher / students and apparatus

ignore store metal under oil

2

(c) OH^-

1

(d) as diameter increases, reactivity increases

1

(because as diameter increases) outer electron is further from the nucleus

allow (because as diameter increases) outer shell is further from nucleus

1

(so) outer electron is less attracted to the nucleus

allow (so there is) increased shielding

1

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(so) outer electron is lost (more) easily

1

[8]

Q9.

(a) group 0

1

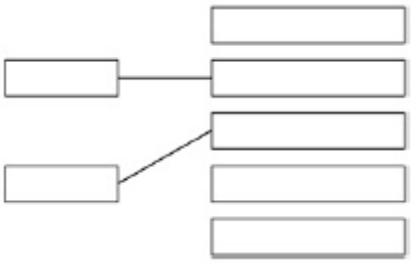
(b) left gaps

1

in some places changed the order based on atomic weights

1

(c)



1

1

(d) (electron) **A**

(neutron) **B**

(proton) **C**

*3 correct answers scores **2** marks*

*1/2 correct answers scores **1** mark*

2

(e) $\frac{23}{6.02 \times 10^{23}}$

1

$3.820598... \times 10^{-23}$

1

3.8×10^{-23}

*an answer of 3.8×10^{-23} scores **3** marks*

1

(f) $227 \times 10^{-12} \times \frac{1}{10\,000}$ m

1

[11]

Q10.

(a) any **two** from:

- hydrogen is in group 1 on Newlands table
- fluorine / chlorine / halogens are in group 1 on Newlands table
- alkali metals are in group 2 on Newlands table

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allow converse arguments relating to modern table
allow lithium / sodium / potassium for alkali metals

2

(b) undiscovered

1

(c) atomic number

1

(d) **D**

1

E

1

A

1

must be in this order

(e) has a complete outer shell of electrons
allow because has a stable arrangement of electrons

1

(f) noble gases

1

[9]

Q11.

(a) has 2 electrons in the outer shell
allow energy level for shell

1

(b) 3 : 2 : 6 : 18

1

(c)

$$\frac{9 \times 3}{537} \times 100$$

1

= 5.0 (%)
*an answer of 5.0 (%) scores **2** marks*
allow 1.7 (%)
allow 5.027932.. (%)

1

(d) correct formulae

1

correct balancing of correct formulae
allow multiples
allow an answer of
$BeCl_2 + 2K \rightarrow 2KCl + Be$
*for **2** marks*

1

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(e) potassium is more reactive

1

so will displace beryllium

1

(f) **(test)**
place in (simple) electrical circuit

1

(result)
conducts electricity

(alternative test and result)
add (dilute) acid
produces hydrogen gas (with acid)

1

[10]

Q12.

(a) any **two** from:

- hydrogen is in a group
  allow converse arguments
  allow hydrogen is with the halogens
- only seven groups
- no group 0
  allow no noble gases
- halogens are in Group 1
  allow fluorine and / or chlorine are in Group 1
- other elements are in one group higher
  allow one example of this
- transition metals included in groups
  allow one example, eg, iron in same group as aluminium

2

(b) similar properties occur at regular intervals

1

(c) some elements appeared to be in the wrong group

1

(when) the elements were arranged in order of relative atomic mass
allow (so) he placed them into groups with similar properties

1

(d) most elements are mixtures of isotopes

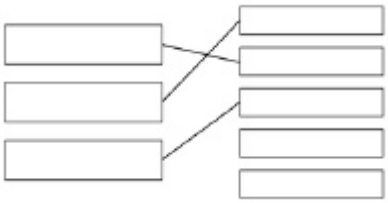
1

(so) should be arranged in order of atomic number

1

(e)

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1
1
1

[10]

Q13.

(a) Carbon and silicon

1

(b) Atomic number

1

(c) Hydrogen / fluorine / chlorine are not in Group 1 of the periodic table
or
Hydrogen and fluorine / chlorine are not in the same group of the periodic table

1

Lithium / sodium / potassium are in Group 1 of the periodic table

1

(d) plum pudding model has a single ball of positive charge and nuclear model has positive charges in the centre / nucleus

1

plum pudding model has electrons in random positions and nuclear model has electrons
in fixed positions

1

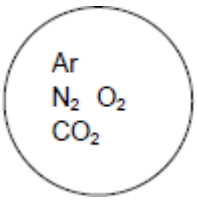
plum pudding model has no nucleus and the nuclear model has a nucleus

1

plum pudding model has no neutrons and the nuclear model has neutrons in the nucleus

1

(e)



1

(f) Covalent bond

1

[10]

Q14.

(a) LiOH (aq)

this order

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1

H_2 (g)

1

(b) **C**

1

(c) **A** and **D**

1

(d) point x at −10 °C

1

point ● at +150 °C

1

(e) substance **B** will not reach its boiling point of 190 °C

1

because the boiling point of water is only 100 °C

1

(f) there is too much substance **B** to melt instantly.

allow answers based on thermal conductivity or temperature gradient from the wall of the test tube to the thermometer

1

[9]

Q15.

(a) 408 kg

1

(b) all points correct

± ½ small square

2

*allow **1** mark if 5 points correct*

best fit line

1

(c) $\frac{1989 \times 100}{36}$

1

5525 dm^3

1

(d) relative formula mass of $TiCl_4$ is 190

1

25.26 %

1

Answer given to 3 significant figures = 25.3 %

1

*25.23% with or without working gains **3** marks*

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(e) argon is unreactive

1

water (vapour) would react with sodium

allow water (vapour) would react with titanium(IV) chloride

1

and air contains oxygen that would react with reactants

allow and air contains oxygen that would react with products

1

(f) (titanium conducts electricity) because electrons in the outer shell of the metal atoms are delocalised

1

and so electrons are free to move

allow the delocalised electrons in the metal carry electrical charge through the metal

1

through the whole structure

1

[15]

Q16.

(a) 1×10^{-10} m

1

(b) 1 / one

allow alkali metals

1

(c) R and S

1

because they have the same number of protons

allow same atomic number, different mass number

1

and a different numbers of neutrons

1

(d) **Level 3 (5–6 marks):**
A relevant and coherent explanation of the trend in reactivity. The response makes logical links between the points raised and considers both the number of energy levels
and the distance between the nucleus and the outer energy level.

Level 2 (3–4 marks):
Statements that are linked to provide a simple explanation of the trend in reactivity using either the number of energy levels or the distance between the nucleus and the outer energy level.

Level 1 (1–2 marks):
Simple statements made about the halogens or the trend in reactivity.

0 marks:

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No relevant comment

Indicative content

Simple statements / descriptions

- have 7 electrons in the outer shell
- need to gain an electron
- form ions with a -1 charge
- halogens further down the group are less reactive (or vice versa)
- halogens further down the group have more shells or energy levels (or vice versa)

Linked statements / explanations

- have 7 electrons in the outer shell so need to gain an electron to have the electronic structure of a noble gas
- halogens further down the group are less reactive because they have more shells or energy levels (or vice versa)
- halogens further down the group have more shells or energy levels so less attractive force on the incoming electron (or vice versa)
- halogens further down the group have more shells or energy levels so more 'shielding' against the incoming electron (or vice versa)
- outer electrons of halogens further down group are further away from the attractive force of the nucleus (or vice versa)
- an electron is less easily gained because there are more shells or energy levels (or vice versa)
- an electron is less easily gained because the outer electrons are further from the attractive force of the nucleus (or vice versa)

6

[11]

Q17.

(a) Desalination

1

Sterilising

1

(b) Chloride ion

1

(c) correct bar for NO_3^-

1

(d) **D**

1

(e) any **two** from:

- people have the right to choose (opinion)
- ethical / moral question
- cannot be tested by experiment

2

(f) $\frac{1.5}{4.0} \times 100$

1

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(g) the percentage tooth decay increases with age

1

by 4 % for each increasing age group

1

(h) reduces tooth decay (for all age groups)

1

greater reduction in older people

1

[12]

Q18.

(a) did not appear because they had not been discovered **or** they are unreactive **or** they did not form compounds

1

(b) arranged in order of atomic / proton number

1

elements in the same group have the same number of electrons in the outer shell

1

(c) chlorine>bromine>iodine

table shows that chlorine displaces bromine and iodine

1

and bromine displaces iodine

1

(d) $Cl_2(aq) + 2\ Br^-(aq) \rightarrow Br_2(aq) + 2\ Cl^-(aq)$

correct formulae

1

correct balancing

1

correct state symbol

1

(e) the further down the group, the halogen becomes less reactive because outer electrons are further from the nucleus

1

so less attractive force on an incoming electron

1

[10]

Q19.

(a) the melting point increases

1

(b) 337 °C

allow an answer in the range 278 °C to 337 °C

1

(c) bromine

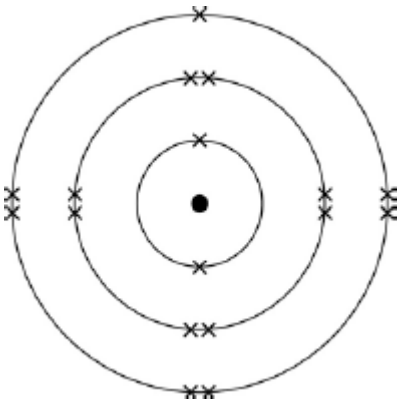
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1

(d) Group 7

1

(e)



7 electrons in outer shell

1

(f) Cl_2 + **2**NaBr $\longrightarrow$ Br_2 + **2**NaCl

correct formulae for products

1

correct balancing

1

(g) fluorine

1

(because it is) more reactive than chlorine

allow because it is the most reactive element

1

[9]

Q125.

(a) any **four** from:

- 3 protons
- 4 neutrons
- 3 electrons

allow electronic configuration is 2.1

- protons **and** neutrons in nucleus
- electrons in energy levels / shells.

*wrong number for any particle **max 3***

references to charges must be correct

4

(b) sodium

1

[5]

Q126.

(a) any **four** from:

- 3 protons
- 4 neutrons

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- 3 electrons

  allow (electronic configuration is) 2.1
- nucleus contains protons **and** neutrons
- electrons in energy levels / shells.

*wrong number for any particle max **3** marks*

references to charges must be correct

*allow up to **3** marks for a correctly labelled diagram if no written description*

*If no other mark gained, allow **1** mark for mention of protons, neutrons **and** electrons*

4

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

- sodium

  allow Na
- potassium

  allow K
- rubidium

  allow Rb
- caesium

  allow Cs
- francium.

  allow Fr

1

(ii) contain different number of protons

accept different proton / atomic number

ignore references to mass (number)

*do **not** allow answers which include particles other than protons*

1

[6]

Q127.

(a) 2 neutrons

1

2 electrons

allow E / e / e^- / a small dot for an electron

*do **not** accept the symbol for a neutron*

1

electrons on outer shell **and** neutrons in nucleus

ignore number of particles

1

(b) stable arrangement of electrons

ignore references to noble gases

allow have a complete / full outer shell (of electrons)

allow have a complete outer energy level (of electrons)

1

(c) will run out (soon)

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ignore references to cost

allow does not remain in Earth's atmosphere only if qualified, eg can't be recovered

1

more important uses

allow is a waste (of helium)

ignore people will inhale it

1

[6]

Q128.

(a) (black) copper oxide formed

explanation must be linked to correct observation

1

loss in mass is due to carbon dioxide / gas production

1

limewater cloudy shows carbon dioxide produced

1

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

ignore references to reactivity

- (bunsen burner flame) not hot enough (to decompose potassium carbonate)

  accept temperature not high enough (to decompose potassium carbonate)
- not all Group 1 carbonates decompose

  allow potassium is in Group 1

1

(ii) potassium carbonate:

(mass) 13.8 g

1

(limewater) colourless

accept no change for colourless

ignore clear

1

zinc carbonate:

(limewater turns) cloudy

Metal carbonate	***Mass after heating in g***	***Limewater***
Potassium carbonate	*13.8*	*colourless*

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Zinc carbonate		*cloudy*

1

[7]

Q129.

(a) (Cobalt) 1

1

(Oxygen) 2

1

(b) (i) the lithium compound / $LiCoO_2$

allow from air / atmosphere / water (vapour)

allow the battery

ignore cracks, fan, gaps, surroundings and computer

1

(ii) lithium oxide

if correctly named, ignore at attempts at formula

allow Li_2O the letters L and O must be uppercase, and the letter i lowercase and the number a subscript

ignore references to di, tri etc

*do **not** accept lithium hydroxide*

1

(c) A = proton

1

B = electron

1

C = neutron

1

(d) (i) any **two** from:

- lithium moves (about on surface)

or

lithium floats

- lithium gets smaller

allow lithium dissolves

ignore lithium melts

- bubbles (of gas)

allow fizzing / smoke

ignore flame, sparks, cloudy water, any colours

2

(ii) lithium hydroxide + hydrogen

in either order

allow LiOH for lithium hydroxide allow H_2 for hydrogen the

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letters L, O and H must be uppercase, and the letter i lowercase and the number a subscript

1

[10]

Q130.

(a) (i) $4Li + O_2 \rightarrow 2Li_2O$

1 *mark for correct symbols and formulae*

1 *mark for correct balancing of correct equation*

allow for 1 mark $2Li + O \rightarrow Li_2O$

2

(ii) lithium compound / $LiCoO_2$

allow from air / water vapour because the battery / seal / it was damaged

1

(b) (i) lithium less dense (than water, so floats)

1

(bubbles / gas because) <u>hydrogen</u> is produced

allow H_2 *capital H and lower case number*

1

(solution is alkaline because lithium) <u>hydroxide</u> is produced

accept OH^- *ions produced*

allow LiOH

1

(ii) reacts in similar way to lithium

accept produces hydrogen and sodium hydroxide

allow has similar properties

allow a description of reaction eg. sodium moves about

1

because in same group / in group 1 / has one electron in outer shell / is an alkaline metal

allow same number of outer electrons

allow for ***2*** *marks:*

produces hydrogen and sodium hydroxide (because) reacts in a similar way to lithium

or

accept for ***1*** *mark (sodium) is more reactive than lithium*

accept for ***2*** *marks (sodium) is more reactive than lithium (because) further down group*

1

[8]

Q131.

carbon

must be in correct order ignore C

1

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chlorine

accept Cl

1

calcium

accept Ca

1

[3]

Q132.

(a) transition (elements / metals)

accept d block (elements / metals)

1

(b) any **three** from:

ignore references to cost

- (good) conductor (of heat)

  ignore references to electricity

- can be bent / shaped

  accept malleable

  ignore moulded

- does not react with water

  allow does not rust

  allow not very reactive

- strong

  allow durable

  ignore tough

- hard enough to make pipes or tanks

- high melting point

  allow ductile

3

(c) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should apply a 'best fit' approach to the marking.

0 marks
No relevant information

(1 – 2 marks)
At least one advantage **or** disadvantage of **either** method is given.

(3 – 4 marks)
At least one advantage **and** one disadvantage is given.
or
At least one advantage of **both** methods is given
or
At least one disadvantage of **both** methods is given.

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(5 – 6 marks)
Advantages and disadvantages of **both** methods are given.
For 6 marks a reasonable attempt at a conclusion is made.

examples of the points made in the response

ignore references to cost unless qualified.
ignore jobs / transport

Advantages of smelting:

- quicker
- extracts more copper
- more economically viable
  allow involves fewer stages

Disadvantages of smelting:

- supply of copper rich ores is limited
- (mining causes) dust / noise pollution
  ignore pollution unqualified
- destruction of landscape or visual pollution
- destruction of habitats
- smelting uses non-renewable fuel
- smelting uses more energy / electricity
- large amounts of waste rock
- (mining / smelting) releases (more) carbon dioxide / causes global warming
  allow (more) greenhouse gases
- (smelting) releases sulfur dioxide / causes acid rain

Advantages of phytomining:

- extracts copper from low grade ores
- conserves copper rich ores
- does not destroy landscape or less visual pollution
  allow does not destroy habitats
  allow carbon neutral

Disadvantages of phytomining:

- produces smaller amount of copper (per unit mass)
- takes up a lot of space
- takes a long time (to grow plants)

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- produces carbon dioxide when plants burnt
- land cannot be used to grow food crops

Electrolysis

- Used in <u>both</u> methods (so neither an advantage or disadvantage)

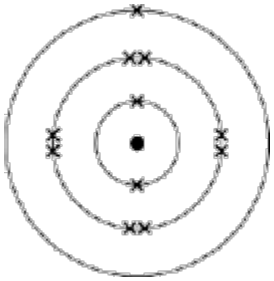
Conclusion supported by comparisons made

6

[10]

Q133.

(a)



1 *mark for 11 electrons shown*

1

1 *mark for 2:8:1 arrangement*
accept any symbol for electrons

1

(b) *max **3** marks if reference to covalent bonding or sharing electrons*

a sodium atom loses one electron

*do **not** accept gains 7 electrons*

1

to become sodium / positive ion(s)

1

a chlorine atom gains one electron

*do **not** accept loses 7 electrons*
*allow **1** mark for sodium loses electrons **and** chlorine gains electrons*

1

to become chloride / negative ion(s)

allow chlorine ion
*for **2** marks accept:*
chlorine gains an electron from sodium
or
chlorine and sodium become ions
*if no other marks scored allow **2** marks for sodium loses electrons and chlorine gains electrons to form ionic bonds*
*if no other marks scored allow **1** mark for:*
both sodium and chlorine get full outer shells
or

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reference to ionic bonding

1

[6]

Q134.

(a) (i) this atom has a nucleus

1

this atom has four electrons **or** two electrons in the inner shell / energy level **and** two electrons in the outer shell / energy level

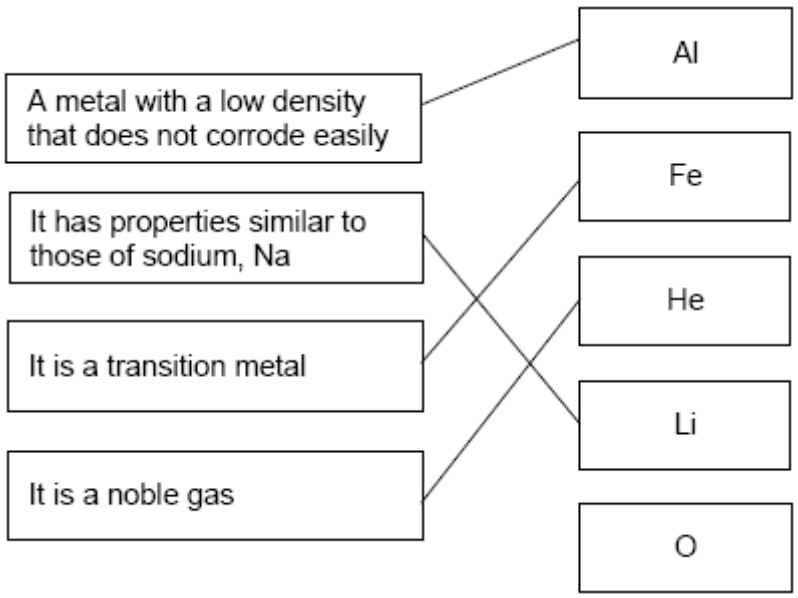
*accept this atom has electron(s) without indication of number(s) for **1** mark*

2

(ii) six / 6

1

(b) award **1** mark for each correct link line



4

[8]

Q135.

(a) + (1)

1

neutron

1

answers must be in the order shown

(b) because there is one / same number of electron(s) in outer energy level / shell

1

(c) (i) unreactive **or** full outer energy level / shell

1

(ii) helium has only two electrons in outer energy level

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accept helium is less dense than air

1

[5]

Q136.

(a) ammonia

accept NH_3

1

(b) (i) because the gases are unreactive

accept because the measuring equipment was not very precise

1

(ii) by fractional distillation

1

(iii) argon has a density greater than the density of nitrogen

1

[4]

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Q1.

(d) 47% of students knew that the type of reaction between chlorine and potassium bromide solution is called displacement.

(e) 73% of students knew that chlorine is more reactive than bromine because chlorine gains electrons more easily.

(f) 60% of students understood that a chlorine atom is smaller than a bromine atom.

Q2.

No reportable questions.

Q3.

Foundation

(a) This question discriminated well with 27% of students achieving some degree of credit. Many students did not consider the most obvious difference and similarity in the electronic structures of sodium and chlorine. Students often used the periodic table shown in the stem of the question to answer this question, but most of these students referred to periods or rows and groups or columns and so failed to gain any marks.

(b) This question discriminated well. 23% of students achieved all four marks, often with concise statements about the transfer of the outer electron of sodium to chlorine.

Some students contradicted their description by mentioning covalent bonding, or the sharing of electrons, which restricted the number of marks they could attain. Poor expression and the use of incorrect terms were the main problem for most students. It was common to see the term ‘atom’ used instead of ‘electron’. 19% of students did not attempt to answer this question.

(c) This question discriminated well. 26% of students achieved both marks; whereas 185 of students achieved a single mark. It was common for students to have incomplete reaction profile diagrams, by failing to include a horizontal line for the products.

Some students confused the two types of energy changes (endothermic and exothermic), while others provided a wide range of incorrect diagrams. Labels were ignored because they were not required to answer the question. 20% of students did not attempt to answer this question.

Higher

(a) 73% of students achieved at least a mark on this question. Many could clearly see the most obvious difference and similarity in the electronic structures of sodium and chlorine. These correct answers were described in a variety ways e.g. different number of electrons or by stating the correct number of electrons in the outer shell. Examples of similarities related to the number of shells or completed inner energy levels.

Students often used the periodic table shown in the stem of the question to answer

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the question, but most of these referred to periods and groups and failed to gain marks. Students should note that there is only one 'outer' shell or level.

(b) This question was well answered with 63% of students achieving all four marks, often with concise statements.

Some students contradicted their description by mentioning covalent, the incorrect type of bonding, or the sharing of electrons, which restricted the number of marks they could attain.

Students need to use scientific terminology accurately. Ionic bonding occurs when a metal transfers its electron(s) to a non-metal (loss and gain of electrons). Whereas covalent bonding involves non-metals sharing electrons, which results in the formation of covalent bonds.

(c) 67% of students achieved both marks, although it was common for students to have incomplete diagrams, by failing to include a horizontal for the products side. Some students confused the two types of energy changes (endothermic and exothermic), while others provided a wide range of incorrect diagrams.

Q4.

(a) Students did not answer this question as well as expected. They were either not aware that chlorine was a gas or were not familiar with state symbols, as answers other than (s), (l) (g) or (aq) were frequently seen. Some wrote the word 'gas' in the space. 36% of students answered correctly.

(b) This question was very well answered with 64% of students achieving full marks. Students showed a good understanding of the number of electrons involved in this example of covalent bonding, by ensuring that they had two electrons in the overlap area and six other electrons in the energy level of each fluorine.

A common mistake was to include two electrons in the overlap, but still included the seven electrons each fluorine originally contained in the level outside the overlap.

(c) 48% of students selected the correct answer to this question. The question followed the diagram of a fluorine (F_2) molecule in part **(b)** and focussed on this species.

A significant number of students incorrectly selected '9' as their response, which is the number of electrons in one fluorine atom.

(d) Students are expected to represent the electronic structures of the first 20 elements of the periodic table and to predict and explain reactions of elements from their position in the periodic table.

A small number of students were able to state the correct formula, $AlBr_3$, with AlBr and $AlBr_2$ being the most common incorrect formulae. But, students did show a good understanding of balancing equations, in this case based upon their wrong formula for aluminium bromide. 68% of students achieved a single mark.

(e) This question was not answered well, with 8% of students achieving three marks for the explanation that included:

- comparative size of atoms
- comparative difference in attraction
- the ease of which an electron was gained.

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This last point was the one that was seen the least and the word 'outer' (shell or level) was omitted in a lot of answers.

Often students would repeat the question stem in terms of chlorine and bromine's reactivity without relating it to the whole of Group 7 and in many instances referring to the reactivity series (of metals).

Q5.

(a) In this 'extended response' question many students used the information effectively and gave very good explanations. 73% of students were able to achieve at least one mark, while 18% of students gave answers sufficient enough to meet the demands of the level 3 descriptor.

Some misunderstood the solubility data and gave SiO_2 as the most soluble. Many understood how pH related to acid, alkali and neutral. Although a common error was the confusion between whether sodium oxide was alkaline or acidic so many gave C and D correct from the solubility data but A and B incorrect.

In long descriptions, students would often contradict chemical identification or properties due to a lack of organisation within their response. A number gave the identity of the substances as elements instead of oxides. Some did not link the letters with any of the four substances listed in the question, choosing other compounds.

(b) Students struggled with the concept that is if an acid is diluted by a factor of 10 then the pH increases by 1. Very few showed any attempt at the correct method, with 12% of students achieving one or two marks. Most students simply multiplied the 3 by 100 to give an answer of 300.

Q6.

(a) 70% of students identified the decrease in melting point as the trend with others correctly answering in terms of negative correlation. A number of students referred to boiling points rather than melting points.

(b) Nearly all students correctly identified the atomic number of caesium as 55. But a significant number failed to read the scale on the graph correctly in order to obtain the melting point of caesium, usually giving an incorrect response of 24 °C or 25 °C. 61% of students achieved the mark.

(c) The most common distractor was '3', where students had determined the number of electrons in a lithium atom rather than in the outer shell. 40% of students were able to select the correct response.

(d) Most students were able to identify oxygen as an element but many thought lithium oxide was a metal. 76% of students achieved at least one mark.

(e) Students found complete the balancing of the equation difficult with the vast majority of responses placing 2 in front of Li. 15% of responses were correct.

(f) More students thought lithium oxide was covalent rather than ionic.

(g) 20% of students gave the correct answer of 30. Incorrect calculations were seen involving every possible combination of the numbers 7 and 16. 112 (7 × 16) was the most common incorrect response.

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Q7.

(a) Around two thirds of students correctly identified the Group 1 elements as alkali metals. Other responses were fairly evenly spread between the other options.

(b) By far the most common response was ‘gloves’, followed by ‘apron/lab coat’. Credit was not given for these precautions relating to general good laboratory practice, although it was pleasing to see that most students were aware of them. The answers required related to this particular experiment. The highest scoring correct response was ‘safety screen’ − described in an assortment of ways, some of which (e.g. barriers) were not accepted.

(c) Around 10% of students did not attempt this question. Many interpreted ‘describe the trend’ as ‘describe the similarities’, tending to state ‘they all…’ rather than comparing the reactions of the elements. Thus, more than half of students scored no marks. A few attempted to explain the trend in terms of the size of the atom; however, the command words here were ‘describe’ and ‘give’, not ‘explain’.

(d) Around 10% of students did not attempt this question. To be awarded the mark, students needed to communicate that the reaction was less controllable in some way, so statements such as ‘very reactive’ were insufficient, as potassium is also very reactive. Many students recognized the higher reactivity of rubidium, but the most common correct response referred to the reaction being dangerous.

(e) Approximately one quarter of students did not attempt this question. Of those who made an attempt, a significant number did not realise that to balance an equation involved putting numbers in front of the substances shown. Some students wrote the name of the substance, others put symbols for various elements or compounds. Even though this should have been a familiar equation, many students tried to add additional reactants or products. Some students who realised that they had to balance the numbers of atoms of the different elements involved struggled to do this correctly. However, around one quarter of students gained the mark for this question.

(f) About three quarters of students correctly identified NaOH as being sodium hydroxide. ‘Sodium dioxide’ was the least popular option.

(g) Any value lying between the diameters of the sodium atom and the rubidium atom was credited as being acceptable, therefore allowing around 80% of students to gain the mark. It appeared that some students had realised what the value was, but did not put the decimal point in front, so answers of 444 and similar were seen. Some students chose a number which was nowhere near any of the values in the table.

(h) More than half opted for the incorrect answer of 3.04×10^{-9} m. There was a fairly even spread between the correct answer of 3.04×10^{-10} m and the incorrect answer of 3.04×10^{-8} m, with very few choosing the fourth option.

(i) Around 10% of students scored all three marks, with a further 10% scoring two marks.

The question asked students to include data from figure 4 in their answer. When students did not achieve all the marks, the main reason was that data was not included, was read incorrectly off the graph or did not include interpretation of the data, such as ‘increased’ or ‘decreased’. Some gave correct data for one use but then generalized for the other two.

Some students were able to gain one mark for the general statement that the amount of lithium used in batteries and in the production of ceramics and glass had

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increased, whereas the use in lubricants had decreased.

A significant number interpreted the command word 'describe' as 'explain' and attempted to give reasons for why lithium was used more in batteries, etc. Some students mis-interpreted the question as being about the use of batteries, for example, and again attempted explanations as to why more batteries were being produced.

Q8.

(a) Over 80% of students correctly drew the electronic structure of the atom.

(b) Many students are aware of basic laboratory safety procedures, however in a question such as this, 'wearing gloves' and 'tying hair back' etc. do not gain credit. The safety precautions required were things specific to this experiment. Around 60% of students gained at least one or two marks. Using a safety screen and keeping a safe distance away were the most common creditworthy answers.

(c) Just under half of students chose the incorrect response of K^+, with around one third opting for the correct answer of OH^-. The other two responses were seen but were chosen by a minority of students.

(d) The command word in this question was 'explain'. A good answer would therefore state how the reactivity changes as the diameter changes and then would explain why.

Just under one half of all students gained one mark, usually for stating that as the diameter increases, the reactivity also increases. There were a number of imprecise expressions used for 'reactivity increases', for instance 'the reaction is higher' or 'it reacts stronger'.

Many students did not attempt an explanation or referred to there being a larger surface area for the reaction to take place. Some students had the correct idea of the explanation but talked about 'electrons' rather than 'the outermost electron'. Around 5% of students scored all four marks with well written explanations and a further 7% gained three marks.

Q125.

(a) There were some very good answers seen containing all five possible marking points. Some students lost marks due to vague language when referring to the nucleus, just stating that the protons and neutrons were in the centre or middle of the atom. Many gave a correct electron arrangement to gain 2 of the 4 marks. A few attempted to give the charges on the particles, but if they made a mistake they were limited to 3 marks maximum, as were students who gave the wrong number for any particle.

(b) The majority of students selected sodium as being in the same group as lithium.

Q126.

(a) The question was well answered. Over a third of the students gained full marks. Errors were generally to do with the numbers of the particles. A few students limited themselves to a maximum of 3 marks because they gave incorrect charges on the particles, which was not required. If they had given what was asked for in the question, most of these students would have gained full marks.

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(b) (i) Only just over half the students answered the question correctly, usually naming sodium or potassium. Beryllium was often given; presumably students had confused groups with periods. Incorrect responses that were often seen, and that are more difficult to explain, included hydrogen and helium.

(ii) The question asked why lithium and other Group 1 elements are classed as different elements. Less than a fifth of the students gave the correct answer. Most listed all three sub-atomic particles.

Q127.

(a) Two marks were available for being able to use the information given about helium to work out the numbers of neutrons and electrons in the atom. A significant number of students did not know what the mass number represents, and either drew 4 neutrons or 4 electrons, usually with 2 of the other particle. The third mark was for the position of neutrons and electrons in the atom. The number of particles shown, and extra shells drawn were ignored. Incorrect responses often drew all the particles together, either in shells or in the nucleus.

(b) Some students recognised that Group 0 are the noble gases, but did not go on to explain why the elements in this group are unreactive. Common incorrect responses were that they are gases or that they don't need electrons. Many students made reference to the mass number or the number of subatomic particles.

(c) A lot of information was given in the question, which many students simply copied. This could only gain marks if some value was added. Many students gained a mark for saying that using helium in party balloons was a waste. Some also said that it would run out soon. The majority of responses included some reference to safety, saying that it was dangerous to inhale helium, or that it led to squeaky voices. Others incorrectly referred to helium being flammable or said that the balloons were at risk of catching fire.

Q128.

(a) Less than half of the students gained one mark or more on this question. The main problem was that they did not link their explanation to an observation. Naming copper oxide as being a product was a common correct response, although some thought that copper was formed. Carbon dioxide was often given as the other product, but this only scored if it was linked to the loss in mass or the change in the colour of the limewater. A surprisingly large number of students linked the colour change of limewater to an incorrect gas, such as oxygen or hydrogen. Hardly any students scored 3 marks, failing for the most part to link the loss of mass with the production of carbon dioxide.

(b) (i) Only a tenth of students said that the temperature needed to be higher or that more energy was needed to decompose potassium carbonate. Many students referred to the compound or potassium being high in the reactivity series, which was ignored. Others said it had a high melting or boiling point.

(ii) Some students realised that the mass of potassium carbonate after heating would be 13.8 g. The response "9.4 g" was seen quite a lot. Other students said that the limewater would turn cloudy for zinc carbonate, but some struggled to describe the limewater for potassium carbonate. If they just said "clear" this did not gain the mark; they had to say "stayed clear". "Nothing" or "none" were insufficient responses for the result with limewater. Quite a lot of students appeared to guess the results for limewater, writing the same answer in both boxes. There were quite few references to fizzing or bubbling.

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Q129.

(b) (i) Very few students said the oxygen came from the lithium compound. Most who gained a mark said the oxygen came from the air or the battery. A lot talked about the fan, which was ignored unless they also mentioned the air.

(ii) Many students did not understand the term product. Some attempted to give the formula, but usually gave LiO_2 which was incorrect. If asked to name something, it is usually safer to write the answer in words. The range of incorrect responses revealed a lack of understanding – sparks, heat, fire, chemical reaction, element, cobalt, battery, gases - to name but a few.

(c) Most students scored a mark for labelling the electron correctly. Some did not name the particles, but stated their relative charges. Others used terms such as atoms, ions, positive electrons or shells.

(d) (i) The most common correct responses referred to bubbles, fizzing or smoke. Some also mentioned that the lithium would move about on the surface of the water, or that it dissolved. There were many references to flames and sparks, or changes in the colour of the water, all of which were ignored.

(ii) For those students who had read the stem of the question, this proved to be a simple question as both products were named there. Some tried to write the formulae, but made errors so were not credited. If a word equation is asked for it is easier to write the answer in words, not as formulae. Some students wrote hydrogen and hydroxide, but this was not enough to gain the mark. Carbon or carbon dioxide was often seen, demonstrating a lack of understanding of chemical reactions.

Q130.

(a) (i) Many students gained the compensation mark for a balanced equation that had the symbol for oxygen, rather than the formula. Some students gave the formula of the lithium compound instead of the symbol for lithium metal.

(ii) Many students correctly stated that the oxygen came from the lithium compound. Some said it came from the air, but did not qualify this by explaining that the battery seal must have been damaged.

(b) (i) Most students had observed the reaction and gave various descriptions of what they saw. Few students scored more than 1 mark, which was either for stating that hydrogen or lithium hydroxide was produced. Very few realised that lithium is less dense than water. A variety of incorrect products was named – carbon dioxide or oxygen gas and lithium oxide. Quite a lot mentioned that one of the products was an alkali, but did not name it.

(ii) Most students gained 1 mark for saying that sodium would react in a similar way to lithium, or for a description of the reaction. The second marking point was more difficult to obtain, although some students did say that both elements were both in Group 1. Some gained 2 marks for stating that sodium is more reactive than lithium because it is lower down the group.

Q131.

The vast majority of students gained full marks. Where marks were lost it was usually because the student had not used the elements listed in the box

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Q132.

(a) Few students knew that the elements in the central block of the periodic table are called transition metals.

(b) Some students did not understand the term property. The most common responses were that copper does not rust or react with water, many students had both of these written down but could only gain credit for this idea once. Another common answer was that copper can be bent or shaped. There was some confusion between strength and hardness, which are two different properties; only strong was creditworthy. Many students said copper was an insulator rather than a conductor. Many referred to cost, which is not a property, and was ignored.

(c) Most students were able to make a reasonable attempt at answering this question. Most Level 1 responses referred to the comparative time of each process. Beyond Level 1 comparative pollution levels were often seen as a second scientific idea, eg visual, noise and dust pollution, however these were often very poorly expressed. Many students only referred to pollution, without qualifying the statement, which was not creditworthy.

A large number of students were able to describe the disadvantages of both methods very clearly; however they struggled to identify advantages of the processes. Advantages could be inferred from statements about disadvantages which were comparative slower or more noise pollution.

To gain full marks students had to follow the instructions given in the question and give advantages and disadvantages of both methods, plus a conclusion. The advantages and disadvantages also had to relate to at least three different ideas to attain Level 3. Many students made good scientific points but did not attempt a conclusion, so only gained 5 marks.

Q133.

(a) It was pleasing to note that the majority of students could correctly complete the diagram of the electronic structure. Where mistakes were made in the configuration, one mark was awarded for showing 11 electrons.

(b) The formation of sodium chloride was less well understood with less than a tenth of students able to gain three or four marks. To gain full marks it was necessary only to state that a sodium atom loses an electron to become a sodium ion and that a chlorine atom gains an electron to become a chloride ion. Many students stated that seven electrons were transferred. There were frequent references to the sharing of electrons. Few students realised that losing an electron results in a positively charged ion and vice versa.

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