AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.2.2 HOW BONDING AND STRUCTURE ARE RELATED TO THE PROPERTIES OF SUBSTANCES (PACK 5)

SCORE	PERCENTAGE
/353	%

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Q1.

(a) ionic

1

(b) a molecule

1

(c) a fullerene

1

(d) covalent

1

(e) 1

1

(f) solid

1

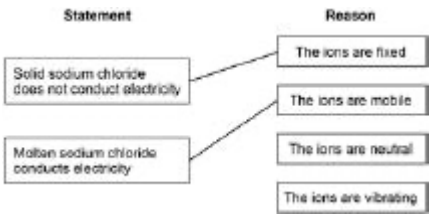
(g) electron

1

(h) dissolved

1

(i)



*do **not** accept if more than 1 line from 1 box*

1

1

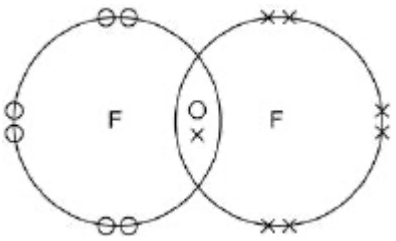
[10]

Q2.

(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*

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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

(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]

Q3.

(a) covalent bonds

1

giant structure / macromolecule

allow each C has 4 bonds

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*allow giant covalent structure for **2** marks*
*allow giant ionic / lattice structure for **1** mark*
ignore lattice

1

lots of energy needed to break / overcome

allow disrupt structure

ignore heat and high temperature

*if no other marks awarded allow **1** mark for strong / many bonds*

1

(b) dissolved (in water) **or** aqueous

allow in solution

1

molten / liquid

1

so ions are mobile **or** free moving

1

***max 2** for incorrect reference to particles or bonds*

(c) delocalised electrons (from outer shell)

1

(free to) move

1

energy transferred (through structure)

ignore conducts thermal energy
ignore electricity

*if no other mark awarded allow **1** mark for ions / atoms vibrate*

1

[9]

Q4.

(a) watch glass

1

(b) identify 0.29 as anomaly

1

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

or

$$\frac{0.41}{3}$$

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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]

Q5.

(a) a mixture designed as a useful product

1

(b) mass = 14 520 g

1

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$(=)\frac{14\,520}{80\ (\text{mol})}$

allow correct substitution of incorrectly converted mass
must use M_r given (80) to gain marks in steps 2 and 3

1

(=) 181.5 (mol)

1

(=) 1.8×10^2 (mol)

allow answer correctly given in standard form to correct sig figs from an incorrect calculation

1

*an answer of 1.8×10^2 (mol) gains **4** marks*

(c) (giant) lattice

allow giant structure

1

ionic

1

strong bonds **or** strong electrostatic forces

*do **not** accept strong intermolecular forces / bonds*

1

large amounts of energy needed to overcome

ignore heat

1

***max 2 marks** for incorrect reference to bonding **or** structure **or** particles*

[9]

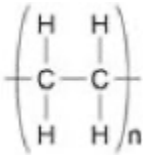
Q6.

(a) five single bonds inside the brackets (1 C−C bond and 4 C−H bonds)

1

two single bonds extending from the carbons

*allow **2** marks for an answer of:*



1

(b) HD (poly(ethene) polymer chains) have no side chains

allow LD (poly(ethene) polymer chains) have side chains
ignore cross links

1

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chains are closer together in HD (poly(ethene) than LD poly(ethene))

1

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

3–4

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

1–2

No relevant content

0

Indicative content

- suspend a poly(ethene) strip / bag
- (use a ruler) to measure length or to locate starting position
- add (known) mass / weight to the strip / bag or pull with a newtonmeter
- determine extension
- repeat using different forces (by adding further masses / weights **or** pulling harder)
- control variables: size / thickness of strip
- repeat and calculate a mean

(d) any **two** from:

- both have increasing extension with increasing force
- both extend non-linearly
- HD poly(ethene) has a smaller extension (than LD poly(ethene)) for a given force

  allow LD poly(ethene) stretches more for a given force
  allow correct readings of extension for a given force for both polymers

- HD poly(ethene) has a smaller maximum extension (than LD poly(ethene))

  allow HD poly(ethene) breaks at a greater (maximum) force
  ignore references to strong / weak

2

(e) $\frac{85}{100} \times 8.0$ (billion)

or

6.8 (billion)

allow $\frac{15}{100} \times 8.0$ *(billion)*

1

(8 billion − 6.8 billion =)
1.2 billion
or
1200 000 000

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or
1.2×10^9

*allow **1** mark for an answer consistent with an incorrect conversion of billion*

*an answer of 1.2 billion scores **2** marks*

*an answer of 1.2 scores **1** mark*

1

(f) **Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

5–6

Level 2: Some logically linked reasons are given. There may also be a simple judgement.

3–4

Level 1: Relevant points are made. They are not logically linked.

1–2

No relevant content

0

Indicative content

similarities
- both made from crude oil
- crude oil is a finite resource
- production and transport of both cause emissions of carbon dioxide
- carbon dioxide contributes to global warming
- both can be disposed of in the same ways

disadvantages of disposable bags
- each disposable bag generates more waste (than one bag for life)
- each disposable bag generates approximately 2.5 times more waste **or** 0.25 g more waste (than one bag for life)
- if 6 disposable bags used they generate approximately 15 times more waste **or** 2.35 g more waste (than one bag for life)
- if 6 disposable bags used it causes more CO_2 to be emitted (than one bag for life)
- if 6 disposable bags used 2.7 g more CO_2 emitted **or** approximately 1.4 times more (than one bag for life)

advantages of disposable bags
- a disposable bag causes less CO_2 to be emitted (than one bag for life)
- a disposable bag emits 5.3 g less CO_2 (than one bag for life)
- if disposable bags used more than once less CO_2 emitted (than one bag for life)
- if bag for life is used fewer than 5 times, it results in more CO_2 being emitted (than one disposable bag)
- disposable bags extend less as made from HD poly(ethene)

[18]

Q7.

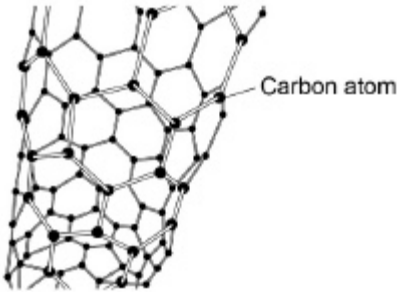
(a) carbon

1

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(b) conduct electricity

1

(c) 

1

(d) carbon

hydrogen

either order

2

(e) a polymer

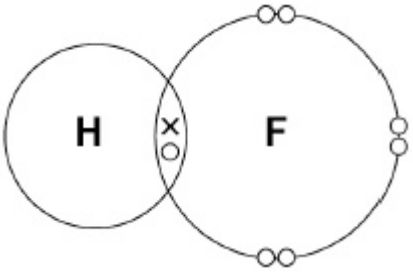
1

(f) slide

1

[7]

Q8.

(a) 

1 *mark for one shared pair of electrons*
1 *mark for six unbonded electrons on F*

2

(b) liquid (l)

1

(c) freezing

1

(d) K loses

1

one electron

1

(to) form a positive ion

1

F gains one electron

1

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(to) form a negative ion

1

(e) lattice / giant structure

allow many ions

1

strong attraction

1

between K^+ and F^- ions / oppositely charged ions

1

(so) a lot of energy is needed to overcome / break

allow strong bonds

1

[13]

Q9.

(a) intermolecular

1

(b) sulfur

1

(c) ions

1

fixed in solid

1

mobile in liquid

1

(d) layers of atoms

allow ions

1

slide over each other

1

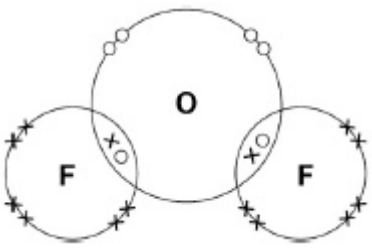
(e) copper

1

[8]

Q10.

(a)



two shared pair of electrons

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all outer shells complete

1
1

(b) gas

1

small molecules

1

(with) intermolecular forces

1

(so require) little energy to overcome

1

(c) calculates sum of all bonds broken:

4× (C–H) + 2× (O=O) = (4×412) + (2×496) = 2640

1

calculates sum of all bonds made:

4× (O–H) + 2(C=O) = (4×463) + (2×803) = 3458

1

overall energy change =

bonds broken – bonds made =

2640 – 3458 = (–)**818**

1

[9]

Q11.

(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

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melted

must be in this order

1

1

[10]

Q12.

(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 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

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carry charge through the metal

1

(f) turns from white

1

to blue

1

[13]

Q13.

(a) **A**

1

(b) covalent

1

(c) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

allow correct multiples

1

(d) reversible (reaction)

1

(e) nitric acid

1

(f) all points correct

tolerance of ± ½ small square

*allow **1** mark if 4 or 5 of the points are correct*

2

line of best fit

1

(g) 20 °C

1

(h) cold pack to treat injuries

1

(i) **D**

1

[11]

Q14.

(a) 2100 W

1

(b) power = potential difference × current

1

(c) 50 (Hz)

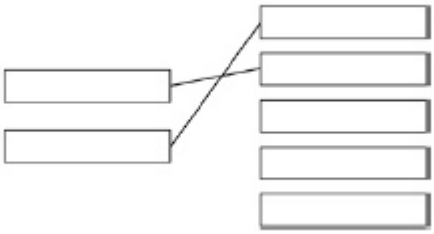
1

(d) direct current (dc) only

1

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(e)



1
1

(f) green **and** yellow

both colours required

1

(g) any **two** from:

- good conductor
- hard
- corrosion resistant

2

(h)

Level 2: Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.	3-4
Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.	1-2
No relevant content	0
Indicative content allow voltage / volts / pd for potential difference • cables transmit electricity at very high potential differences • transformers change the potential difference • step up transformer increases potential difference • overhead cables transfer electricity at a higher potential difference • step down transformer decreases potential difference • the potential difference to the consumers is much lower than the potential difference from the power station • the potential difference to the consumers is much lower than the potential difference in the cables	

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4

[13]

Q15.

(a) has 2 electrons in the outer shell

allow energy level for shell

1

(b) 3 : 2 : 6 : 18

1

(c)

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

1

= 5.0 (%)

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

1

(d) correct formulae

1

correct balancing of correct formulae

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

1

(e) potassium is more reactive

1

so will displace beryllium

1

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

1

(result)
conducts electricity

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

1

[10]

Q16.

(a) 3 bonding pairs of electrons

1

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lone pair of electrons on the nitrogen atom

1

(b) small molecules

allow simple / small molecular structure

1

with weak intermolecular forces

allow weak forces between molecules

1

(which) require little energy to overcome

must be linked to second marking point

1

(c) M_r NH_3 = 17

allow 2 × M_r NH_3 = 34

1

moles NH_3 (= mass / M_r = 72/17) = 4.235

allow ecf from step 1

1

(ratio = 2 moles NH_3 : 1 mole N_2)

1

4.235 moles NH_3 : 2.1175 moles N_2

allow ecf from step 2

mass N_2 = 2.1175 × 28

allow ecf from step 3

1

= 59.3 (g)

allow ecf from step 4

1

*an answer of 59.3 (g) scores **5** marks*

(d) 14 (%)

1

(e) any **six** from:

(yield)

- the best yield is obtained at high pressure and low temperature
- forward reaction is exothermic
- (so) formation of ammonia is favoured at low temperature
- formation of ammonia is favoured at high pressure
- because four reactant molecules but only two product molecules

or

- because greater volume of reactant than product molecules
- pressure used is limited by cost / materials

(rate)

- rate of reaction slow at low temperatures
- (so) higher temperature used to obtain faster rate

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- (so) process is a compromise between a good yield and reasonable rate
- catalyst used to speed up reaction

*max **4** marks if only reference made is to yield*

6

[17]

Q17.

(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]

Q18.

(a) 4 electrons shared

1

each atom has 4 unshared electrons outside the bond

1

(b) carbon dioxide

1

water

1

(c) giant structure of atoms

1

delocalised electrons

1

(delocalised electrons) are free to move

1

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through the whole structure

1

[8]

Q19.

(a) LiOH (aq)

this order

1

H_2 (g)

1

(b) **C**

1

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

1

(d) point x at −10 °C

1

point ● at +150 °C

1

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

1

because the boiling point of water is only 100 °C

1

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

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

1

[9]

Q20.

(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]

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Q21.

(a) 408 kg

1

(b) all points correct

± ½ *small square*

2

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

best fit line

1

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

1

5525 dm^3

1

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

1

25.26 %

1

Answer given to 3 significant figures = 25.3 %

1

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

(e) argon is unreactive

1

water (vapour) would react with sodium

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

1

and air contains oxygen that would react with reactants

allow and air contains oxygen that would react with products

1

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

1

and so electrons are free to move

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

1

through the whole structure

1

[15]

Q22.

(a) Flask

1

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(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]

Q23.

(a) small molecules

1

with weak intermolecular forces

1

(so) only a small amount of energy is needed to separate the molecules

any reference to bonds being weak or being broken negates the second and third mark unless they are stated to be intermolecular bonds or bonds between molecules

1

(b) decreases

1

because the equilibrium shifts in the endothermic direction

allow reverse reaction favoured if forward reaction is exothermic

1

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(c) increases

1

because there are more molecules of gas on the left-hand side

or converse

1

[7]

Q24.

(a) Carbon and hydrogen only

1

(b) Methane has the lowest boiling point and decane has the highest melting point

1

Octane is liquid over a larger temperature range than methane

1

(c) heat / steam

1

catalyst

1

(d) **Level 3 (5–6 marks):**
A detailed and coherent evaluation is provided that considers a range of relevant points, quotes relevant data from the table and comes to a conclusion consistent with the reasoning.

Level 2 (3–4 marks):
An attempt to describe relevant points which comes to a conclusion. The logic and use
of data may be inconsistent at times but builds towards a coherent argument.

Level 1 (1–2 marks):
Discrete, relevant points made. The logic may be unclear and the conclusion, if present, may not be consistent with the reasoning.

0 marks:
No relevant content.

Indicative content

- conclusion as to which bag is more environmentally friendly

Points that may be used in argument

- Paper bags are made from a renewable resource (wood)
- Paper bags more sustainable
- Paper bags are biodegradable
- Plastic bags are made from a finite resource (oil or gas)
- Plastic bags not sustainable
- Paper bags require more energy to manufacture (1.7 MJ compared with
  1.5 MJ)
- Paper bags produce more waste (50 g compared with 14 g)
- Paper bags create less CO_2 than plastic bags
- So manufacture of plastic bags has more effect on global warming / climate change / environmental effects

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- Plastic bags can be recycled
- Recycling reduces use of energy sources in manufacture
- justified

6

[11]

Q25.

(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

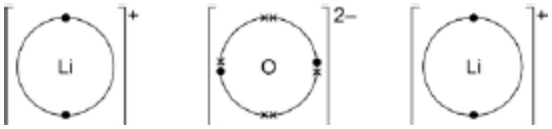
which reduces the attraction to the nucleus

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]

Q98.

(a) (i) *(advantages of titanium)*

ignore references to figures

less dense

allow lighter

1

stronger

ignore references to corrosion

1

(disadvantage of titanium)

more expensive

1

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(ii) high resistance to corrosion

1

(b)

Metal	Method of extraction
Gold	Mined as the pure metal from the ground
Iron	Reduction of metal oxide with carbon
	Electrolysis of molten compound

extra line from any metal negates mark

1
1

(c) silver

ignore chemical symbols

1

(d) (i) mixture

1

(ii) 12 (%)

1

(iii) plants

1

[10]

Q99.

(a) 40 (%)

1

(b) (i) C_2H_4

1

(ii) Many ethene molecules join together.

extra ticks negate mark

1

The monomer is ethene.

1

[4]

Q100.

(a) 40 (%)

*allow **1** mark for evidence of* $\frac{18}{45} (\times 100)$

or

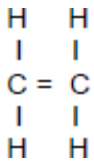
$\frac{\text{incorrect calculation}}{45} \times 100$

***and** percentage correctly calculated*

2

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(b) (i)



1

(ii) many monomers / small molecules

1

join together

1

to form very large molecules
or
polymers

1

[6]

Q101.

(a) (i) atom

1

(ii) protons

1

(b) metals

accept metal with carbon
allow iron with carbon
allow metal with (an)other element(s)
ignore a mixture of gold and silver

1

(c) any **three** from:

- silver
- oxygen
  *do **not** accept oxide*
- (silver) two atoms
  accept two ions / Ag^+
- (oxygen) one atom
  accept one (oxide) ion / O^{2-}

3

[6]

Q102.

(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

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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 <u>two</u> silver ions **and** <u>one</u> 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]

Q103.

(a) balls are far apart from each other

1

balls move randomly

1

(b) solid

1

gas

1

[4]

Q104.

(a) transition (elements / metals)

accept d block (elements / metals)

1

(b) any **three** from:

ignore references to cost

- (good) conductor (of heat)

  ignore references to electricity

- can be bent / shaped

  accept malleable

  ignore moulded

- does not react with water

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allow does not rust
allow not very reactive

- strong
  allow durable
  ignore tough
- hard enough to make pipes or tanks
- high melting point
  allow ductile

3

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

0 marks
No relevant information

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

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

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

examples of the points made in the response
ignore references to cost unless qualified.
ignore jobs / transport

Advantages of smelting:

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

Disadvantages of smelting:

- supply of copper rich ores is limited
- (mining causes) dust / noise pollution
  ignore pollution unqualified
- destruction of landscape or visual pollution

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- destruction of habitats
- smelting uses non-renewable fuel
- smelting uses more energy / electricity
- large amounts of waste rock
- (mining / smelting) releases (more) carbon dioxide / causes global warming
  allow (more) greenhouse gases
- (smelting) releases sulfur dioxide / causes acid rain

Advantages of phytomining:

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

Disadvantages of phytomining:

- produces smaller amount of copper (per unit mass)
- takes up a lot of space
- takes a long time (to grow plants)
- produces carbon dioxide when plants burnt
- land cannot be used to grow food crops

Electrolysis

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

Conclusion supported by comparisons made

6

[10]

Q105.

(a) any **two** from:

(Earth has)
ignore figures unless qualified
allow converse responses

- smaller percentage carbon dioxide
  allow less
- larger percentage nitrogen

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allow more

- larger percentage oxygen
  allow more

2

(b) (Mars) temperature below freezing point of water
allow too cold (for liquid water to form)
allow water will freeze or ice will form

1

(Venus) temperature above boiling point of water
allow too hot (for liquid water to form)
allow water would boil or would be steam / gas
if no other mark awarded allow one mark for not enough water vapour

1

[4]

Q106.

(a) (i) C_5H_{12}
ignore attempts at balancing

1

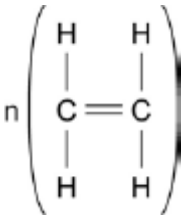
(ii) (pentane has higher boiling point as) it condenses
accept ethene does not condense

or

(as) it collects as a liquid
*accept pentane is a liquid **and** ethene is a gas*

1

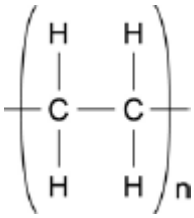
(b) (ethene)



(polyethene)

1

carbon-carbon single bond **and** 4 carbon-hydrogen single bonds



1

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lines correctly drawn to outside of brackets

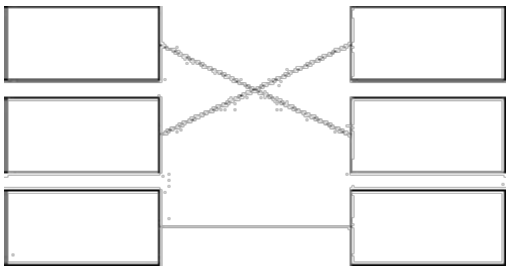
*do **not** allow additional atoms / elements added*

1

[5]

Q107.

(a)



*all 3 correct for **2** marks*

*1 or 2 correct for **1** mark*

extra line from statement box cancels mark

2

(b) solid

liquid

gas

*all 3 correct for **2** marks*

*1 or 2 correct for **1** mark*

must be in correct order

2

[4]

Q108.

(a) 11.35

only acceptable answer

1

(b) increases (tensile) strength

allow stronger

1

decreases melting point

allow mp

1

decreases density

ignore figures

1

(c) (joint / solder) stronger

allow firmer / more solid

or

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lower working temperature / so lead pipes do not melt

ignore lower melting point unqualified

ignore references to poison / weight

1

[5]

Q109.

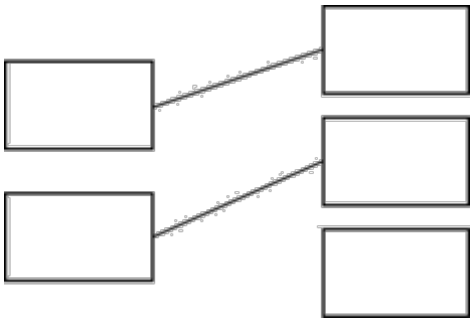
(a) (i) unreactive

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]

Q110.

(a) (liquid C)

no mark awarded for stating liquid C

no marks awarded if liquid A or B chosen

(causes) biggest temperature decrease

allow cools quicker / the quickest

1

(because it) evaporates quickest

allow evaporates quicker

allow most / more evaporated

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ignore references to boiling

1

(b) all of the liquid has evaporated

accept no net energy transfer

allow it was dry

1

(c) particles with most energy / highest speed evaporate

allow hottest particles

1

these particles escape from the (surface of the) liquid

accept overcoming the attractive forces (between particles)

1

decreasing mean energy of particles (left in liquid)

allow some reference to the total energy of the liquid reducing

1

which lowers the temperature

ignore cool down

1

[7]

Q111.

(a) oxygen / O_2 / O

1

(b) (i) zinc boils / evaporates out of furnace because of its low boiling point

1

therefore because lead has a high boiling point it remains in the furnace

1

(ii) on cooling the zinc forms a solid and the lead remains liquid

accept because zinc is less dense it floats on lead

1

therefore the lead can be poured off / decanted from the zinc

accept therefore the zinc can be poured off / decanted from the lead

1

[5]

Q112.

(a) (i) 344 – 350(°C)

1

(ii) 216(°C)

1

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(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]

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Q1.

(a) 47% of students correctly identified that the diagram for calcium oxide showed ionic bonding.

(b) 41% of students recognised that the bonding diagram for methane showed a molecule of methane.

(c) The diagram of a fullerene was not recognised by 71% of students.

(d) 44% of students correctly identified, from the diagram, that the type of bond in graphite is covalent.

(e) This question proved to be difficult because it required students to understand that in one covalent bond there is a shared pair of electrons, so one electron comes from each atom. 11% of students gave a correct answer.

(f) This question was accessible to most students (76%) because the answer should have been obvious from the diagram that showed a solid between the electrodes.

(g) 66% of students knew that copper conducts electricity by the movement of delocalised electrons.

(h) 49% of students could use the labelled diagram to understand that the sodium chloride was dissolved to form the sodium chloride solution.

(i) 19% of students knew that solid sodium chloride does not conduct electricity because the ions are fixed, whereas molten sodium chloride conducts electricity because the ions are mobile. Some students did not follow the instructions and drew more than one line from each statement box. 56% of students were awarded at least one mark.

Q2.

(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.

Q3.

(a) The question was well attempted with 80% of students achieving at least one mark. The marks awarded were fairly evenly distributed between the three marking points.

Students rarely achieved full marks (14%), often because they confused the type of particles or bonding involved. While many could identify that covalent bonds were used and lots of energy was needed to break these bonds, they found it difficult to describe the structure involved.

A common response was that diamond contains four carbon atoms rather than each carbon atom having four bonds, which would have been sufficient to be awarded the

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second marking point.

(b) The diagram showed a structure made up of ions. These have to be free moving to conduct electricity. 7% of students achieved full marks. Generally students missed out on full marks because they only included one way to produce ions, dissolving or melting. There was confusion among students between the terms liquid and solution. Many said that sodium chloride needs to be 'molten' or 'liquid', presumably often meaning molten or dissolved (in water).

The most common mistake in responses was that students thought that electrons were involved in the conduction of electricity in this situation.

(c) 49% of students achieved at least one mark, usually for marking points one or two. Higher attaining-students frequently achieved two marks for 'delocalised electrons free to move'.

Marking point three was rare and was often poorly expressed. Lots of responses repeated the question stem with phrases such as 'so it conducts thermal energy' or 'thermal energy passes between the particles'. Very few students mentioned energy being transferred. A common statement was that 'delocalised electrons carry electric charge' but not (thermal) energy.

Q4.

(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

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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.

Q5.

(a) 22% of students knew the definition from the specification or were able to give an equivalent statement. Often students mentioned only that it was 'a mixture or chemicals mixed together' but omitted the idea of 'to form a useful product'. Some students were able to give examples, but not a definition.

As the question stem mentioned fertilisers, a few students answered the question with phrases such as a substance / something to help plants grow or to enhance plant growth.

(b) 5% of students achieved full marks but many students (63%) gained some credit for their calculation. The most common answers that achieved two marks were 0.18 or 0.1815, (not converting 14.52 kg to g and an omission or incorrect conversion of their calculation into standard form to two significant figures).

An answer of 1.8×10^{-1} achieved three marks, the calculation being correct, but the students had not undertaken the initial conversion of kg into g. Several students had multiplied an answer within their calculation by Avogadro's number.

(c) 51% of students achieved some credit on this question. However, there were many references to intermolecular forces (often strong intermolecular forces), covalent bonds and molecules, all of which limited the response to a maximum of two marks.

Many students described in detail how potassium, being in Group 1 of the periodic table would transfer one electron to chlorine which is in Group 7 to obtain full outer shells meaning that the compound would have a high melting point. 'Ionic bonds' was often seen but normally as part of a lengthy explanation of how and why potassium transfers one electron to chlorine.

1% of students achieved full marks, with 7% of students achieving three marks; the description of a 'lattice' or 'giant structure' was seldom seen.

Q6.

Foundation

(a) Around one quarter of students did not attempt this question.

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Of those who did, very few, around 1%, were able to draw the correct diagram. Some scored 1 mark, usually for the five single bonds within the bracket.

The most common incorrect diagram was just a repeat of the structure of ethene which had been given in the question. The significance of the 'n' was not understood by some students − some answers showed a pattern of 'n's around the outside of the bracket.

(b) Around 8% of students gained both marks. Many students, around 50%, gained one mark, usually for pointing out that the LD poly(ethene) has side chains, whereas HD does not.

Despite the fact that both the polymer chains and the side chains were labelled, many students chose to ignore these terms to talk about 'wiggly lines' and 'a cracked appearance'.

(c) More than 40% of students did not attempt this question.

Of those who did attempt it, some did not describe a method, merely stating that poly(ethene) extends when a force is applied.

Of those who attempted to describe a method, many failed to score more than two of the four marks available because their account lacked detail and would not lead to a valid outcome. In many cases, this was because 'see how much it stretches' was stated with no detail as to how this would be done. In other cases, there was no indication that more than one force would be applied to the poly(ethene).

There were quite a few references to pulling the polythene and examining it under a microscope. A small number of students described the extension of a spring experiment, with no mention of poly(ethene) at all.

(d) Around 10% of students gained one mark for this question, with a very small number gaining both marks. The answers tended to be very imprecise, such as 'HD needs a greater force than LD' and 'LD has a greater extension than HD'.

Many students stated that one extended faster than the other; as no time values were given, this is incorrect.

(e) Around 18% of students scored two marks for this question, with a further 20% gaining one mark. Some worked out 85% of 8 billion, and quoted this as their answer, failing to subtract this from the original 8 billion.

A commonly seen error was dividing by 0.85 instead of multiplying.

Another common error was to put an incorrect number of zeros for billion (instead of just leaving it as 'billion'). Another common error was an inability to perform the percentage calculation correctly. To work out 85% of 8 billion, many students worked out 10% of 8 billion, and then 1%, then added 8 lots of 10% to five lots of 1%. Coupled with a large number of zeros, this method had the potential for errors to arise.

(f) More than 20% of students did not answer this, the last question on the paper. Most students who wrote something made a good attempt at this 'evaluation' question based on LCAs. Many students were able to point out that bags for life were better from the point of view of 'waste'. A simple comparison for CO_2 emissions on a 'per bag' basis was also given by many. Few students processed the data for CO_2 emissions to show that on a 'per use' basis, bags for life were more environmentally desirable. Some students misinterpreted the word 'emitted' and referred to the use

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of CO_2 during the production and transport of the bags. Few students did calculations when comparing the data.

A Level 2 answer (three or four marks) involved comparing the two types of carrier bag qualitatively, e.g. 'more waste is generated from the production of one disposable bag compared with a bag for life' and addressing both waste and carbon dioxide. Around 40 % of students fell into this category.

A few students (around 4%) achieved Level 3 (five or six marks) for going a step further and involving calculations such as 'around two and a half times as much waste is generated from the production of one disposable bag compared with a bag for life'. In addition, both waste and carbon dioxide had to be addressed quantitatively. Also, a judgement needed to be made, either saying which type of bag was better, with reasons why, or giving the pros and cons of both types of bag.

Students whose answers were Level 1 standard (one or two marks) tended to discuss only one aspect of the information given, or to ignore the information altogether and write something from their own knowledge. Answers which merely stated the given information without any comparisons did not gain credit.

Higher

(a) Around 7% of students did not attempt this question. Very few students were able to draw the correct diagram. Some scored one mark, either for the five single bonds within the bracket or for the two single bonds extending outwards from the two carbons.

The most common incorrect diagram was just a repeat of the structure of ethene which had been given in the question. Another incorrect answer was to ignore the monomer diagram and to draw out a structure, usually of an alkane, or an alkane-type structure but with carbon-carbon double bonds.

(b) Most students attempted this question, with around one quarter gaining both marks. A further 50% gained one mark, usually for pointing out that the LD poly(ethene) had side chains, whereas HD did not. A number of students also picked up on the difference between the polymer chains but commented about the difference in number rather than their proximity.

Despite the fact that both the polymer chains and the side chains were labelled, a minority of students chose to ignore these terms to talk about 'wiggly lines' and 'cracks'.

(c) The question asked was to describe a method to investigate how the extension of poly(ethene) changes with the force applied. A number of students did not take on board that the command word was 'describe' but attempted to explain (a different command word) why poly(ethene) extends.

Many students who did describe a method failed to score more than two of the four marks available because their account lacked detail and would not lead to a valid outcome. In many cases, this was because 'measure the extension' was stated with no detail as to how this would be done. In other cases, there was no indication that more than one force would be applied to the poly(ethene).

A small number of students described the extension of a spring experiment, with no mention of poly(ethene) at all.

(d) Fewer than 2% of students scored both marks, although a further quarter gained one of the marks, often for stating that for both types of poly(ethene) the extension

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increases as the force increases.

Other answers tended to be too vague, such as ‘LD’s extension is greater than HD’. Answers which gained credit qualified such an answer with ‘…for a given force’ or quoted a value for force and compared the values of the two extensions.

Some students stated that one extended faster than the other; as no time values were given, this is incorrect.

(e) Around half of students scored two marks for this. Of those who did not gain both marks, some worked out 85% of 8 billion, and quoted this as their answer, failing to subtract it from the original 8 billion.

Another common error was to put an incorrect number of zeros for billion (instead of just leaving it as ‘billion’).

Some students made mathematical mistakes in performing the percentage calculation. To work out 85% of 8 billion, many students worked out 10% of 8 billion, and then 1%, then added 8 lots of 10% to five lots of 1%. Coupled with a large number of zeros, this method had the potential for errors to arise.

(f) Many students made a good attempt at this 'evaluation' question based on LCAs.

A Level 2 answer (three or four marks) involved comparing the two types of carrier bag qualitatively, e.g. ‘more waste is generated from the production of one disposable bag compared with a bag for life’ and addressing both waste and carbon dioxide. Around 60% of students fell into this category.

Some students (around 14 %) achieved Level 3 (five or six marks) for going a step further and involving calculations such as ‘around two and a half times as much waste is generated from the production of one disposable bag compared with a bag for life’. In addition both waste and carbon dioxide had to be addressed quantitatively. Also, a judgement needed to be made, either saying which type of bag was better, with reasons why, or giving the pros and cons of both types of bag.

Students whose answers were Level 1 standard (one or two marks) tended to discuss only one aspect of the information given, or to ignore the information altogether and write something from their own knowledge.

Q98.

(a) (i) This question was well answered with over half the students gaining all 3 marks. When students lost marks it was generally for just quoting figures from the table without adding value, or for not writing comparative statements. Saying titanium ‘is strong’ or ‘has a low density’ was insufficient.

(ii) Most students gained the mark for identifying that titanium has a high resistance to corrosion.

(b) Most students gained the mark for gold being mined as the pure metal from the ground.

(c) Almost all students named the metal as silver, having been able to locate Ag in the periodic table.

(d) (i) Most students knew that an alloy is a mixture, although some thought it is a compound.

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(ii) Most students correctly subtracted 88 from 100 to calculate the percentage of tin in the alloy.

(iii) Most students thought that fossils were used in phytomining. Only a third of them correctly selected plants.

Q99.

(a) Most students correctly calculated the percentage of polymers used for packaging.

(b) (i) Most students counted the correct number of carbon and hydrogen atoms, but they did not always write them correctly as a formula. Many wrote the numbers as superscripts, or wrote them too large. The subscripts must be no higher than half way up the capital letter.

(ii) Well over half of the students gained a mark for knowing that many ethene molecules join together to from poly(ethene). Fewer knew that the monomer is ethene.

Q100.

(a) Just under half of the students gained full marks for an answer of 40%. An answer of 60% could gain 1 mark, but only if they had shown their working. They had used the mass of all the other uses of polymers, 27 megatonnes, but correctly worked out a percentage. There were many addition errors, with students unable to correctly add figures given to 2 decimal places.

(b) (i) Students had to draw the displayed structure of ethene. Common errors were to draw a single bond instead of a double bond between the carbon atoms, or to show open bonds sticking out from either side of the molecule as in a polymer. Some students did not take enough care when writing the symbols, which should have been roughly the same height as each other.

(ii) To gain full marks students had to refer to many monomers joining together to form a polymer or a very large molecule. The number of monomers and size of the molecule formed were important. Some good responses went on to explain how the double bond in the alkene broke to allow the molecules to join together. Some students confused polymerisation and cracking.

Q101.

(a) (i) Just over two thirds of students knew that an element consists of only one sort of atom.

(ii) Three quarters of students knew that elements are different because they have different numbers of protons.

(b) Correct responses usually stated that alloys are a mixture of metals, or of two or more metals. “Metal” on its own was not creditworthy. Common incorrect responses included elements or compounds. Atoms, molecules, chemicals, ions and gold and silver were also frequently seen. Descriptions of steel alloys, for example, metal with carbon, were rarely seen.

(c) About two thirds of the students gained 2 marks for naming silver and oxygen, though Ag was sometimes identified as gold, aluminium or argon. Students found it more difficult to interpret the formula to give the numbers of the atoms and many thought that $_2$O meant two oxygen atoms. Some students wrote down oxide instead

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of oxygen, which meant they could not obtain the mark for naming the element, nor for the idea of number, as oxide ion was needed. Others followed the instruction to use the Data Sheet but then showed a lack of understanding of the technical terms and gave the atomic numbers or relative atomic mass numbers of the elements.

Q102.

(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.

Q103.

(a) Most students could recognise how the model represented the movement of particles in a gas. Some had not followed the instructions and ticked more than two boxes.

(b) Many students misinterpreted the question stem, or did not understand what a state of matter is, and answered yes or no. Some gave air instead of gas.

Q104.

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

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

(c) Most students were able to make a reasonable attempt at answering this question. Most Level 1 responses referred to the comparative time of each process. Beyond Level 1 comparative pollution levels were often seen as a second scientific idea, eg visual, noise and dust pollution, however these were often very poorly expressed. Many students only referred to pollution, without qualifying the statement, which was

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not creditworthy.

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

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

Q105.

(a) Whenever differences are asked for comparative statements must be given in the response. Just quoting figures from the table without qualification does not gain a mark.

(b) The required answers were that on Mars the temperature is below the freezing point of water, and on Venus it is above the boiling point of water. These were not seen, but as minimum statements, Mars is too cold and Venus is too hot were allowed. Students should be encouraged to write scientific responses. Some students mixed up the data and said that Venus was too cold and Mars was too hot.

Q106.

(a) (i) Most students worked out that there should be 5 carbon atoms and 12 hydrogen atoms in the formula for pentane. The mark was sometimes lost because either the letters were not capitals, or the numbers were not written as subscripts. The general rule of thumb is that the subscripts must be no more than half the height of the capital letter, so C5H12 is incorrect.

(ii) Less than a fifth of the students scored on this question. A lot of students referred to the formulae of the compounds, rather than using the diagram, and tried to explain in terms of the number of carbon atoms. Pentane condenses was seen a few times, but the most common correct answer was that pentane is a liquid and ethene is a gas.

(b) There were many untidy drawings with crossed out bonds. The most common error was that the bonds extending outside the brackets for poly(ethene) were not drawn. Sometimes a bond between a carbon and hydrogen had been omitted which meant the mark could not be gained.

Q107.

(a) A very well answered question with most students gaining at least one mark. Almost all students labelled the gas correctly.

(b) A well answered question with almost two-thirds of students obtaining full marks. The most common error was to mix up solid and gas, but these students still gained one mark for liquid.

Q108.

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(a) Just over half of students answered this question correctly however, it was surprising to see how many could not use the data in the table to find the correct answer.

(b) Whilst many students were able to interpret the data given in the table and draw correct conclusions regarding the patterns of the properties, some students referred to boiling point rather than melting point or to the unit rather than the name of the property. Some students only gave one or two properties and should be encouraged to look at the number of marks the question is worth to judge how many points need to be made.

(c) Students usually answered in terms of strength, though most did not gain credit as they failed to give a comparison eg 'strength' rather than 'stronger'. Other incomplete responses referred to the melting point but without appreciating that it gave a lower working temperature or that the lead pipes would not melt. Only a quarter of students answered this question correctly.

Q109.

(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.

Q110.

(a) A large number of students gave liquid A as their answer, so gained zero marks. The most common correct answer was that liquid C cooled the quickest. Some thought it was being heated and there were a lot of references to boiling.

(b) Very few students gave a correct response. Most said that the room temperature prevented it cooling further, or that room temperature was 7 °C. There were many incorrect references to boiling or freezing points, condensing and turning to a liquid. A poor understanding of cooling by evaporation and change of state was demonstrated.

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(c) Many students did not understand the graph which led to confused responses. It was clear that evaporation is not well understood. Few students realised that the particles with the most energy evaporated. The most common mark gained was for particles escaping from the liquid. Some students gave descriptions referring to the total energy of the liquid reducing but few went on to mention that this lowered the temperature of the liquid. They usually just repeated information given in the question and said the liquid cooled down, which was not enough for the last marking point.

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