AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.1.1 ATOMIC STRUCTURE, SYMBOLS, RELATIVE ATOMIC MASS, CHARGE AND ISOTOPES (PACK 7)

SCORE	PERCENTAGE
/584	%

STEMUP

These questions belong to AQA, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by AQA. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with AQA and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. AQA has not endorsed, approved or been involved in the production of it. AQA and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

AQA publishes its past papers, mark schemes and examiner reports. Always check the current specification at aqa.org.uk before you revise, because content and wording can change between series.

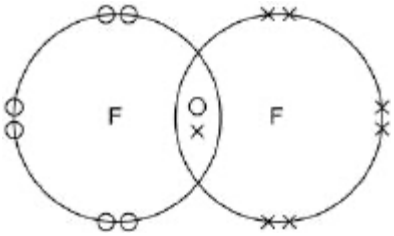
If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

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

STEMUP.CO.UK

(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

STEMUP.CO.UK

- add solid to water

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

[9]

Q3.

(a) B

1

(b) calcium oxide **or** CaO

1

carbon dioxide **or** CO_2

1

either order

(c) decomposition

1

(d) endothermic

1

(e) 32 (g)

allow 31−33 (g)

1

(f) $\frac{32}{5.2} \times 24$

1

148 (g)

allow a range 143−153 (g)

or

uses graph e.g. 12 dm^3 gives 74 (g) (1)

(then factors up so that 24 dm^3 gives) 148 (g) (1)

allow a range 143−153 (g)

1

*an answer of 148 (g) scores **2** marks*
*allow ecf from part **(e)***

(g) (mistakes)
increase in mass = 3 (not 4)

allow mistakes in either order

1

inserted numbers inversely into formula

allow numbers wrong way round

1

(calculation)

*an answer of 250 scores the **2** calculation marks*

1

STEMUP.CO.UK

$\text{gradient} = \frac{750}{3}$

allow $\frac{1000}{4}$

250 (cm^3 per g)

if no calculation marks awarded

allow $\frac{750}{4}$ ***or*** *187.5* ***or*** $\frac{3}{750}$

or *0.004 for* ***1*** *mark*

1

(h) 3 × 16 or 48

1

(48) + 12 or 60

allow their mass of oxygen + 12

1

84 − (60) **or** 24

allow 84 − their mass of carbonate

1

magnesium **or** Mg

magnesium ***or*** *Mg without working scores this mark*

1

an answer of 24 scores the ***3*** *calculation marks*

[16]

Q4.

(a) (difference)
sodium has one and chlorine has seven electrons in <u>outer</u> 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

STEMUP.CO.UK

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)

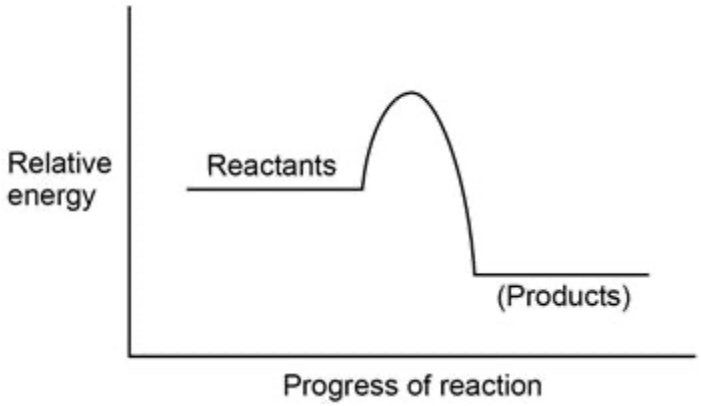
1

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)



ignore labels

any curve / line going up and then down

products line below reactants

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

1

1

[8]

Q5.

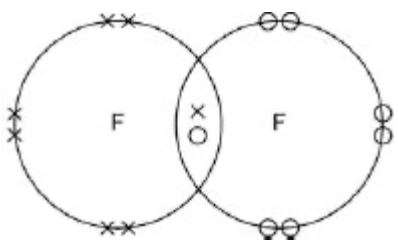
(a) g

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

*do **not** accept gas*

1

(b)



STEMUP.CO.UK

*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 (⟶ 2 $AlBr_2$)

1

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

(e) chlorine is a smaller atom
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]

Q6.

(a) CaO

1

CO_2

1

either order
ignore names

(b) [12 + (3 × 16)]
or 60

1

STEMUP.CO.UK

(197 − 60 =) 137

1

barium **or** Ba

*barium **or** Ba without working scores this mark*

1

*an answer of 137 scores the **2** calculation marks*

(c) (working) Y increase and X increase measured from graph and substitution into $\frac{\Delta Y}{\Delta X}$

y-axis	*80−85*	*162−170*	*248−252*	*330−335*
x-axis	*0.5*	*1.0*	*1.5*	*2.0*
=	*160−170*	*162−170*	*165−168*	*165−168*

1

(answer) 167

allow answer in range 160−174

1

(units) cm^3/g

allow $cm^3\ g^{-1}$

1

*if no other mark awarded allow **1** mark for the inverse ($\frac{\Delta Y}{\Delta X}$)*
***or** 0.006*
*an answer of 160−174 scores the **2** calculation marks*

(d) (from graph)
volume to 240 cm^3 mass
= 1.45 g

allow answer based on any reading from the graph
(e.g. 250 cm^3 = 1.5 g)

1

ratio is $\frac{1}{100}$ (ie $\frac{24000}{240}$)

allow ratio from their volume
eg $\frac{24000}{250}$

1

100 × 1.45

$\left(\frac{24000}{250}\right) \times 1.5$

1

STEMUP.CO.UK

145

allow range 140−150

1

or

allow method using answer from part **(c)**

$x = \frac{y}{m}$ (1)

*(rearrangement of $y = mx$ where m = answer from part **(c)**)*

24 (dm^3) to 24 000 (cm^3) (1)

$\frac{24\,000}{\text{answer from part (c)}}$ (1)

144 (1)

allow range 140−150

[12]

Q7.

(a) hydrogen **or** H_2

allow hydrogen gas
ignore H without the 2 subscript

1

(b) filtration / filter

*allow magnet **or** decant*
ignore heating

1

(c) (Mg) $\frac{0.12}{24}$ or 0.005 (moles)

mark is for ÷ by 24

1

(Fe) $\frac{2}{3} \times 0.005 = 0.00333 \times 56$

mark is for $\times \frac{2}{3}$

1

(mass Fe) = 0.00333 × 56

mark is for × 56

1

= 0.1866 (g)

1

= 187 (mg)

1

STEMUP.CO.UK

*an answer of 280 (mg) scores **4** marks*

*an answer of 0.280 scores **3** marks (no ratio from equation)*

*184 scores **0** [= (3 × 24) + (2 × 56)]*

OR

$$(\text{Mg}) = \frac{0.12}{(3 \times 24 =)72} \quad (1)$$

$$= 0.00166 \textbf{ or } \frac{1}{600} \text{ (moles) (1)}$$

(mass of Fe) = 0.00166

$$\textbf{or } \frac{1}{600} \times 112(2 \times 56) \text{ (1)}$$

= 0.1866 (g) (1)

187 (mg) (1)

OR

72 g Mg ⟶ 112g Fe (1)

$$1 \text{ g Mg} \rightarrow \frac{112}{72} \textbf{ or } 1.56 \text{ g Fe (1)}$$

$$0.12 \text{ g Mg} \rightarrow \frac{112}{72} \times 0.12 \text{ (1)}$$

= 0.1866 (g) (1)

= 187 (mg) (1)

*an answer of 185−190 (mg) scores **5** marks*

*an answer of 0.185−0.19 scores **4** marks*

(d) Fe^{3+}

1

(because) reduction is gain <u>of electrons</u>

allow change in oxidation state / (+)3 to 0

1

$Fe^{3+} + 3e^{(-)} \longrightarrow Fe$

1

[10]

Q8.

(a) 16

1

(b) 8 e^- in 2nd shell
6 e^- in 3rd shell

STEMUP.CO.UK

allow •, x ,e^- or any combination

1

(c) oxygen ⟶ sulfur dioxide

allow = in place of ⟶
*do **not** accept sulfur oxide*
ignore symbols

1

(d) acid rain

1

(e) yes / no

any **two** from:

- increases

  allow goes up

- constant

  allow similar

- decreases

  allow goes down
  allow levels off (at the end)

2

correct date range for any one of the above

- (increases) 1984−1987
- (constant) 1987−1990
- (decreases) 1990−2014

1

(f) (69 + 6 =) 75

1

100 − 75 = 25(%)

allow a final percentage calculated from an incorrect value in the first step

1

*an answer of 25(%) scores **2** marks*

[9]

Q9.

(a) watch glass

1

(b) identify 0.29 as anomaly

1

$$\frac{0.12 + 0.14 + 0.15}{3}$$

or

STEMUP.CO.UK

$\frac{0.41}{3}$

allow $\frac{0.12 + 0.29 + 0.14 + 0.15}{4}$

or

$\frac{0.70}{4}$

1

(=) 0.14 (g)

allow 0.18 (g) if first marking point not awarded

1

*an answer of 0.14 (g) scores **3** marks*

(c) evaporating
or
vaporisation

allow from liquid to vapour / gas
*do **not** accept boiling*

1

(d) pure
or
no salt

allow converse answers relating to seawater
allow not a mixture
allow desalinated
*do **not** accept less salt*
*do **not** accept filtered*

1

(e) uses (a lot of) energy

allow needs heating
allow needs electricity
*allow needs fuel **or** any suitable fuel*
ignore references to equipment
ignore references to time

1

(f) filtering removes particles

*allow solids **or** suitable named solids*

1

sterilising kills bacteria / microbes

allow destroys viruses
allow kills viruses

1

[9]

Q10.

(a) lines from:
- independent to size of marble chips

1

STEMUP.CO.UK

• control to volume of acid

1

ignore arrowheads
*do **not** accept if more than one line from one box*

(b) calcium chloride

carbon dioxide

*do **not** accept carbon oxide*

water

*do **not** accept hydrogen oxide*

2

*all three needed for **2** marks*
*allow **1** mark if two correct*

(c) stops loss of acid

allow stops loss of water / liquid
allow to ensure that only the gas escapes
*do **not** accept stops acid evaporating*
*do **not** accept stops gas / CO_2 / water vapour escaping*

1

(d) 0.053

allow 0.05
allow 0.053333…
*do **not** accept 0.052*
ignore units

1

(e) g/s

1

(f) all points correctly plotted

*allow **1** mark for 5 points correctly plotted*
allow ± ½ a small square

2

line of best fit

should be a curve nearer to (10,0.8) than the anomaly (20, 0.6) and through all other points
if plotting incorrect allow 1 mark for appropriate line of best fit through student's points

1

(g) the eight small marble chips have a larger surface area, so more frequent collisions

1

[11]

Q11.

(a) condenses

1

STEMUP.CO.UK

(b) the fractions have different boiling points

1

(c) propane

*do **not** accept propene*

1

(d) C_nH_{2n+2}

1

(e) CH_4 + **2** $O_2 \longrightarrow CO_2$ + **2** H_2O

allow multiples

1

(f) bromine water

1

(g) to assess the environmental impact (of the stages in the life of a product)

allow to see the effect / harm / damage on the Earth / environment / planet

ignore references to energy, pollution, carbon footprint, carbon dioxide, sustainability

1

(h) **Level 2:** Scientifically relevant features are identified; the ways in which they are similar / different is made clear and the magnitude of the similarity / difference noted.

3–4

Level 1: Relevant features are identified and differences noted.

1–2

No relevant content

0

Indicative content

- burning 10 000 bags produces 10 kg more of carbon dioxide than landfill
- putting 10 000 bags in landfill produces 0.02 kg more of solid residue than burning
- putting 10 000 bags in landfill produces 50% more sulfur dioxide than burning
- burning 10 000 bags produces 25 kg of carbon dioxide, but landfill only produces 15 kg
- putting 10 000 bags in landfill produces 0.07 kg of solid residue but burning only produces 0.05 kg
- landfill produces less carbon dioxide than burning
- landfill produces more solid residue than burning
- burning produces less sulfur dioxide than landfill

[11]

Q12.

(a) $CaCl_2 + CO_2 + H_2O$

products in any order

1

balancing: **2** (HCl)

STEMUP.CO.UK

dependent on correct formulae for products

1

(b) value from graph used to show volume increase

must include a time or volume value

1

values from graph used to show the volume increases less rapidly

must include time interval or volume increment

1

volume **or** time stated when graph line levels off

*allow levels off at 60 (cm^3) **or** 28 to 30 s*
allow descriptions in terms of rate of reaction

1

values must be approximately correct

(c) draw tangent at 15 s

allow draw a straight line on the curve at 15 s

1

calculate gradient

allow correct description of gradient calculation
ignore calculations if given

1

(d) centimetres cubed per second

*allow cm^3/s **or** $cm^3\ s^{-1}$ (all lower case)*
allow mixture of abbreviations and words, e.g. centimetres cubed/s
*do **not** accept non-SI abbreviations (e.g. sec for s)*

1

(e) (rate) increases as chips get smaller

allow converse

1

(f) same amount of acid
or
same number of moles of acid

allow same volume of acid
allow same concentration of acid
allow same mass of $CaCO_3$ / marble chips
allow one reactant is the limiting factor

1

(g) (surface area of each face = 2 × 2 =) 4

1

(6 × 4 =) 24 (cm^2)

allow 6 × student's value from step 1

1

*an answer of 24 (cm^2) scores **2** marks*

(h) small(er) chips have large(r) surface area (for the same volume)

allow converse

STEMUP.CO.UK

1

so more frequent collisions

allow more chance of collisions
allow more likely to collide

*do **not** accept reference to speed of particles or energy of collisions*

ignore more collisions
ignore more successful collisions

1

(i) (sloping part is less steep because) reaction is slower

1

due to less frequent collisions

*do **not** accept reference to speed of particles or energy of collisions*
ignore fewer collisions

1

fewer acid particles (in same volume)

ignore weaker acid

1

or
(sloping part is less steep because) reaction is slower (1)

there are fewer acid particles (in same volume) (1)

(graph levels off lower) so less gas is produced (1)

allow converse for more concentrated acid

[17]

Q13.

(a) electron

1

atom

1

nucleus

1

orbit

1

(b) positive charge is provided by protons

1

(every atom of the same element contain the) same number of protons

*do **not** accept same number of protons and neutrons*
ignore reference to electrons

1

STEMUP.CO.UK

(c) $v = 300\,00\,000 \times \left(\frac{7}{100}\right)$

allow any correct method of determining 7% of 300 000 000

1

v = 21 000 000 (m/s)

allow 2.1 × 10^7 (m/s)

1

*an answer of 21 000 000 scores **2** marks*

(d) r = 6 × 2.5 × 10^{-11}

allow a ratio in the range of 5.7−6.3 or measurements that would give this range, correctly substituted

1

r = 1.5 × 10^{-10} (m)

allow 1.4 × 10^{-10} to 1.6 × 10^{-10}

*their ratio × 2.5 × 10^{-11} correctly calculated scores **1** mark*

1

*an answer in the range 1.4 × 10^{-10} to 1.6 × 10^{-10} scores **2** marks*

[10]

Q14.

(a)

name of particle	**relative mass**	**charge**
proton	(1)	(+1)
neutron	1	0
electron	(very small)	−1

1 + 1

1

allow words instead of numbers
*allow neutral **or** no charge for the neutron*

(b) (protons) 3

1

(neutrons) 4

1

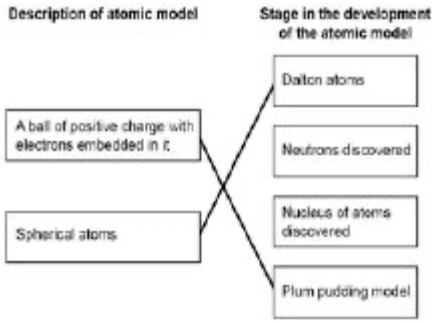
(electrons) 3

1

allow words instead of numbers

(c)

STEMUP.CO.UK



1
1

[8]

Q15.

(a) the mass number
or
number of protons **and** neutrons
ignore (relative) atomic mass

1

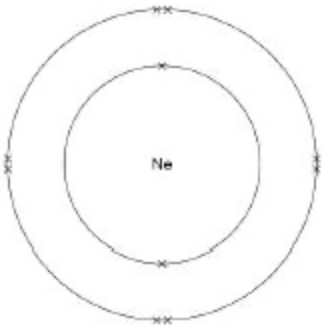
(b) 18

1

(c) 22

1

(d)



ignore pairing of electrons

1

(e) positive

1

(f) equal number of protons **and** electrons
*do **not** accept equal number of protons, electrons and neutrons*

1

(therefore) the positive cancels out the negative charge
allow (therefore) equal number of positives and negatives

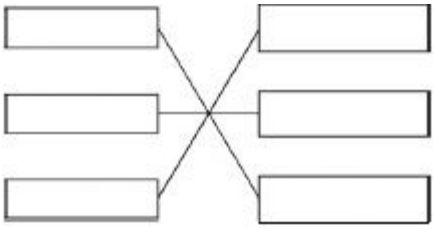
1

(g) isotopes

1

(h)

STEMUP.CO.UK



2

[10]

Q16.

(a) atoms / electrons gain energy

1

(some) electrons move to a higher energy level

allow (sub) shell for energy level

1

(so) as the electrons fall to a lower / original energy level

allow (sub) shell for energy level

1

(EM) radiation with a frequency / wavelength within the visible region of the spectrum is emitted

1

(b) there should be two electrons on the inner shell (not three)

1

there should only be four electrons in the outer shell
or
there should only be six electrons in total

1

there should be one more proton

allow should be six protons

1

there should be one fewer neutron

allow should be seven neutrons

1

*allow **2** marks for one of the neutrons should be a proton*

(c) $^{0}_{-1}e$

1

(d) a neutron splits into a proton **and** an electron

allow beta particle for electron

1

so there is an extra proton (in the nucleus)

1

(e) 12.5% is 3 half lives
or

STEMUP.CO.UK

5730 × 3

1

17 190 (years old)

1

*an answer of 17 190 (years old) scores **2** marks*

[13]

Q17.

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

allow negative correlation

1

(b) 55
and
29 (°C)

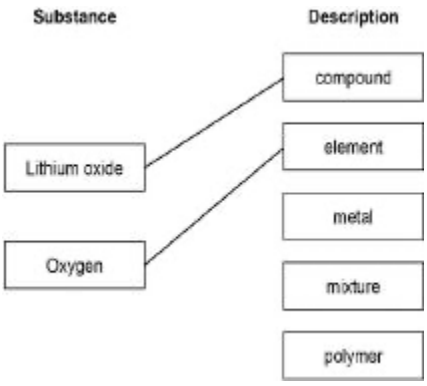
allow values in range 28−32 (°C)

1

(c) 1

1

(d)



1
1

(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

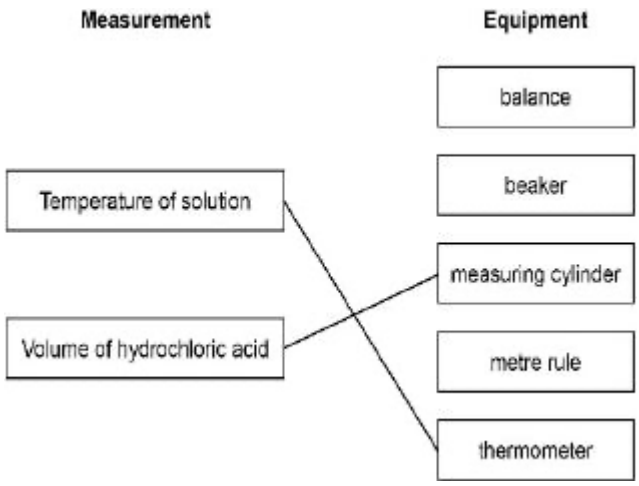
*an answer of 30 scores **2** marks*

[9]

Q18.

(a)

STEMUP.CO.UK



1
1

(b) $(\text{mean} =) \frac{6.1 + 6.1 + 6.4}{3}$

1

= 6.2 (°C)

*allow an answer of 6.6 (°C) for **1** mark*

1

*an answer of 6.2 (°C) scores **2** marks*

(c) use a lid on the polystyrene cup

1

(d) sodium chloride

allow NaCl

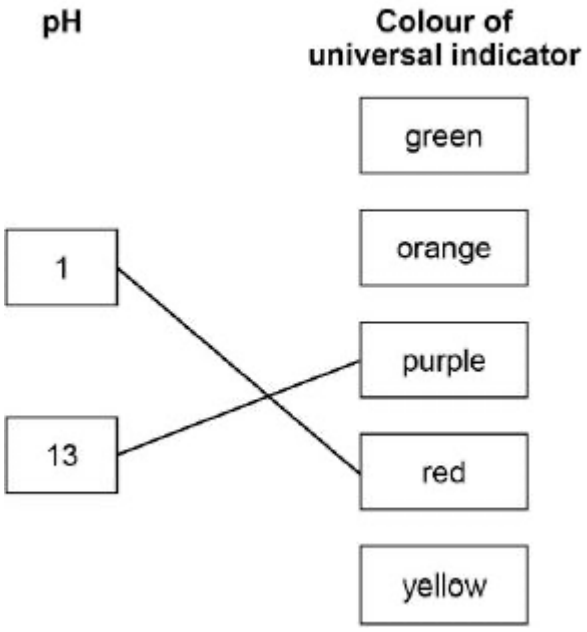
1

water

allow H_2O

1

(e)



STEMUP.CO.UK

1
1

[9]

Q19.

(a) shared electron pair

allow electrons drawn as dots, crosses, circles or $e^{(-)}$

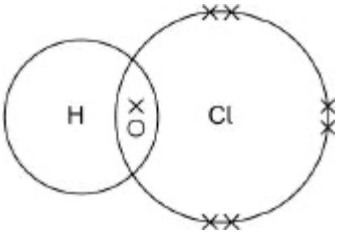
1

1 hydrogen electron and 7 chlorine electrons drawn on outer shells

ignore inner shell electrons drawn on chlorine

1

an answer of



*scores **2** marks*

(b) correct symbols and formulae

1

correct balancing of equation containing HCl

allow correct multiples

1

an answer of $H_2 + Cl_2 \longrightarrow 2HCl$ *scores **2** marks*

(c) A activation energy

1

B (overall) energy change

1

(d) energy of products is less than the energy of the reactants

1

(e) hydrogen chloride molecules do not have an overall electric charge

allow hydrogen chloride does not contain ions

1

hydrochloric acid contains ions*

1

(which) are free to move so charge can flow*

1

*do **not** accept reference to delocalised electrons*

[10]

Q20.

(a) reference to glow

1

STEMUP.CO.UK

(which) shows energy is being transferred to the surroundings

1

allow 'heat' for energy
allow (which) shows energy is being given out

(b) (M_r CuO =) 79.5

1

$$\left(\text{moles copper oxide} = \frac{\text{mass}}{M_r} = \frac{1.59}{79.5}\right) = 0.02$$

allow an incorrectly calculated value for M_r from step 1

1

(mass Cu = 0.02 × 63.5) = 1.27 (g)

1

alternative approach:
79.5 (g) CuO ⟶ 63.5 (g) Cu (1)
$(\text{mass Cu} =) \frac{63.5}{79.5} \times 1.59$ *(1)*
(mass Cu) = 1.27 (g) (1)
*an answer of 1.27 (g) scores **3** marks*
*an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps*

(c) hydrochloric acid reacts with zinc oxide

allow hydrochloric acid and zinc oxide produce zinc chloride

1

(to) form a solution (of zinc chloride)

1

copper does not react (with dilute acid)

1

(so copper) remains as a solid

allow (so copper) will collect in filter paper

1

(d) zinc has been oxidised because the zinc atoms have lost electrons

1

[10]

Q21.

(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

STEMUP.CO.UK

(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

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

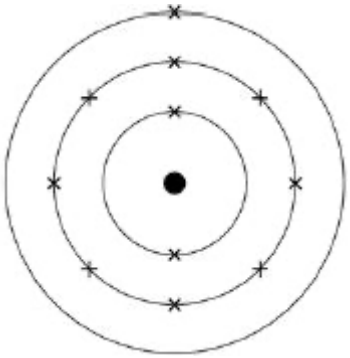
*if no other marks awarded allow **1** mark for batteries and glass / ceramics increased, lubricants decreased, with no or incorrect data*

[13]

Q22.

(a)

STEMUP.CO.UK



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

(so) outer electron is lost (more) easily

1

[8]

Q23.

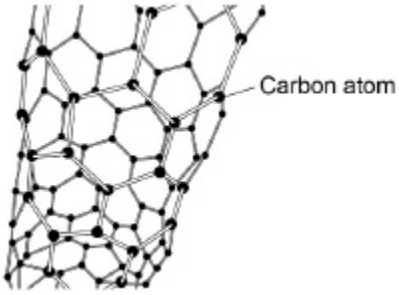
(a) carbon

1

(b) conduct electricity

1

STEMUP.CO.UK

(c) 

1

(d) carbon

hydrogen

either order

2

(e) a polymer

1

(f) slide

1

[7]

Q24.

(a) 3

1

(b) 5

1

(c) water

1

(d) opposite charges attract

1

(e) silver is less reactive than hydrogen

1

(f) oxygen

1

(g) universal indicator

allow other indicators

1

blue / purple

1

[8]

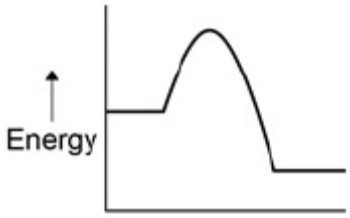
Q25.

(a) (a reaction that) transfers energy to the surroundings

1

STEMUP.CO.UK

(b)



1

(c) 2 × 16 (= 32)

1

(M_r =) 44

1

72.7 (%)

1

(d) 2 2

allow multiples

1

(e) 3.2 g of O_2 produced from 6.8 g of H_2O_2

1

32 (g)

1

[8]

Q26.

(a) group 0

1

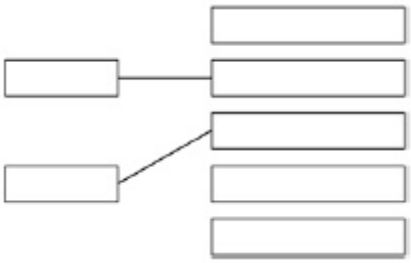
(b) left gaps

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*

STEMUP.CO.UK

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]

Q27.

(a) electron
proton
neutron

this order only
*all 3 correct = **2** marks*
*1 or 2 correct = **1** mark*

2

(b) **A** = electron has less mass so is deflected more
or
electron deflected towards positive because it is negatively charged

1

B = neutron because the neutron's path does not change as not charged

1

C = proton <u>and</u> proton has greater mass (accept heavier) so is deflected less (than electron)
or
proton is deflected towards negative because it is positively charged

1

this is because the lower plate is negative
or
upper plate is positive

1

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

1

3.82×10^{-23}

answer to 3 significant figures

1

(d) 2.27×10^{-14}

1

[9]

STEMUP.CO.UK

Q28.

(a) formulation

1

(b) 1/10

1

(c) make them palatable

1

(d) neutralisation

1

(e) carbon dioxide

1

(f) water has a boiling point of 100 °C

1

water has a melting point lower than room temperature

1

(g) $CaCl_2$

1

(h) crushed

1

melted

must be in this order

1

[10]

Q29.

(a) 0.1%

1

(b) bar correctly drawn to ±½ square

1

(c) argon

1

(d) increased

1

data values to justify

1

(e) electricity and industry are equal

1

electricity and industry are highest

1

transport is lowest

1

electricity or industry is double transport

STEMUP.CO.UK

1

(f) use of renewable energy sources
or
specific example

1

(g) limited investment in renewable technology
or
disagreement between countries

accept specific reason which relates to response to (f), eg insufficient sunlight

1

[11]

Q30.

(a) sodium chloride

1

(b) points correctly plotted

*allow **1** mark if 4 correct*

2

correct line of best fit

*do **not** accept straight line*

1

(c) 0.38–0.50

*allow for **1** mark for working shown on graph*

2

(d) ≥5 seconds and <8 seconds

1

[7]

Q31.

(a)

Level 2: Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity / difference is noted.	3-4
Level 1: Relevant features are identified and differences noted.	1-2
No relevant content	0
Indicative content • bioleaching is very slow, but although slow, phytomining can be made more efficient by growing quick growing plants • bioleaching extracts copper from quarrying waste, but phytomining extracts	

STEMUP.CO.UK

copper from contaminated ground • phytomining decontaminates polluted ground, but bioleaching can produce toxic run off which may go into rivers • phytomining takes a long time to stop • bioleaching is a very slow process • plants are burned in phytomining	

4

(b) (plants burned to produce) ash

1

copper compounds in ash dissolved in sulfuric acid

1

(c) $CuSO_4 + Fe$

1

$\rightarrow Cu + FeSO_4$

1

(d) electron transfer

1

(e) delocalised electrons

1

carry charge through the metal

1

(f) turns from white

1

to blue

1

[13]

Q32.

(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

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

STEMUP.CO.UK

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]

Q33.

(a) sodium fluoride

1

(b) electrostatic

1

(c) conducts electricity when molten

1

high melting point

1

(d) any **four** from:

- sodium loses electron(s)
- fluorine gains electron(s)
- reference to one electron being transferred
- (forming) positive sodium ion and negative fluoride ion
- ions have complete outer shells
- oppositely charged ions are attracted towards each other

4

(e) the diagram only shows a two-dimensional representation

or

the diagram is not three-dimensional

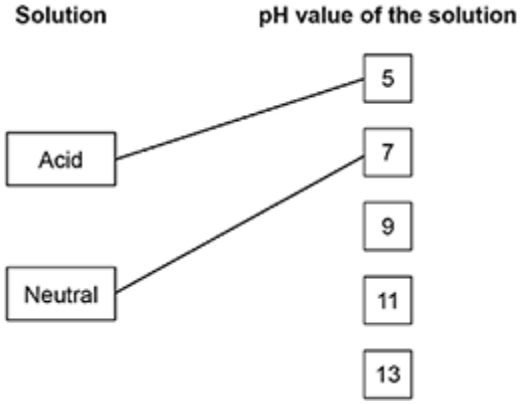
1

[9]

Q34.

(a)

STEMUP.CO.UK



extra lines from solution negate the mark

2

(b) H^+

1

(c) 3

1

(d) Neutralisation

1

(e) sodium sulfate

1

(f) Add indicator to sodium hydroxide solution

allow add indicator to sulfuric acid

1

Add sulfuric acid (gradually)

allow add sodium hydroxide solution (gradually)

1

allow pH probe

until indicator just changes (colour)

or until universal indicator turns green or shows pH7

1

[9]

Q35.

(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

STEMUP.CO.UK

1

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

1

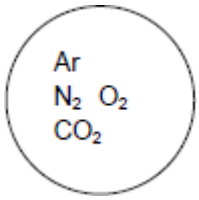
plum pudding model has no nucleus and the nuclear model has a nucleus

1

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

1

(e)



1

(f) Covalent bond

1

[10]

Q36.

(a) A base

1

(b) forces

1

(c) calcium loses electrons and oxygen gains electrons

max 3 for incorrect reference to atom / ion or to oxygen / oxide

1

two electrons are transferred

1

calcium has a 2^+ charge

1

oxide has a 2^- charge

1

[6]

Q37.

(a) 1×10^{-10} m

1

(b) 1 / one

allow alkali metals

1

STEMUP.CO.UK

(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:
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]

STEMUP.CO.UK

Q38.

(a) Flask

1

(b) Fractional distillation

1

(c) **A** – boiling

in this order

1

B – condensing

1

(d) Octane

1

(e) Formulation

1

(f) the fuel is a pure compound

1

and crude oil is a mixture

or

the fuel is made up of four hydrocarbons

allow crude oil contains a large number of compounds and the fuel contains four

and crude oil could have many more

1

(g) (35 + 37 + 37 / 3) = 36.33

1

36

1

*allow (35 + 48 + 37 + 37 / 4 =) 39(.25) for **1** mark*

[10]

Q39.

(a) Desalination

1

Sterilising

1

(b) Chloride ion

1

(c) correct bar for NO_3^-

1

(d) **D**

1

STEMUP.CO.UK

(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

(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]

Q40.

(a) because the mass of an electron is very small

do not accept has no mass

1

(b) 5 / five

1

(c) +5

1

(d) 6

1

(because) mass number = no. protons + no. electrons

allow atomic number = 5

1

(so the number of) neutrons = 11 – 5

allow mass number – number of protons

1

(e) (16 / 31) × 100 = 51.6

1

= 52

*incorrect sig. figs max **1** mark*

1

[8]

Q41.

(a) density = mass / volume

1

STEMUP.CO.UK

(b) any **two** from:

- no forces shown between spheres
- atoms / molecules / ions are not solid spheres
- not all the same size.

2

(c) at higher temperatures particles have more kinetic energy

1

(so) the (average) speed of the particles increases

1

(so there are) more frequent collisions with the wall of the container

1

which apply a greater force on wall of container (so pressure rises)

1

[7]

Q42.

(a) **mobile phase** propanone

1

stationary phase paper

1

(b) any **three** from:

- contains chlorophyll a, b and carotene
- contains Pigment B
- does not contain pheophytin
- contains (at least) one unknown substance
- contains five substances
- contains a substance that does not dissolve in the solvent

3

(c) $Rf = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$

1

(d) both measurements correct

solvent front = 9.0 cm and pigment B distance = 5.0 cm

1

R_f = 5.0 / 9.0

1

= 0.56

allow ecf from incorrect measurements

1

(e) origin line drawn in ink

1

so it will run **or** dissolve in the solvent **or** split up

1

STEMUP.CO.UK

spots under solvent **or** solvent above spots / origin line

1

so they will mix with solvent **or** wash off paper **or** colour the solvent **or** dissolve in the solvent

1

[13]

Q43.

(a) most alpha particles went straight through, suggesting lots of empty space

1

a few alpha particles bounced back, suggesting small central nucleus

1

with all the positive charge

1

the plum pudding model does not explain the results because it shows the whole atom as a ball of positive charge with no empty space

1

(b) the figures show that the radius of an atom is 10 000 times bigger than the nucleus

1

consistent with the nuclear model, which says that the atom has a tiny nucleus at the centre of the atom

1

(c) all hydrogen atoms have just one proton (in the nucleus)

1

some hydrogen atoms also have one neutron

1

protons and neutrons have the same relative mass so mass number of these atoms is 2

1

(d) neutrons are not attracted or repelled by a positive nucleus

1

so the neutrons would all pass through the foil

1

[11]

Q44.

(a) Chemical properties

1

(b) three / 3

1

(c) They all have a stable arrangement of electrons

1

(d) less dense than water

STEMUP.CO.UK

allow lighter than water

1

gas / hydrogen produced

1

an alkali / hydroxide is produced

1

sodium is more reactive than lithium

1

[7]

Q45.

(a) the melting point increases

1

(b) 337 °C

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

1

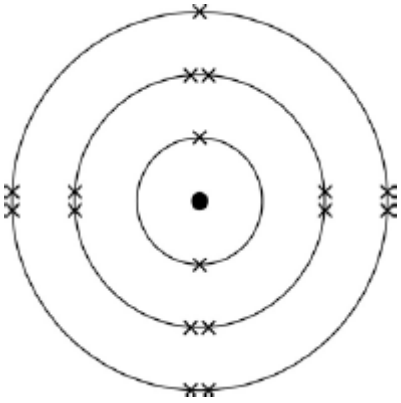
(c) bromine

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]

STEMUP.CO.UK

Q46.

(a) because they form hydroxides

1

that give alkaline solutions (in water)

1

(b) the atoms have more electron shells (as move down the group)

1

so the electron in the outer shell is further away from the nucleus

1

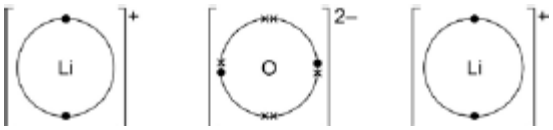
which reduces the attraction to the nucleus

1

so the electron is lost more easily from the atom

1

(c)



electronic structure of lithium drawn correctly

1

electronic structure of oxygen drawn correctly

1

correct charge on ions (Li^+ and O^{2-})

1

correct number of each ion (2 lithium, 1 oxygen)

1

[10]

Q196.

(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]

Q197.

(a) (i) any **three** from:

- (crude) oil is heated
- (crude) oil evaporates
- vapour condenses

STEMUP.CO.UK

allow fractions condense

- at different temperatures.

allow the fractions have different boiling points

3

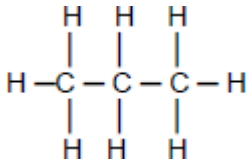
(ii) (as number of carbon atoms increases)
(Boiling point) increases

1

(Viscosity) increases

1

(b) (i)



1

(ii) any **two** from:

- carbon dioxide

allow CO_2

- water

allow H_2O

allow water vapour

- carbon monoxide

allow CO

- carbon.

allow soot

2

(iii) any **one** from:

- lack of availability of LPG
- cars need to be modified.

allow LPG cars are more expensive

1

[9]

Q198.

(a) any **four** from:

- 3 protons
- 4 neutrons
- 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

STEMUP.CO.UK

(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]

Q199.

(a) glucose ⟶ ethanol + carbon dioxide

allow sugar for glucose

allow correct formulae

ignore attempts at balancing

1

(b) (i) filtration

1

(ii) (fractional) distillation

allow evaporation then condensation

1

[3]

Q200.

(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

STEMUP.CO.UK

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

1

(c) will run out (soon)

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]

Q201.

(a) contains only one sort of atom

1

(b) platinum is not a compound / mixture / alloy

or

platinum is an element so should have own (unique) symbol

or

symbol shown represents 2 different sorts of atom

allow platinum is (an element so) not made of gold and silver

1

(c) it contains two silver ions **and** one oxide ion

maximum of 1 mark if mention of being mixed together / covalently bonded
allow silver atoms for silver ions
allow oxygen atom / ion for oxide ion
*allow for **1** mark:*
it is silver oxide
or
it is made of silver and oxygen
or
it is a compound
or
correct ratio of 2:1 atoms / ions for incorrect element(s)

2

[4]

Q202.

(a) (Cobalt) 1

1

STEMUP.CO.UK

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

1

[10]

Q203.

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

***1** mark for correct symbols and formulae*

STEMUP.CO.UK

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]

Q204.

carbon

must be in correct order ignore C

1

chlorine

accept Cl

1

calcium

accept Ca

1

[3]

STEMUP.CO.UK

Q205.

(a) (i) 4 / four

ignore atoms

1

(ii) 2 / two

ignore atoms

1

(iii) a compound

1

(b) (proton) +1

must be in correct order

allow positive / +

1

neutron

1

electron

1

[6]

Q206.

(a) aluminium **and** chlorine

ignore reference to products

*do **not** accept chloride*

1

(aluminium) two (atoms)

and

(chlorine) six (atoms)

1

(b) (i) proton +1 (charge)

1

neutron 0 **or** no charge **or** neutral

1

electron -1 (charge)

*allow for **2** marks proton has positive / + (charge), neutron is neutral / 0 / has no charge and electron has negative / - (charge)*

*allow for **1** mark (particles) proton, neutron and electron, if no other marks gained*

1

(ii) number of protons is equal to the number of electrons

allow amount for number

accept has 13 protons and 13 electrons

or

STEMUP.CO.UK

equal numbers of positive and negative charges

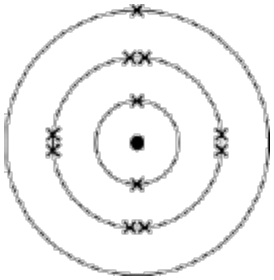
accept has 13 positive charges and 13 negative charges

1

[6]

Q207.

(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
reference to ionic bonding

1

[6]

Q208.

(a) (i) unreactive

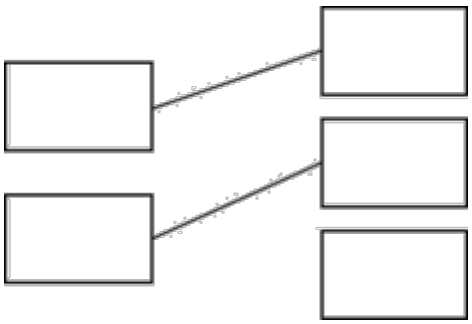
STEMUP.CO.UK

1

(ii) atoms

1

(b)



extra line from particle negates mark

1

(c) (i) mixture of metals

accept mixture of a metal with other element(s)

1

(ii) to make it harder

accept to make it more resistant to wear / corrosion / tarnishing

allow keeps it shiny

allow makes it stronger

ignore bronze won't rust

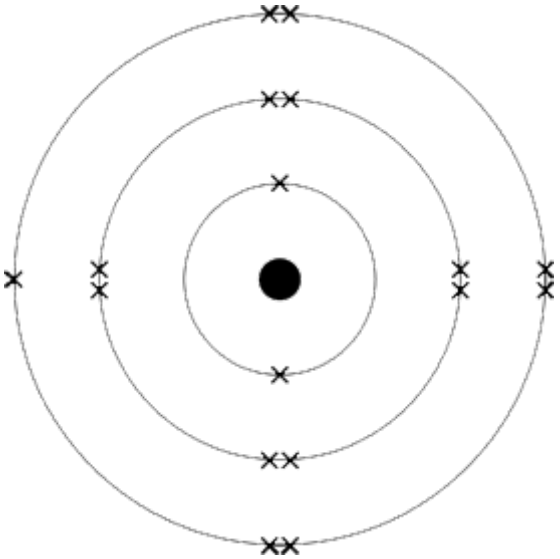
ignore references to reactivity

1

[6]

Q209.

(a)



accept dot / small circle / e instead of any cross

electrons need to be arranged as 2, 8, 7 but do not have to be in pairs

STEMUP.CO.UK

1

(b) *if sharing electrons / covalent bonds mentioned only allow maximum of **2** marks*

lithium loses electrons

*accept for **2** marks lithium has only two electrons left*

1

one electron

1

to form a positive ion / Li^+

allow lithium (atom) <u>becomes</u> positively charged

or

ion has a charge of 1^+

allow has a complete outer shell / energy level / orbit (of electrons)

1

[4]

Q210.

(a) protons = 79

allow proton number is 79

ignore atomic number

1

electrons = 79

1

neutrons = 118

1

protons **and** neutrons in nucleus and electrons in shells / energy levels / orbits around nucleus

*allow for **1** mark, protons, neutrons and electrons if no other mark obtained*

1

(b) (i) supply of copper(-rich) ores is limited

allow can extract copper from low grade ores

or

to limit the environmental impact (of traditional mining)

ignore environmentally friendly unqualified

or

more economical than other methods

ignore it is cheaper unless qualified

1

(ii) plants (grown on land containing copper)

1

(plants) absorb copper compounds / ions

STEMUP.CO.UK

allow minerals
ignore copper / metal

1

(plants) burned to produce ash / metal compounds

1

[8]

Q211.

(a) *if only formula given it must be correct*

any **three** from:

- ammonia
  accept NH_3
- methane
  accept CH_4
  allow ethane / butane / propane
- hydrogen
  accept H_2
- water vapour
  accept H_2O vapour / steam
- carbon dioxide
  accept CO_2
- carbon monoxide
  accept CO
  allow oxygen / O_2
  allow nitrogen / N_2
  ignore nitrogen oxide
  ignore carbon

3

(b) (in atmosphere today)
ignore references to water vapour
allow converse

(much) less carbon dioxide / CO_2
allow carbon dioxide was the main gas (in Earth's early atmosphere)

1

more nitrogen / N_2
allow nitrogen is now the main gas (in the atmosphere today)
or
nitrogen is now 78 × 80%

1

more oxygen / O_2

STEMUP.CO.UK

1

no ammonia / NH_3 or less methane / CH_4 or more argon / Ar or more noble gases

allow less ammonia / NH_3

1

(c) (fractional) distillation

1

gases have different boiling points

allow gases condense at different temperatures

ignore condensing points / levels

ignore evaporating points / levels

1

[9]

Q212.

(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

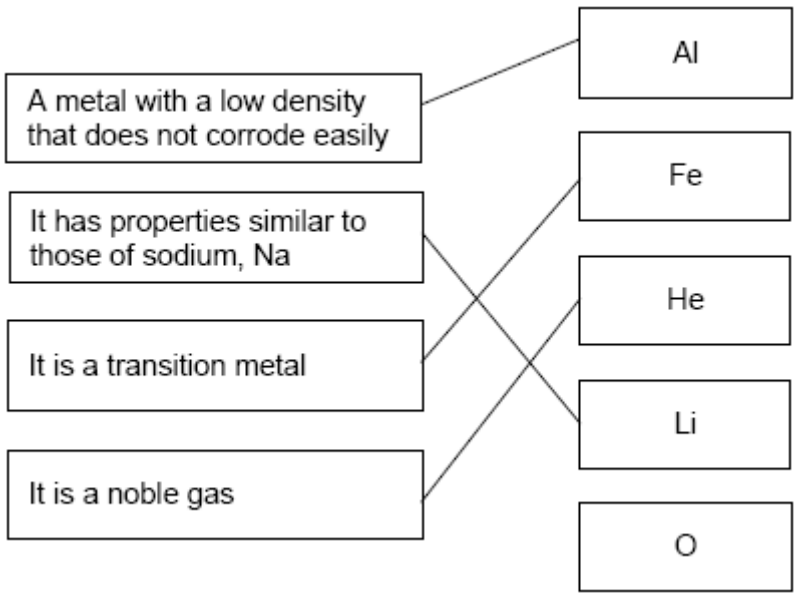
*accept this atom has electron(s) without indication of number(s) for **1** mark*

2

(ii) six / 6

1

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



4

[8]

Q213.

(a) + (1)

1

STEMUP.CO.UK

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

accept helium is less dense than air

1

[5]

Q214.

(a) (i) 344 – 350(°C)

1

(ii) 216(°C)

1

(iii) the vapours / gases cool as they rise up the fractionating column

1

which causes the vapours / gases to condense

1

at different temperatures or into fractions that have different boiling points

1

(b) (i) $10 \longrightarrow 6 + 8$

1

$7 \longrightarrow 6 + 8$

1

(ii) first reaction is complete combustion

accept first reaction has excess/enough oxygen

1

second reaction is incomplete combustion

accept second reaction has limited oxygen

1

[9]

Q215.

(a) ammonia

accept NH_3

1

(b) (i) because the gases are unreactive

STEMUP.CO.UK

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]

STEMUP.CO.UK

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.

(b) Even though the stem informed students that the products were a metal oxide and a gas, very few students (6%) could name both of the products formed when calcium carbonate ($CaCO_3$) is heated.

(c) 63% of students knew that the type of reaction when a compound breaks down is called decomposition.

(d) 60% of students knew that the type of reaction that takes in energy from the surroundings is called an endothermic reaction.

(g) This question discriminated between students well. The two mistakes made in the student's calculation were often poorly expressed or ambiguous such as, 'the calculation is wrong'; 'used the wrong numbers'; 'the volume is wrong'; and 'readings are taken from the wrong place'.

Many students correctly identified at least one of the mistakes but several of these students continued to use either the incorrect mass or the inverse formula for their calculation.

13% of students expressed the mistakes well and correctly calculated the gradient. There were 12% of students who did not attempt to answer this question.

Q4.

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

STEMUP.CO.UK

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 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.

Q5.

(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

STEMUP.CO.UK

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.

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).

Q6.

(a) The question was not answered well, with large numbers of students missing the key word 'formula' in the question stem. As a result, lots of responses included the names of a wide range of chemicals. Quite a few knew the formula for carbon dioxide.

(b) Those students who were aware that carbonate had a formula of CO_3 usually came up with the correct answer. Many opted for more well-known Group 2 carbonates such as calcium and magnesium, usually with little justification.

(c) A good number of students could successfully calculate the gradient. Most students knew the method but could not get the correct figures from the graph. Students seemed to make their life very difficult when selecting values from the graph to calculate the gradient.

The easiest methods would have been to:

- use the increase in mass from 0 g to 1 g, with the equivalent volume increase of 167 cm^3, to give a simple calculation of 167 ÷ 1
- increase in mass from 0 g to 0.5 g, or 0 g to 2 g would have also given relatively easy calculations.

There were very few inverted equations but very few correct units, these were

STEMUP.CO.UK

invariably inverted as g/cm^3

When determining a gradient students should be encouraged to draw the sides of their triangle as large as possible, as this reduces the error in reading the *x* and *y* values from the graph.

(d) This question was answered well by only the highest-attaining students with 4% achieving full marks. Their working followed those methods in the mark scheme or routes based upon these, which also achieved full credit. These students could either see the link from the graph, where 240 cm^3 had a mass of 1.45 g, and the subsequent conversion from 240 cm^3 to 24 dm^3 or they divided the volume (in cm^3) by their gradient.

Some students used a volume on the *y*-axis of 24 cm^3, which gave a mass of approximately 0.15 g on the *x*-axis, which scaled up to (a correct answer of) 150. However, because their scale was so small, some got the mass as 0.16 g. As this is within half a small square and scaled up to 160, these students were also awarded full credit.

Students should be aware that when larger values are taken from the *x* and *y*-axes, errors in subsequent calculations are minimised.

Q7.

(a) 66% of students answered this question correctly. The most common incorrect answer was water.

(b) 47% of students appreciated the need for filtration or the use of a magnet. The most common incorrect responses were electrolysis, distillation, heating / evaporation or displacement using carbon.

Students need to understand the list principle. If they give two answers (one correct and one incorrect) when only one is required, no mark can be awarded. This was the case with those students who gave filter and another method that was incorrect e.g. simple distillation.

(c) Students found this question tough, but it discriminated well with higher-attaining students being able to achieve four or five marks (10%). 74% of students scored zero marks.

The most common mistake found in correct calculation methods was the absence of a conversion from g to mg. Some got to 0.185 g and then stopped or converted g to mg incorrectly. Common errors were dividing by 1000 rather than multiplying by 1000 or using a factor of 10 or 100 to convert g to mg.

Stoichiometry was not well understood which resulted in students obtaining an answers of:

- 280 mg or 0.280 g due to the omission of the stoichiometric ratio (× 2/3) or
- 124 mg or 0.124 g where they had divided by 72 and multiplied by 112, and had multiplied by 2/3 as well, so they had taken the ratio into account twice.

Some students got as far as 0.12/24 or 0.12/72 and then no further. Others tried to calculate RFMs for the compounds involved and got no further and gained no marks.

(d) The most common mark achieved was for stating that reduction was the gaining of

STEMUP.CO.UK

electrons. Many students quoted OILRIG but gave an incomplete answer of 'reduction was gain', without stating what it was that was being gained.

Few students specifically identified the 'reduced species' being reduced. Some did identify iron was reduced but didn't say which ion of iron, others gave magnesium or iron chloride.

Only a small number of students correctly wrote the half equation. 1% of students achieved two or three marks.

Q8.

(a) 45% of students achieved this mark. Common errors included 32 (most frequently seen), but also 48 and 8.

(b) 62% of students achieved this mark. Of those who did not gain credit:

- about half gave electronic structures which showed no understanding of the maximum number of electrons in any given shell
- about half were aware that there should be no more than 8 electrons in the 2nd and 3rd shells, but gave, for example, 6 electrons in the 2nd shell and 8 in the outer shell.

(c) 59% of students achieved this mark. Some students gave '=' in place of the '⟶' in the equation, but this was allowed.

Many of the incorrect responses indicated that students were not able to recognise that an equation has reactants and products separated by an arrow, and therefore do not understand the concept of an equation. These students often simply wrote 'oxygen' or another similar single word on the answer line. Some students added further products, e.g. carbon dioxide, hydrogen or water. A few students failed to gain credit because they wrote 'sulfur oxide' as the product.

(d) 77% of responses were correct with global warming as the most popular incorrect answer.

(e) This question discriminated between students well. 61% of students achieved full marks and correctly described enough of the graph, including year ranges, to demonstrate that the mass of sulfur dioxide in the atmosphere did not decrease every year in the period shown in Figure 3. A very good proportion of students were able to correctly read from the *x*-axis to give year ranges.

Lower-attaining students were unable to give accurate year ranges, although most gained at least one mark by describing the change in mass of sulfur dioxide in one or more of the three main time periods without referring to correct year ranges.

(f) 81% of students gave a correct answer with clear working, achieving two marks.

Some students confused the percentage calculation with angle measurement on the pie chart. So although they realised that industry represented a quarter of the pie chart, they took 360°, divided by four, and gave 90(%).

Others misread the value of 6% for transport, and added 9 to 69, giving 78%, and a final answer of 22%. This achieved one mark. Some students correctly calculated 75 for one mark, but then subtracted this from 360, giving an incorrect final answer of 285(%). Others multiplied or divided the values of 6 and 69, achieving no marks.

STEMUP.CO.UK

Q9.

(a) 44% of students correctly selected ‘watch glass’. However, almost an equal number of students selected ‘condenser’, suggesting unfamiliarity with this required practical.

(b) 24% of students achieved all three marks, and 30% achieved two marks. Most students understood the basic concept of finding a mean, although there were a variety of errors. The most commonly seen error was to include the anomaly, 0.29 in the calculation. These students achieved a maximum of two marks for a correctly calculated answer from this.

Other students did not give the answer to two significant figures, either giving the wrong number of significant figures or rounding incorrectly. They also achieved a maximum of two marks if the rest of the calculation was correct.

There was evidence of incorrect addition and division, suggesting that some students did not have, or were not able to correctly use, a calculator.

(c) Evaporation as a change of state was well known, and frequently given, along with the description, turning form a liquid to a gas. 41% of students were achieved this mark.

Commonly seen incorrect responses were ‘condensation’, ‘boiling’ and ‘bubbling’. Some confusion between evaporation and condensation was evident. Answers such as ‘heating’ or ‘change in temperature’ indicated that the concept of change of state was not recognised by these students.

(d) 51% of students gained credit, mostly for stating that the water in the test-tube contains no salt. A smaller proportion stated that it is pure.

Many of the incorrect responses indicated a weak understanding of distillation, often referring to the water being filtered, or made clean, or the salt evaporating. Other students described part of the distillation process, but did not suggest in what way the water in the test-tube was different. Answers suggesting that there was less salt in the test-tube water were not credited as there would be no salt.

(e) 27% of students recognised that energy costs are the greatest contributor to the expense of distillation. Commonly seen incorrect responses often referred to the cost of equipment, of the workforce, of the scale of the process or of the time taken for the process. Some students are confusing distillation with filtration, suggesting that the cost of filtering is the main expense.

(f) 47% of students achieved one mark, and 165 achieved both marks. Students gaining credit often gave clear, precise responses with correct terminology. Responses which were less precise did not gain credit, for example filtering or sterilising makes the water clean, or sterilising is to remove bacteria.

Some students did not understand the concept of filtration, suggesting that it would remove salt or bacteria from the water. With sterilisation, bacteria are killed or destroyed, not removed. Less precise responses such as removal of germs or diseases were not credited.

Q10.

(a) A substantial number of students found selecting the independent and control variable challenging. Of these students, some gave multiple suggestions, and others gave the control variable as the independent variable and vice versa. The mass lost

STEMUP.CO.UK

from the flask, and the time taken were frequently selected. A number of students ignored the instruction to 'Draw **one** line from each type of variable' and drew several. 30% of students achieved one mark and 15% achieved two marks.

(b) 24% of students were able to name all the products of the reaction, although 40% named two. Among the incorrect responses, many students named elements in the products (e.g. hydrogen or calcium), and others were unable to distinguish reactants from products.

While some students appeared to readily recognise $H_2O_{(l)}$ as water, others referred to it as hydrogen oxide. Other students were unable to name calcium chloride, leaving it as 'calcium'. Many incorrect responses included cobalt.

(c) 6% of students answered this question correctly. Of these, only a very small proportion of students realised that the cotton wool prevents acid or water escaping from the flask. By far the most commonly seen response suggested that the cotton wool prevents the escape of gas from the flask. Other students suggested that it prevented heat loss, or stopped air or oxygen from getting in the flask.

(d) 72% of students successfully calculated the mean rate of the reaction. Of those who did not succeed, most had difficulties with powers of ten, giving answers such as 5.3 or 0.53. A smaller proportion of students inverted the calculation, giving the answer as 18.75 (= 30 ÷ 1.6). Some students attempted to multiply 1.6 × 30.

(e) 78% of students selected the correct response, g/s. The most popular incorrect responses were g and s.

(f) This question discriminated well with a nice spread across the mark range. 66% of students achieved at least one mark, with 11% achieving all three.

Lower-attaining students were challenged by the *y*-axis scale and attempted to plot a graph using a scale of one small square to 0.1 g rather than two small squares to 0.1 g.

The points requiring a reading of the *y*-axis scale for 0.8 g and 1.8 g proved more difficult than those at 0.6 g and 1.6 g. This resulted in difficulty drawing a sensible line of best fit. Some students omitted to plot the point at (0,0).

A number of students who succeeded in plotting the points correctly interpreted the term 'line of best fit' as requiring a straight line, whereas a curve was correct. The term 'line of best fit' applies to either a straight line or a curve. Most students realised that the point at 20 s was an anomaly, and excluded it from their line of best fit. Some students attempted a bar chart.

(g) Most of the responses were almost equally divided between the 2nd and 4th responses, indicating that students were aware that more frequent collisions were involved, but unsure whether thee eight small marble chips had a larger or smaller surface area than the large marble chip.

Q11.

Foundation

(a) 58% of students selected the correct response 'condenses'. The most commonly seen incorrect answer was 'dissolves'.

(b) 54% of students recognised that the fractions separate due to different boiling

STEMUP.CO.UK

points.

(c) 15% of students gained credit, recognising the alkane to be propane. This suggests that students are not familiar with the use of models to represent alkanes.

(d) The correct answer of C_nH_{2n+2} was the most commonly chosen, by 42% of students, although C_nH_{2n} proved an effective distractor.

(e) Balancing an equation such as this combustion of methane was very demanding for the vast majority of students. 13% of students achieved this mark.

Multiples were accepted. Some students who did not gain credit had a valiant attempt at balancing, evidenced by their calculations and working alongside the question. Others had little idea, either inserting a variety of numbers and / or formulae on the answer lines, or simply not attempting it.

(f) The correct answer of bromine water was the most commonly chosen, by 44% of students, although limewater proved an effective distractor.

(g) 8% of students knew the definition from the specification, or were able to give an equivalent statement. A large number of vague responses were seen such as ‘to see how we can do things better’.

(h) The least creditworthy responses discussed in general terms the effect on the environment of burning waste plastic and using landfill. Students writing these responses made little reference to the information in the table, and many of these students missed the key command word, ‘Compare’.

13% of students achieved marks in level 1 by giving some comparisons of the gases and residue either in qualitative terms or by quoting values from the table. To access level 2, students were expected to ‘note the magnitude’ of the differences, as stated in the generic level descriptor in the mark scheme. 30% of students were awarded a level 2 mark.

Some students had difficulty interpreting the information in the table, reversing the causal relationship, and attempted to suggest that the emissions caused the disposal method. A number of students were unable to express the comparisons clearly or accurately, for example suggesting that the processes used carbon dioxide or sulfur dioxide, or writing that landfill increases the sulfur dioxide by 10%. Some students’ calculations from the table were incorrect, for example the difference the mass of sulfur dioxide produced by the two methods was sometimes given as ‘10’, and the difference between the mass of solid residue given as ‘20’.

Students did demonstrate a good understanding of environmental responsibility.

Higher

(a) 83% of students achieved this mark. None of the other three possible answers proved to be dominant.

(b) 79% of students achieved this mark. ‘The fractions have different melting points’ proved to be dominant wrong answer.

(c) 49% of students gained credit, recognising the alkane to be propane. Most popular incorrect answer was butane. Some students gave a formula even though the question asked for the name of the alkane.

(d) The correct answer of C_nH_{2n+2} was the most commonly selected response by

STEMUP.CO.UK

students (77%) although C_nH_{2n} proved to be the most effective distractor.

(e) 56% of students successfully balanced equation for the combustion of methane. Multiples were regularly seen, and credit accordingly given.

(f) The correct answer of bromine water was chosen by 67% of students. Anhydrous copper sulfate proved to be the most effective distractor.

(g) 28% of students knew the definition from the specification or were able to give an equivalent statement. A large number of vague incorrect responses were seen encompassing issues such as pollution, sustainability, energy and carbon footprint.

(h) In this 'extended response' question students were asked to compare the two methods for the disposal of biodegradable plastic bags using information given in the table.

26% of students gained full marks on this question and a further 38% of students achieved marks at level 2. To access level 2, students were expected to 'note the magnitude' of the differences, as stated in the generic level descriptor in the mark scheme.

17% of students achieved marks in level 1 by giving some comparisons of the gases and residue either in qualitative terms or by quoting values from the table.

The least creditworthy responses discussed in general terms the effect on the environment of burning waste plastic or the benefits of burning plastic bags to generate electricity. Students writing these responses made little reference to the information in the table and many of these students ignored the key command word, 'Compare'. However, the higher-attaining students had logically worked their way down the information in the table, comparing and calculating differences when constructing their answer.

Q12.

(a) 9% of students managed to correctly complete and balance the equation. Many different errors were seen. Students found it difficult to write the correct formulae of the products, for example, calcium chloride (CaCl), carbon dioxide (CO_3) and hydrogen (H_2) instead of water, but H_2 was probably written to balance the extra oxygen attributed to carbon dioxide.

Some students wrote down random products including ones with none of the elements present in the reactants. A sizeable minority of students simply repeated the reactants on the products side. Those students who did get the formulae of the products correct were usually able to balance the equation.

(b) This question discriminated well with only 6% of students failing to achieve any marks for their answer. Most students quoted values (times and / or volumes) when describing the trend shown in the graph. Usually for the volume increase and the point at which the reaction stopped; as a result 53% of the students achieved two marks.

Many students failed to include in their answer that the rate slowed down. Three marks were awarded to 26% of students. Lower-attaining students simply described the shape of the graph without reference to any values.

(c) Many students described drawing a line up from the *x*-axis to the curve and then another line across to the *y*-axis to read off the value which was not creditworthy.

STEMUP.CO.UK

Several students mistakenly described how to calculate average rate of reaction.

24% of students correctly drew a tangent and explained how to work out the gradient. However, a few students incorrectly quoted y/x rather than $\Delta y/\Delta x$.

(d) 69% of students gave the correct answer of cm^3/s on this question. Nearly all other incorrect variations, for example cm/s, s/cm^3 and cm/sec were seen.

(e) 67% of students gained credit for a correct response. Although, many responses were confused; students stated that 'a larger chip would have a faster rate of reaction because its surface area is bigger'. Some responses referred to how size of the marble chip affected the amount of gas produced, rather than the rate of its production.

(f) 29% of students achieved credit on this question. Many responses incorrectly stated that '60 cm^3 was the maximum amount of gas that was in the chips' or 'it's the maximum volume the syringe can hold'. Some students thought that both reactants had 'been used up'. However, 'a limiting factor' was often seen as was 'same mass of $CaCO_3$ used'.

(g) 54% of students achieved both marks for this question. Most students successfully calculated the surface area of one side of the large cube and then multiplied the answer by six (sides). An answer of 48 was regularly seen (volume of large cube × number of sides).

(h) 13% of students achieved both marks for this question. Many students were unable to correctly link the surface area to the size of the marble chips. Students often answered in terms of 'more collisions' with no reference to the frequency of those collisions.

A sizable number of students seem to think it was the marble chips colliding. Or they answered in terms of number of chips available (smaller the chips − more available to react) rather than considering the size the chips relative to their surface area.

(i) In this question 82% of students achieved some credit for their response. 14% of students achieved all three marks. Both marking pathways were equally represented. However, very often students would start to answer in terms of one concentration then repeat information in the converse form for the other concentration but gaining no further marks.

Volume of gas evolved, or rate of reaction were the most common points addressed in student responses. Responses that stated 'fewer acid particles' or as highlighted in part **(h)**, their effect on the 'frequency of collisions', were seen less often.

Q13.

Foundation

(a) This question required students to label diagrams with given labels. A third of students gained all 4 marks.

(b) Three-quarters of students scored zero on this item and only a tiny number gained both marks. Of the students who gained 1 mark, this was usually for identifying that a proton has a positive charge. Many answers were ambiguous or did not answer the question asked.

(c) Students were required to calculate 7 per cent of the speed of light and many

STEMUP.CO.UK

students managed to do this from either multiplying by 0.07, by 7/100, or by finding 10%, 5% and 1% or similar and adding appropriately. Occasionally the latter method led to a wrong answer because adding large numbers with plenty of zeros it was possible to slip a zero somewhere and so only the method mark was gained.

The most common mistake was students multiplying 300,000,000 by 7. Problems arose when students either used an incorrect method, struggled with the arithmetic, or went on to calculate 93% instead. 40% of students scored both marks, 48% scored zero while 10% made no attempt.

(d) A fifth of students made no attempt at this question with a tiny minority scoring both marks. The range of values acceptable for full marks ensured that most students who knew what to do gained the 2 marks. A few students obtained an incorrect ratio − these could gain 1 mark if they then calculated correctly with their ratio value. Some students assumed that they needed to measure radii, these students were more likely to get an incorrect ratio with smaller measurements and the centre not clearly defined. Some appeared to choose a number to multiply by with no evidence of a ratio attempt, or even substituted the 2.5 from the hydrogen radius with a measurement of 7.5 or similar from the magnesium diagram.

Powers of 10 were confusing for some students − some changed the 10^{-11} by multiplying, adding or subtracting this power.

Higher

(a) This question required students to label diagrams with given labels and the majority gained all 4 marks.

(b) 59% of students scored zero on this item. Of the students who gained 1 mark, this was usually for identifying that a proton has a positive charge. Many answers were ambiguous.

(c) Students were required to calculate 7 per cent of the speed of light and many students managed to do this from either multiplying by 0.07, by 7/100, or by finding 10%, 5% and 1% or similar and adding appropriately. Occasionally the latter method led to a wrong answer because adding large numbers with plenty of zeros it was possible to slip a zero somewhere and so only the method mark was gained.

The most common mistake arose when students simply multiplied 300,000,000 by 7. Problems arose when students either used a totally incorrect method, struggled with the arithmetic, or then went on to calculate 93% instead. A fifth of students scored zero marks.

(d) Nearly 40% of students scored a mark on this question with 27% scoring two marks.

The range of values acceptable for full marks ensured that most students who knew what to do gained the two marks.

A few students obtained an incorrect ratio these could gain one mark if they then calculated correctly with their ratio value. Some students assumed that they needed to measure radii, these students were more likely to get an incorrect ratio with smaller measurements and the centre not clearly defined. Some chose a number to multiply by with no evidence of a ratio attempt, or substituted the 2.5 from the hydrogen radius with a measurement of 7.5 or similar from the magnesium diagram.

Powers of 10 were confusing for weaker students − some changed the 10^{-11} by multiplying, adding or subtracting this power

STEMUP.CO.UK

Q14.

(a) This recall question discriminated well and an even distribution of marks from zero to three was seen. 73% of students achieved at least one mark.

(b) 66% of students gave the number of protons, neutrons and electrons from the diagram.

(c) Students found this question difficult, with 57% achieving full or partial credit.

Q15.

(a) This symbol does not come from the periodic table so the commonly seen answers of atomic mass or relative atomic mass were not correct. 13% of students achieved mark for 'the number of protons and neutrons' but a greater number knew it was the mass number.

(b) 75% of students achieved a mark in this question for giving the number of protons.

(c) 41% of students achieved the mark for giving the number of neutrons.

(d) 68% of students correctly assigned the 10 electrons in the two shells.

(e) Most students confused the overall charge on an atom (neutral) with the question here which was asking for the charge on the nucleus (positive). Consequently, 32% of students gained credit.

(f) A large number of students saw that the number of each particle was 10 and re-wrote that in their own words. Some wrote 'they are all balanced'. 9% of students achieved the first mark while 3% gained the second mark.

(g) 31% of students correctly selected isotope.

(h) Students are clearly familiar with the model representations of particles in solids, liquids and gases with 93% achieving both marks.

Q16.

(a) 84% of students did not gain any marks in this high demand question. 3% of students achieved three or four marks. The most common mark given was for electrons / atoms gaining energy.

(b) This question discriminated between students very well with almost equal proportions of students spread across the mark range. Students would appear to have a sound understanding of atomic structure, with 85% achieving at least one mark, and 20% achieving full marks.

Common misconceptions were that 'electrons must be drawn in pairs' and 'neutrons should equal protons'. Some stated that the number of protons, electrons and neutrons was wrong without stating details.

(c) 69% of all students answered this question correctly. The fourth option was the most common incorrect choice.

(d) A significant number of students gave answers in term of nitrogen changing into carbon. Few answers offered the complete story of a neutron splitting to produce a proton and an electron.

STEMUP.CO.UK

There was considerable confusion about the meaning of the subscripted and superscripted numbers preceding the atomic symbols. The subscripted number was taken to be the number of electrons. As a result many answers were in terms of atomic number increasing because an electron had been gained. 16% of students achieved one or two marks for this question.

(e) 13% of students understood the idea of half-life sufficiently to achieve both marks. Otherwise students attempted to calculate 12.5% of 5730. The most common reasonable error was to use the calculation for 4 half-lives.

Q17.

(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.

Q18.

(a) Nearly all students were able to identify the thermometer as the equipment needed to measure temperature but a number answered in terms of a beaker rather than a measuring cylinder as being the most suitable piece of equipment to measure volume. 71% of students achieved both marks.

(b) 41% of students successfully identified the anomalous result and went on to calculate the correct value for the mean.

A significant number of students added all four values together and divided by four, the answer obtained by this method, 6.6, was credited with one mark for being able to calculate a mean. A significant minority of students gave the mode value rather than the mean.

(c) 44% of students answered correctly, with most popular distractor to use a thermometer with a resolution of 1 °C.

(d) 6% of students were able to name both products in this neutralisation reaction, with a significant number of students answering salt or sodium oxide instead of sodium

STEMUP.CO.UK

chloride and hydrogen instead of water. There was often no link to the reactants and it was difficult to see where students had obtained their answer from.

(e) 36% of students were able to identify the colour of universal indicator at both the pHs given. Others were not able to link the colours of universal indicator at different pHs to the relative strength of acids and alkalis.

Q19.

Foundation

(a) 28% of students did not attempt this question. Of those that did the majority of students were able to draw a bonding electron pair. However, many were not able to work out or recall that chlorine had seven electrons in its outer shell and included 17 electrons on the outer shell. Others tried to draw the inner shells and then overlapped these with the hydrogen electron shell. 23% of students achieved full credit.

(b) This question was not answered well with 6% of students achieving one or two marks.

Most students were not able to recall that chlorine gas is a molecule with the formula Cl_2 but some were however able to access mark point two which required the correct balancing of an equation with HCl given. Others, despite Figure 1 showing a hydrogen chloride molecule, gave formulas such as H_2Cl_2 or H_2Cl

Some students gave a word equation despite the instruction in the question to complete a balanced chemical equation.

(c) 5% of students achieving one or two marks. A variety of responses were seen including amplitude and wavelength descriptions. Very few students appeared to know the term ‘activation energy’ and even less that B was the overall energy change.

(d) Responses needed to be specifically linked to the reaction profile diagram rather than stating what an exothermic reaction is. 3% of students managed to obtain this mark with many describing the pattern, for example, it goes up then down or talking about an energy decrease but without a link. 27% of students did not attempt this question.

(e) 30% of students did not attempt this question. Those that did attempt the question displayed a lack of understanding of the structure of a small molecule. Many students stated that gases do not conduct electricity but liquids do.

6% of students achieved one mark which was usually for stating that hydrochloric acid contains ions. A few students could also state that hydrogen chloride does not contain ions. Hardly any students referred to how these ions would enable an electric current to flow.

Higher

(a) 59% of students were able to work out or knew that chlorine had seven electrons in its outer shell and consequently complete the diagram correctly. Others who gave an incorrect number of electrons were usually able to draw a bonding electron pair.

(b) Many students were not able to recall that chlorine gas is a molecule with the formula Cl_2 but some were able to access mark point two which required the correct

STEMUP.CO.UK

balancing of an equation with HCl given. Others, despite figure 1 showing a hydrogen chloride molecule, gave formulas such as H_2Cl_2 or H_2Cl.

(c) This question was not well answered with a variety of responses seen from products and reactants to wavelength descriptions. Activation energy was the most common correct response. Few knew B was the overall energy change, with students often giving insufficient responses about energy released or lost, with no reference to change, for this marking point. 35% of students were able to achieve full or partial credit.

(d) Responses needed to be specifically linked to the reaction profile diagram rather than stating what an exothermic reaction is. There were some responses showing that reactants were higher than products on the diagram but few related this to energy. 20% of students achieved the mark.

(e) Generally there was a lack of understanding of the structure of a small molecule. 8% of students achieved two or three marks.

The first marking point was the lowest achieved of the three, with answers in terms of full outer shells and also suggesting that the non-conductance was due to the gaseous state and the larger spacing of the molecules. Those who did obtain this mark usually gave hydrogen chloride not containing ions rather than the lack of an overall charge.

A significant number of students gave answers for marking point two and three in terms of (delocalised) electrons rather than ions even though ions were mentioned in the stem of the question. For the third marking point, students often said that ions were free to move but failed to say how this facilitated conduction.

Q20.

(a) 65% of students achieved marks on this question by being able to identify the glow (spreading through the mixture) as the observation that would be made. Many also had the idea that energy was transferred to the surroundings, but some linked this point to allowing the mixture to cool in step five meant that heat was given out.

(b) 20% of students were able to calculate the mass of copper produced in this question that differentiated between students well. For those not achieving full marks, finding the relative formula mass for copper oxide was also achieved by 23% of students, though few of these students were able to continue to correctly calculate the number of moles present. Many gave this as 79.5 ÷ 1.59 or having calculated the relative formula mass of copper oxide then used 1.59 ÷ 63.5.

Few students gave a full explanation of what they were doing instead just using numbers in various formats. The front of the paper does state that working should be shown in calculations and this may well help to gain more marks for students. Most students who were able to calculate the number of moles correctly were then able to continue to use this value to calculate the mass of copper. Few students used the alternative approach allowed in the mark scheme.

(c) This proved a difficult question for students to score highly on, with 3% achieving three or four marks. A significant number of students' answers focused on zinc being more reactive and displacing copper, rather than the products of this reaction which was the mixture obtained in step five. In other cases, there was confusion about what had reacted; zinc reacting with hydrochloric acid for example.

Some students used the term 'dissolve', rather than react. Very few realised that

STEMUP.CO.UK

copper remained as a solid as it did not react with hydrochloric acid and others just repeated the last part of the question.

(d) Students found this question difficult with two of the other distractors proving to be more popular responses. 28% of students achieved the mark.

Q21.

(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

STEMUP.CO.UK

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 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.

Q22.

(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.

Q196.

(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.

STEMUP.CO.UK

Q197.

(a) (i) Most students who gained a mark said that the oil is heated. Clear descriptions of the oil evaporating, and the vapour or fraction condensing, were rarely seen. Many just gave information from the table about the boiling point of the fractions without any description of the separation process.

(ii) Almost a third of the students did not attempt the question, and many others only gave a response for the boiling point. It was clear that many did not understand the term 'viscosity' and would say things like 'the viscosity increases making them runnier'. Some gave definitions of boiling point and viscosity, indicating that they had not read the stem of the question properly. Descriptions of how long it would take to boil the hydrocarbons were ignored. A lot of students presented their answers in very complicated ways. Although the question was phrased in relation to an increasing number of carbon atoms, many answered in terms of shorter carbon chains, or described one property in terms of increasing chain length and the other in terms of decreasing chain length. Full marks could obviously be obtained, but students seemed to be making things more complicated than they needed to be. Quite a lot compared the boiling point to viscosity, without mention of the number of carbon atoms in the molecule, so had not answered the question.

(b) (i) A quarter of the students did not attempt the question, but over half of those who did were able to correctly draw the displayed structure. A common error was to position the H atoms correctly, but then forget to draw in the bonds. Some students drew in most, but not all, of the bonds. A few added a double bond somewhere in the structure. Only a few represented the hydrogen atoms with h rather than H.

(ii) The most common correct answer was carbon dioxide. Some students gave sulfur dioxide, which was not credited. Students would have benefitted from looking at the displayed formula for propane and basing their response on the elements shown in the molecule. Quite a lot gave carbon and hydrogen as their answers, for which they gained 1 mark; however, it is possible that they just named these two as elements from the molecule. Other common errors were to gives the names of fuels, or types of energy. Two products were asked for. Where two correct products were named, plus an incorrect one, only 1 mark was given. It is a good idea for students to stick to the instruction and name the two products which they have most confidence in.

(iii) Few students were able to suggest a reason why LPG is used less than petrol. Responses that were not creditworthy included references to pollution, fuel consumption, and engine performance.

Q198.

(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.

(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

STEMUP.CO.UK

different elements. Less than a fifth of the students gave the correct answer. Most listed all three sub-atomic particles.

Q199.

(a) This question was very poorly answered with hardly any students being able to give the correct word equation for the fermentation of sugar, which is detailed in the specification. Many equations were badly written, and students did not appear to know the basic rules. For example, an equals sign was used instead of an arrow; a sequence of reactions was presented with arrows between each stage; reactant(s) and products were not on the correct sides of the equation. Many students added yeast and water to the reaction. If these were written on both sides of the equation they were ignored, as they would cancel each other out. However, they were usually just added as reactants. The most common error, for those students who made a reasonable attempt at the word equation, was to omit carbon dioxide as a product. They just gave ethanol. Others gave a correct equation for the hydration of ethene. Students should be taught the difference between a word equation and a symbol equation, and be discouraged from combining the two.

(b) (i) Filtration would be used to separate the yeast from ethanol and water. Some said ‘distillation’ or ‘evaporation’ which were both ignored. Many students displayed a lack of knowledge of technical terms. The equipment to be used was often named as a sieve and words such as ‘colander’ were also seen. Others suggested using a funnel but made no reference to filtering. Others gave descriptions of decanting but did not name the process.

(ii) The question asked how ethanol could be separated from the mixture of ethanol and water. There were many references to evaporating the ethanol, but to gain the mark students had to also say how the ethanol would be collected. Many thought that boiling the mixture would evaporate the water first and leave the ethanol behind.

Q200.

(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.

Q201.

STEMUP.CO.UK

(a) Less than a third of the students could define what an element is. Reference to atoms was needed in the definition. Some students had obviously learnt about the periodic table and said an element is a metal or a non-metal, or simply that an element is a substance listed in the periodic table. There were some poorly expressed responses that did not gain the mark, for example, “An element is made up of one atom”, or “It is a pure substance”. A few gave confused answers relating to molecules, compounds, mixtures or alloys.

(b) Over half of the students gained the mark, usually for saying that platinum isn’t made from gold or from gold and silver, or that there is no gold in platinum. Students who just said “Platinum is an element” did not gain credit as this was given in the question. They needed to add some value by saying that platinum is not a mixture, compound or an alloy.

(c) Most students recognised that the formula Ag_2O represents a compound made of silver and oxygen, and many gave its name as silver oxide. All of these points could gain 1 mark. Some incorrectly thought the symbol Ag represents gold, but they could still gain 1 mark for the correct ratio of the elements. To gain both marks they had to give the correct numbers and names, as well as referring to ions or atoms. Just saying “There are two silver and one oxygen” only gained 1 mark. Several students thought Ag_2O represented a mixture, or that it was covalently bonded, which restricted their mark to 1.

Q202.

(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.

Q203.

(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

STEMUP.CO.UK

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.

Q204.

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

Q205.

(a) (i) Only a quarter of the students identified that there were four atoms in the formula $AlCl_3$. Many gave an answer of two.

(ii) Approximately half of the students recognised that there were two different types of atom in the formula.

(iii) Only half of the students realised that aluminium chloride is a compound. Many thought it is a mixture.

(b) Almost a third of the students gained no marks for this question. Many said a proton has a charge of 1 which was insufficient, as reference to the charge was required, ideally written as +1. The names of the remaining two particles were either not known or they were written in the wrong order in the table.

Q206.

(a) Many students did not realise Cl represents chlorine and stated chloride instead. There was also misunderstanding of what the numbers represent – 2 aluminium atoms were usually correctly identified, but then either 3 or 5 chlorine atoms were given.

(b) (i) Almost a quarter of the students did not attempt this question. Just over half of the students gained at least 1 mark for naming the three sub-atomic particles, and many gained 2 marks for being able to describe the charges on them. However, few students understood the term relative electrical charge and did not write +1 and -1. The charge and the number 1 were both required to describe the relative charges on protons and electrons.

(ii) Many students did not attempt this question. Of those who did some gained the mark for saying that there was the same number or amount of protons as electrons. Others who simply said that the protons and electrons balanced

STEMUP.CO.UK

each other out did not gain the mark. A reference to number or amount was required.

Q207.

(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.

Q208.

(a) (i) The majority of students gave the correct response selecting ‘unreactive’. A few students selected ‘coloured’.

(ii) More than a third of students thought that gold is an element because all of its molecules are the same. Few selected that gold is an element because its symbols are the same.

(b) Many responses gave the numbers for protons and neutrons the wrong way round or the number of neutrons being the same as the mass number.

(c) (i) The most common response was a mixture of two metals. Some students went on to say that an alloy was stronger than a pure metal. Marks were lost when students said the metals formed a compound. Some responses simply gave examples of alloys, for example, steel or bronze, which was not enough for the mark.

(ii) Only a fifth of students answered this question correctly. Many students said bronze was cheaper than copper, even though the question stated that they cost the same. Other incorrect responses stated that bronze was less reactive, lighter, or easier to get than copper. Many thought that copper rusts.

Q209.

(a) Many students drew the correct electronic structure of 2,8,7. Some errors were made with counting, especially when the electrons were positioned separately. Fewer errors were made when students drew the electrons in pairs.

(b) Just over a tenth of students were able to score at least one mark for this question. Just over a fifth of students did not make an attempt. Some students seemed to be describing the reaction of lithium with water, mentioning a coloured flame, fizzing or an explosion. Many responses gave vague statements about lithium joining or bonding with chlorine without explaining what happened to the lithium

STEMUP.CO.UK

atom, which was what the question asked. There was much confusion with covalent bonding and sharing electrons, which limited the answer to a maximum of two marks. The transfer of atoms, rather than electrons, was often mentioned. A lot of students picked up one mark for mentioning that a full outer shell was achieved.

Q210.

(a) Many students did not understand the question and described what gold looks like or its properties, particularly its position in the reactivity series, rather than its structure. Most students said that gold had 79 protons, but often mixed up the numbers of electrons and neutrons. Some thought the total number of particles added up to 197. A few students gained the last marking point for a description of the positions of the three particles in the atom. A few tried to work out the electron arrangement and ran into problems, but this did not affect their marks.

(b) (i) Responses stating that copper rich ores are in limited supply were rarely seen and most statements about environmental impact or economic reasons were generally too vague. Environmental impact had to relate to scars on the landscape due to traditional mining. Most responses about cost were not qualified, 'it's cheaper' was not enough to gain the mark. Many students mentioned that it was cheaper or more environmentally friendly than electrolysis, not realising that the final stage in phytomining to extract the copper is by electrolysis. Just over a tenth of students answered this question correctly.

(ii) This question was not answered well and over a third of students did not attempt to answer it. Phytomining is a new topic to the specification and perhaps is not familiar enough to students. Students rarely gave the three stages of phytomining. When an attempt to answer the question was made, many students gained one mark for saying it involved the use of plants. If they went on to talk about plants absorbing something, they usually incorrectly stated copper rather than copper ions, compounds or minerals. Some students mentioned that the plants were burned, but did not explain that copper was extracted from the ashes. Although this was a high demand question, students at standard demand should be able to explain the stages of phytomining.

Q211.

(a) A well answered question with almost all students gaining at least two marks. However, a surprising number of students think that carbon is a gas. Some did not relate their answers to the formula shown, saying argon and helium were present. Only the most able students responded in terms of ammonia and methane.

(b) The question asked students to describe the differences between the Earth's early atmosphere and the atmosphere today. However, many students did not give comparative statements about the gases but tried to explain why the levels of gases changed, which they were not asked to do. Students could gain marks for saying carbon dioxide was the main gas in the early atmosphere and nitrogen is the main gas today, but comparative statements would have been much better. Some students talked about carbon rather than carbon dioxide. Most students were able to gain at least one mark.

STEMUP.CO.UK

(c) The most common process given was distillation, although combustion and cracking were often named. Students who knew that the process was fractional distillation usually understood that the separation was due to the different boiling points, although some did answer in terms of condensing points. A fifth of students scored full marks for this question.

STEMUP.CO.UK