AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.2.1 CHEMICAL BONDS: IONIC, COVALENT AND METALLIC (PACK 1)

SCORE	PERCENTAGE
/402	%

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Q1.

(a) FeS_2

*do **not** accept equations*

1

(b) 26

1

30

1

26

1

must be this order

(c) any **two** from:

- iron has a high(er) melting / boiling point
- iron is dense(r)
- iron is hard(er)

allow iron is less malleable / ductile

- iron is strong(er)
- iron is less reactive

allow specific reactions showing difference in reactivity

- iron has ions with different charges
- iron forms coloured compounds
- iron can be a catalyst

allow iron is magnetic

allow the converse statements for sodium
allow transition metal for iron
allow Group 1 metal for sodium

ignore references to atomic structure

ignore iron rusts

2

(d) carbon is more reactive (than nickel)

allow converse

1

(so) carbon will displace / replace nickel (from nickel oxide)

allow (so) nickel ions gain electrons

or

(so) carbon will remove oxygen (from nickel oxide)

allow (so) carbon transfers electrons to nickel (ions)

1

(e) (total M_r of reactants =) 87

1

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(percentage atom economy)

$= \frac{59}{87} \times 100$

allow (percentage atom economy)
$= \frac{59}{\text{incorrectly calculated } M_r} \times 100$

1

= 67.8 (%)

allow an answer from an incorrect calculation to 3 sig figs

1

*an answer of 67.8 (%) scores **3** marks*
*an answer of 67.8160919 (%) or correctly rounded answer to 2, 4 or more sig figs scores **2** marks*
an incorrect answer for one step does not prevent allocation of marks for subsequent steps

[11]

Q2.

(a) potassium chloride **and** iodine

either order
allow KCl for potassium chloride and I_2 for iodine

1

(b) (chlorine's) outer electrons / shell closer to the nucleus

allow chlorine has fewer shells
allow chlorine atom is smaller than iodine atom
ignore chlorine has fewer outer shells

1

(so) the chlorine nucleus has greater attraction for outer electrons / shell

allow chlorine has less shielding
*do **not** accept incorrect types of attraction*

1

(so) chlorine gains an electron more easily

1

***max 2** marks can be awarded if the answer refers to chloride / iodide instead of chlorine / iodine*
allow converse statements
allow energy levels for shells throughout

(c) hydrogen chloride is made of small molecules

allow hydrogen chloride is simple molecular

1

(so hydrogen chloride) has weak intermolecular forces*

1

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(intermolecular forces) require little energy to overcome*

1

*do **not** accept reference to bonds breaking unless applied to intermolecular bonds*

(d) (bonds broken = 4(412) + 193 =)1841

1

(bonds formed = 3(412) + 366 + **X** =) 1602 + **X**

1

−51 = 1841 − (1602 + **X**)

allow use of incorrectly calculated values of bonds broken and / or bonds formed from steps 1 and 2 for steps 3 and 4

1

(**X** =) 290 (kJ/mol)

allow a correctly calculated answer from use of −51 = bonds formed − bonds broken

1

OR

alternative method ignoring the 3 unchanged C−H bonds

(412 + 193 =) 605 (1)

366 + **X** (1)

−51 = 605 − (366 + **X**) (1)

(**X** =) 290 (kJ/mol) (1)

*an answer of 290 (kJ/mol) scores **4** marks*

*an answer of 188 (kJ/mol) scores **3** marks*

*an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps*

[11]

Q3.

(a) chlorine is toxic

allow carbon monoxide is toxic

allow poisonous for toxic
ignore harmful / deadly / dangerous

allow a poisonous gas is used / produced

allow titanium chloride is corrosive

1

(b) any **one** from:

- very exothermic reaction

allow explosive
allow violent reaction
ignore vigorous reaction
ignore sodium is very reactive

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- produces a corrosive solution

  allow caustic for corrosive
  ignore alkaline
- produces hydrogen, which is explosive / flammable

  allow flames produced
  ignore sodium burns

1

(c) argon is unreactive / inert

allow argon will not react (with reactants / products / elements)

1

oxygen (from air) would react with sodium / titanium
or
water vapour (from air) would react with sodium / titanium

allow elements / reactants / products for sodium / titanium

1

(d) metal chlorides are usually ionic

allow titanium chloride is ionic

1

(so)(metal chlorides) are solid at room temperature
or
(so)(metal chlorides) have high melting points

allow titanium chloride for metal chlorides

1

(because) they have strong (electrostatic) forces between the ions

ignore strong ionic bonds

or
(but) must be a small molecule or covalent

allow molecular

1

allow alternative approach:

*titanium chloride must be covalent **or** has small molecules (1)*

with weak forces between molecules
*do **not** accept bonds unless intermolecular bonds(1)*

(but) metal chlorides are usually ionic (1)

(e) sodium (atoms) lose electrons

*do **not** accept references to oxygen*

1

(f) $Na \longrightarrow Na^+ + e^-$

*do **not** accept e for e^-*

1

(g) (M_r of $TiCl_4$ =) 190

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$(\text{moles Na} = \frac{20000}{23} =) \ 870 \text{ (mol)} *$

1

$(\text{moles } TiCl_4 = \frac{40000}{190} =) \ 211 \text{ (mol)} *$

1

allow **1 mark for 0.870 mol Na **and** 0.211 mol $TiCl_4$*

allow use of incorrectly calculated M_r from step 1

either

(sodium is in excess because) 870 mol Na is more than the 844 mol needed

or

(because) 211 mol $TiCl_4$ is less than the 217.5 mol needed

the mark is for correct application of the factor of 4

other correct reasoning showing, with values of moles or mass, an excess of sodium or insufficient $TiCl_4$ is acceptable

allow use of incorrect number of moles from steps 2 and / or 3

1

alternative approaches:

approach 1:

(M_r of $TiCl_4$ =) 190(1)

(40 kg $TiCl_r$ needs)

$\frac{40}{190} \times 4 \times 23$ *(kg Na) (1)*

(=) 19.4 (kg) (1)

so 20 kg is an excess (1)

approach 2:

(M_r of $TiCl_4$ =) 190(1)

(20 kg Na needs)

$\frac{20}{4 \times 23} \times 190$ *(kg $TiCl_4$) (1)*

(=) 41.3 (kg) (1)

so 40 kg is not enough (1)

(h) $(\text{actual mass} =) \frac{92.3}{100} \times 13.5$

or

(actual mass =) 0.923 × 13.5

1

= 12.5 (kg)

allow 12 / 12.46 / 12.461 / 12.4605 (kg)

1

*an answer 12.5 (kg) scores **2** marks*

[15]

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Q4.

(a) **A**

1

(b) **D**

1

(c) **C**

1

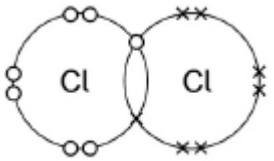
(d) **E**

1

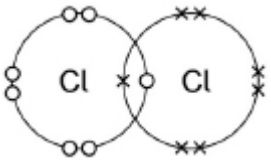
(e) bonding pair of electrons drawn

electrons can be dots, crosses or $e^{(-)}$ in any combination

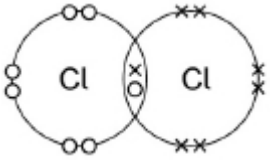
eg



or



or



*do **not** accept if electrons added to outer shells outside overlap*

1

(f) weak forces between molecules

1

(g) MnO

1

(h) ions move around in the liquid

1

[8]

Q5.

(a) lithium (atom) loses (one) electron(s)

1

chlorine (atom) gains (one) electron(s)

1

reference to transfer of one electron

1

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to form positive and negative ions

allow to form noble gas electronic structures
or
allow to form stable electron arrangements
or
allow to form full outer shells
or
allow reference to ionic bonding

1

(b) $\frac{161}{81+98} \times 100$

1

= 89.944134

1

= 89.9 (%)

1

*an answer of 89.9 (%) scores **3** marks*

(c) more sustainable **or** less waste

allow any sensible economic or environmental reason but not 'cheaper' without qualification

1

(d) 50 / 1000 (dm^3) or 0.05 dm^3
or
80 / 1000 (g / cm^3) or 0.08 g / cm^3

1

= 4(.00) (g)

1

*an answer of 4(.00) (g) scores **2** marks*

[10]

Q6.

(a) **J**

1

(b) **M** and **Q**

either order

1

(c) **Q**

1

(d) **M**

1

(e) **L**

1

(f) **Level 3 (5-6 marks):**

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A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

Level 2 (3-4 marks):
Some logically linked reasons are given. There may also be a simple judgement.

Level 1 (1-2 marks):
Relevant points are made. They are not logically linked.

Level 0
No relevant content

Indicative content

comparative points
- both tables have more than one element in a box
- both have similar elements in the same column
- both are missing the noble gases
- both arranged elements in order of atomic weight

advantages of Mendeleev / disadvantages of Newlands
- Newlands did not leave gaps for undiscovered elements
- Newlands had many more dissimilar elements in a column
- Mendeleev left gaps for undiscovered elements
- Mendeleev changed the order of some elements (e.g. Te and I)

points which led to the acceptance of Mendeleev's table
- Mendeleev predicted properties of missing elements
- elements with properties predicted by Mendeleev were discovered
- Mendeleev's predictions turned out to be correct
- elements were discovered which fitted the gaps

6

[11]

Q7.

(a) precipitate / solid formed
allow colour change

1

(b) total mass before = 257.68 g
total mass after = 257.68 g

1

so the mass of products equals
the mass of the reactants

1

(c) 0.01 g

1

(d) 207 + (2 × 14) + (6 × 16)
or
207 + 2 × [14 + (3 × 16)]

1

= 331

1

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*an answer of 331 scores **2** marks*

(e) CrO_4^{2-}

1

(f) carbon dioxide is a gas

allow a gas is produced

1

the gas escapes during the reaction

1

(so) the mass at the end is less than expected

1

[10]

Q8.

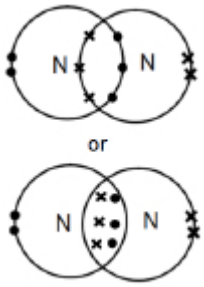
(a) six electrons in the overlap

allow dots, crosses or $e^{(-)}$ for electrons

1

2 non-bonding electrons on each nitrogen atom

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



1

(b) weak forces

1

between molecules
or
intermolecular

do not allow references to covalent bonding between molecules

1

(which) need little energy to overcome

1

(c) each (carbon) atom forms three covalent bonds

1

forming layers (of hexagonal rings)

1

(soft)
(because) layers can slide over each other

1

(conducts electricity)

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(because of) delocalised electrons

1

(d) molecules are spherical

1

(so molecules) will roll

1

(e) surface area (= 20 × 20 × 6) = 2400 (nm^2)

1

volume (= 20^3) = 8000 (nm^3)

1

ratio = 0.3 (nm^3): 1 (nm^3)
ratio = 0.3 (nm^3): 1 (nm^3)
or
1 (nm^3): 3.33 (nm^3)

1

(f) (nanoparticles) have a larger surface area to volume ratio

1

so less can be used for the same effect

1

[16]

Q9.

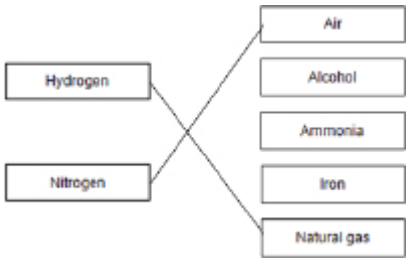
(a) 4

1

(b) reversible (reaction)

1

(c)



1
1

(d) −40 °C

1

(e) recycled to the reactor

1

(f) ionic

1

(g) nitrogen

1

phosphorus

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1

(h) 0.24 × 50 × 5

allow £87.50

1

= £60

1

*an answer of £60 scores **2** marks*

(i) may need to use nitrogen, phosphorus and potassium

allow neither fertiliser has all the elements / nutrients needed.

[12]

Q10.

(a) in a closed system

1

the rate of the forward and backward reactions are equal

1

(b) concentration increases

1

(because) reaction / equilibrium moves to the left / reactant side

1

(since the) reverse reaction is exothermic

allow (so that) temperature increases

1

(c) becomes blue

1

(because) reaction / equilibrium moves to the right / product side

1

(so) concentration of blue cobalt compound increases

allow (so that) concentration of hydrochloric acid decreases

1

(d) (cobalt has) ions with different charges

allow (cobalt is a) transition metal

1

(e) Co^{3+}

1

(f) they allow reactions to reach equilibrium more quickly

1

they provide a different reaction pathway

1

(g) $\mathbf{13}H_2 + \mathbf{6}CO \rightarrow C_6H_{14} + \mathbf{6}H_2O$

allow multiples

1

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(h) C_8H_{18}

1

(i) curve below printed curve

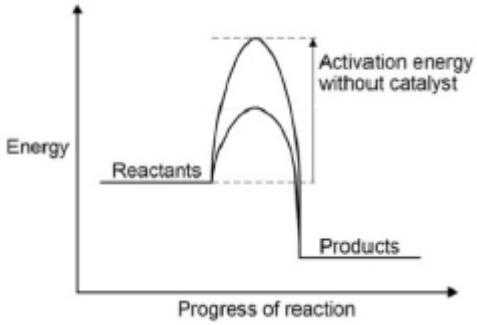
*do **not** accept different reactant or product levels*

1

vertical arrow from reactant level to peak of **printed** curve

1

an answer of:

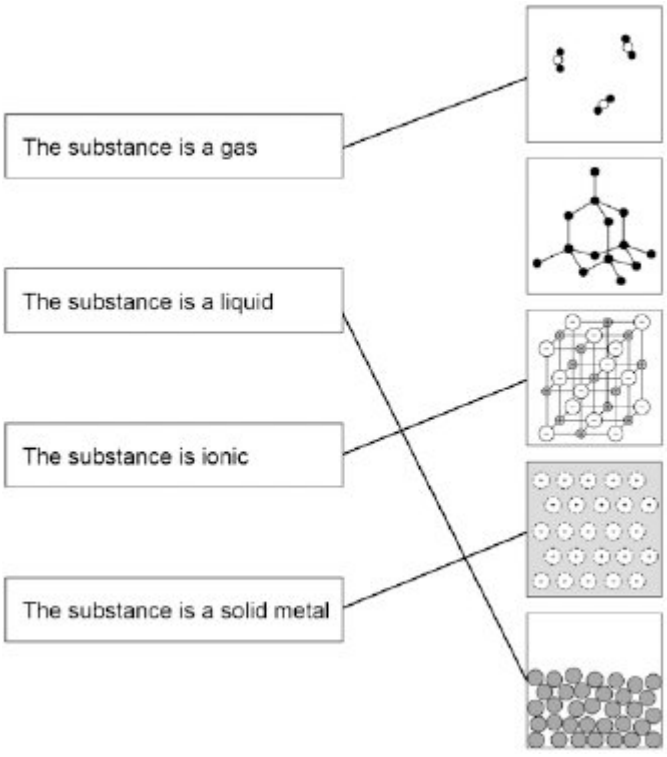


scores **2** marks

[16]

Q11.

(a) **Statement** **Structure**



more than one line drawn from a variable negates the mark

4

(b) Carbon

1

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(c) It has delocalised electrons

1

(d) the atoms / particles / ions are different sizes

*do **not** accept molecules*

1

so there are no rows / layers to slide

accept the layers are disrupted

1

(e) $\frac{2}{27} \times 100$

1

7.4%

1

*allow 7.4% with no working shown for **2** marks*

(f) Mixture

1

[11]

Q12.

(a) electrons transferred from potassium to sulfur

1

two potassium atoms each lose one electron

1

forming K^+ / 1+ ions

1

sulfur atoms gain 2 electrons

1

forming S^{2-} / 2− ions

1

(b) there are no gaps / sticks between the potassium ions and sulfide ions

1

(c) (two) shared pairs between H and S

1

rest correct - no additional hydrogen electrons and two non-bonding pairs on sulfur

second mark dependent on first

1

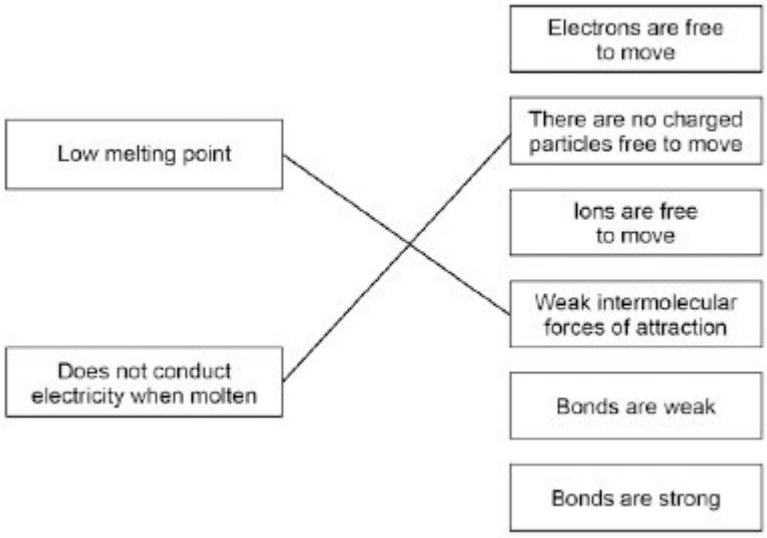
(d) 342

2

*allow **1** mark for evidence of (2 × 27) + 3[32 + (16 × 4)]*

(e) **Property** **Explanation of property**

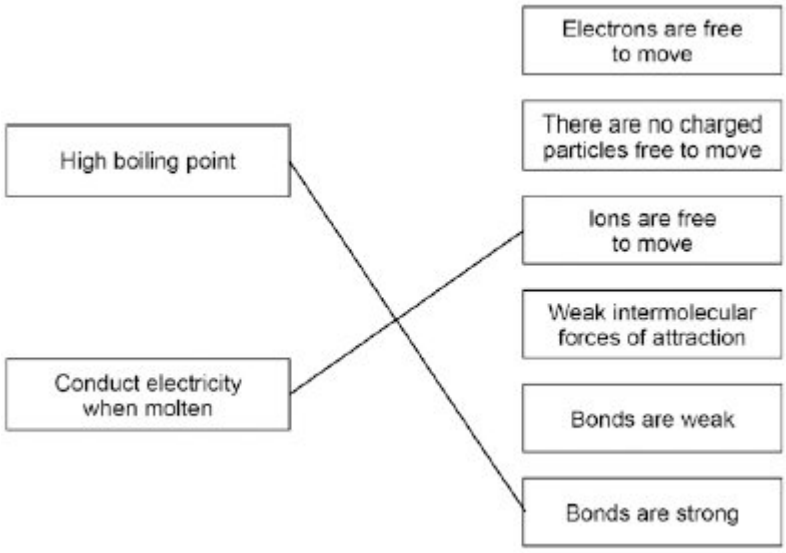
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more than one line drawn from a variable negates the mark

2

(f) **Property** **Explanation of property**



more than one line drawn from a variable negates the mark

2

[14]

Q13.

(a) line goes up before it goes down

1

energy given out correctly labelled

1

activation energy labelled correctly

1

(b) electrostatic force of attraction between shared pair of negatively charged electrons

1

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and both positively charged nuclei

1

(c) bonds formed = 348 +4(412) + 2(276) = 2548 kJ / mol

1

bonds broken − bonds formed = 612 + 4(412) + (Br-Br) − 2548 = 95 kJ / mol

1

Alternative approach without using C-H bonds
For step 1 allow = 348 + 2(276) = 900 kJ / mol
Then for step 2 allow 612 + (Br-Br) − 900 = 95 kJ / mol

193 (kJ / mol)

1

*accept (+)193 (kJ / mol) with no working shown for **3** marks*
*−193(kJ / mol) scores **2** marks*
allow ecf from step 1 and step 2

(d) **Level 3 (5–6 marks):**
A detailed and coherent explanation is given, which demonstrates a broad understanding of the key scientific ideas. The response makes logical links between the points raised and uses sufficient examples to support these links. A conclusion is reached.

Level 2 (3–4 marks):
An explanation is given which demonstrates a reasonable understanding of the key scientific ideas. A conclusion may be reached but the logic used may not be clear or linked to bond energies.

Level 1 (1–2 marks):
Simple statements are made which demonstrate a basic understanding of some of the relevant ideas. The response may fail to make logical links between the points raised.

0 marks:
No relevant content.

Indicative content

Size and strength
- chlorine atoms have fewer electron energy levels/shells
- chlorine atoms form stronger bonds
- Cl–Cl bond stronger than Br–Br
- C–Cl bond stronger than C–Br

Energies required
- more energy required to break bonds with chlorine
- more energy given out when making bonds with chlorine
- overall energy change depends on sizes of energy changes

Conclusions
- if C−Cl bond changes less, then less exothermic
- if C−Cl bond changes more, then more exothermic
- can't tell how overall energy change will differ as do not know which changes more.

6

[14]

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Q14.

(a) (i) 7 / seven

1

(ii) 1

*do **not** accept –1*

1

Electron

1

(iii) isotopes

1

(b) (i) (sodium +) fluorine → sodium fluoride

1

(ii) compounds

1

(iii) mole

1

(iv) sodium (atom) loses

1

fluorine (atom) gains

1

one electron

1

ions formed

1

*allow sodium forms positive (ion) **or** fluorine forms negative (ion)*
allow form ionic bond
allow to gain a full outer shell of electrons
allow forms noble gas structure
***max 3** if reference to incorrect particle / bonding*

(v) Dissolve in water

1

High melting point

1

[13]

Q15.

(a) (i) hard

ignore strong

1

(ii) hundred

1

(b) (i) Covalent

1

(ii) 3

1

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(iii) Soft and slippery

1

(c) (i) cross-links

allow bonds

ignore links

*do **not** accept intermolecular*

1

(ii) melt

1

(iii) any **two** from:

- temperature

  allow heat(ing)
- pressure
- catalyst

2

(d) (i) CH_4

1

(ii) Small molecules

1

[11]

Q16.

(a) electricity

allow an electric current

1

(b) (i) chlorine/Cl_2

*do **not** accept chloride*

1

(ii) (zinc ions are) positive

ignore to gain electrons

1

and (opposite charges) attract

1

(iii) reduction

1

(c) (i) in alloy:

accept converse

different sized atoms/particles

or

no layers/rows

accept layers distorted

1

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so cannot slide

1

(ii) shape memory (alloys)

accept smart

1

[8]

Q17.

(a) (i) (mass number = 16) because there are 8 protons and 8 neutrons (in the nucleus)

accept mass number is total number of protons and neutrons
*for **1** mark*

2

(ii) same number of protons **or** both have 6 protons

accept same atomic number

1

^{12}C has 6 neutrons

1

^{14}C has 8 neutrons

1

*accept different number of neutrons for **1** mark*
numbers, if given, must be correct
*incorrect reference to electrons = **max 2** marks*

(b) (i) 2 bonding pairs

1

additional unbonded electrons negates this mark

4 unbonded electrons around oxygen

1

accept dot, cross or e or – or any combination

(ii) covalent

1

(iii) any **one** from:

- no delocalised / free electrons
  ignore mobile electrons
- no overall electric charge
  accept no charge (carriers)
- no ions

1

*do **not** accept any implications of the presence of ions*

(c) (i) larger

accept the size of a few hundred atoms
accept atoms are smaller (than nanoparticles)
allow up to 1000 atoms)

1

(ii) (nanoparticles have) large(r) surface area

1

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[11]

Q18.

(a) magnesium loses two electrons **and** chlorine gains one electron

*accept magnesium loses electrons **and** chlorine gains electrons for 1 mark*

ignore oxidation and reduction

2

one magnesium and two chlorines

accept $MgCl_2$

1

noble gas structure

or

eight electrons in the outer shell

accept full outer shell (of electrons)

or

(electrostatic) attraction between ions

or

forms ionic bonds

*do **not** accept covalent bonds*

1

*reference to incorrect particles **or** incorrect bonding **or** incorrect structure = **max 3***

(b) (i) because ions can move

ignore ions attracted

*do **not** accept molecules / atoms moving*

*do **not** accept incorrect reference to electrons moving*

1

(and ions move) to the electrodes

or

(and ions) carry charge

1

accept converse for solid

(ii) magnesium (ions) attracted (to the electrode)

1

so magnesium ions gain electrons

accept magnesium ions are reduced

ignore oxidised

1

2 electrons

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*accept a correct half equation for 2nd **and** 3rd marking points*

1

(iii) hydrogen

allow H_2

1

(iv) magnesium is more reactive than hydrogen

accept converse

*allow magnesium is high in the reactivity series **or** magnesium is very/too reactive.*

*do **not** accept magnesium ions are more reactive than hydrogen ions*

1

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

must be completely correct

1

(c) layers (of particles/atoms/ions)

1

(particles/atoms/ions/layers) can slide

1

*any mention of intermolecular / weak bonds/forces = **max 1***

[14]

Q19.

(a) has delocalised electrons

accept free (moving) electrons

1

(so electrons) can move through the structure/metal

accept (so electrons) can carry charge through the structure/metal

accept (so electrons) can form a current

1

*reference to incorrect particles **or** incorrect bonding **or** incorrect structure = **max 1***

(b) giant structure

accept lattice

accept each atom forms four bonds (with other carbon atoms)

ignore macromolecular

1

strong bonds

accept covalent

*do **not** accept ionic*

1

*reference to intermolecular forces/bonds **or** incorrect particles = **max 1***

(c) thermosetting polymers do not melt (when heated)

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accept thermosetting polymers do not change shape (when heated)
accept thermosetting polymers have high(er) melting points
ignore thermosetting polymers do not soften (when heated)

1

due to cross-links (between chains)
accept due to bonds between chains

1

*reference to smart polymers = **max 1***
accept converse argument

[6]

Q20.

(a) (i) C

1

(ii) B

1

(iii) A

1

(iv) D

1

(b) (i) SO_2

1

(ii) shared

1

(iii) covalent

1

[7]

Q21.

(a) (i) neutrons
this order only

1

electrons

1

protons

1

(ii) box on the left ticked

1

(b) (i) effervescence / bubbling / fizzing / bubbles of gas
*do **not** accept just gas alone*

1

magnesium gets smaller / disappears
allow magnesium dissolves

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*allow gets hotter **or** steam produced*

ignore references to magnesium moving and floating / sinking and incorrectly named gases.

1

(ii) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking Guidance and apply a 'best–fit' approach to the marking.

0 marks
No relevant content

Level 1 (1−2 marks)
There are simple statements of some of the steps in a procedure for obtaining magnesium chloride.

Level 2 (3−4 marks)
There is a description of a laboratory procedure for obtaining magnesium chloride from dilute hydrochloric acid and magnesium.

The answer must include a way of ensuring the hydrochloric acid is fully reacted **or** a method of obtaining magnesium chloride crystals.

Level 3 (5−6 marks)
There is a well organised description of a laboratory procedure for obtaining magnesium chloride that can be followed by another person.

The answer must include a way of ensuring the hydrochloric acid is fully reacted **and** a method of obtaining magnesium chloride crystals.

examples of the points made in the response:
- hydrochloric acid in beaker (or similar)
- add small pieces of magnesium ribbon
- until magnesium is in excess or until no more effervescence occurs *
- filter using filter paper and funnel
- filter excess magnesium
- pour solution into evaporating basin / dish
- heat using Bunsen burner
- leave to crystallise / leave for water to evaporate / boil off water
- decant solution
- pat dry (using filter paper).

*Student may choose to use a named indicator until it turns a neutral colour, record the number of pieces of magnesium added then repeat without the indicator.

6

[12]

Q22.

(a) because sulfur dioxide causes <u>acid rain</u>

1

which kills fish / aquatic life **or** dissolves / damages statues / stonework **or** kills / stunts growth of trees

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if no other mark awarded then award 1 mark for sulfur dioxide is toxic or causes breathing difficulties.

1

(b) (i) <u>electrons</u> are lost

1

(ii) $Cu^{2+} + 2e^- \rightarrow Cu$

allow $Cu^{2+} \rightarrow Cu - 2e^-$

ignore state symbols

1

(iii) copper sulfate

allow any ionic copper compound

1

(c) (lattice of) positive ions

1

delocalised electrons

accept sea of electrons

1

(electrostatic) attraction between the positive ions and the electrons

1

electrons can move through the metal / structure **or** can flow

allow electrons can carry charge through the metal / structure

if wrong bonding named or described or attraction between oppositely charged ions then do not award M1 or M3 − MAX 2

1

(d) (copper compounds are absorbed / taken up by) plants

allow crops

1

which are burned

1

the ash contains the copper compounds

do not award M3 if the ash contains copper (metal)

1

(e)

/ A_r	55.6 / 63.5	16.4 / 56	28.0 / 32
moles	0.876	0.293	0.875
ratio	3	1	3
formula	Cu_3FeS_3		

*award **4** marks for Cu_3FeS_3 with some correct working*

*award **3** marks for Cu_3FeS_3 with **no** working*

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*if the answer is not Cu_3FeS_3 award up to **3** marks for correct steps from the table apply ecf*

*if the student has inverted the fractions award **3** marks for an answer of $CuFe_3S$*

4

[16]

Q23.

(a) (i) the products are at a lower energy level than the reactants

accept products have less energy / less energy at the end than the beginning

1

(ii) because a catalyst provides an alternative / different pathway / mechanism / reaction route

accept adsorption or 'increases concentration at the surface'

ignore absorption

1

(that has) <u>lower activation energy</u>

allow weakens bonds

allow idea of increased successful collisions.

DO NOT ALLOW answers stating catalysts provide energy for M1 and M2

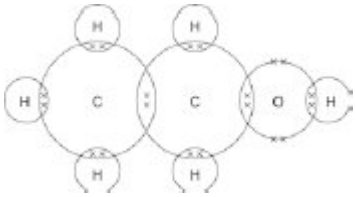
1

(b) one pair of electrons in each overlap (8 pairs in total)

allow any combination of dots, crosses or other symbols

1

the rest of the diagram correct with four non-bonding electrons on the oxygen giving a total of eight electrons in oxygen outer energy level.



*gains **2** marks*

1

(c) (i) ±3024 (J)

*correct answer with or without working gains **3** marks*

*if the answer is incorrect, award up to **2** marks for the following steps:*

- *$\Delta T = 14.4(°C)$*
- *50 x 4.2 x 14.4*

allow ecf for incorrect ΔT

3

(ii) 0.015(2173913)

*correct answer with or without working gains **3** marks*

if answer is incorrect, allow 1 mark each for any of the following steps up to a max of 2.

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- *0.70g*
- *M_r of ethanol = 46*
- *0.70 / 46*

allow ecf in final answer for arithmetical errors

3

(iii) ±198 720(J / mole)

c(i) ÷ c(ii)

*allow ecf from **(c)(i)** and **(c)(ii)***

0.015 gives 201600

0.0152 gives 198947

0.01522 gives 198686

1

(d) (as the molecules get bigger **or** the number of carbon atoms increases) the intermolecular forces

allow intermolecular bonds

1

(intermolecular forces) increase

allow more / stronger (intermolecular forces)

1

and therefore require more (heat) energy to overcome

*breaking covalent bonds or unspecified bonds max **1** mark (M3)*

1

[15]

Q24.

(a) (i) Proton

1

(ii) Neutron

1

(b) In order of increasing atomic number

1

(c) (i) 9

1

(ii) Gas

1

(d) (i) gains (one) electron

1

(to gain a) full outer energy level **or** noble gas configuration

allow because it has seven outer electrons

1

(ii) add sodium hydroxide (solution)

*allow ammonia (solution) **or** ammonium hydroxide **or** any other soluble hydroxide **or** flame test*

1

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(forms a) blue precipitate

second mark dependent on suitable reagent being added

allow blue−green / blue / green if flame test given

1

[9]

Q25.

(a) circle round any one (or more) of the covalent bonds

any correct indication of the bond − the line between letters

1

(b) Methane contains atoms of two elements, combined chemically

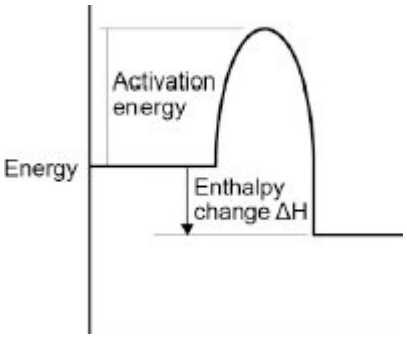
1

(c) (i) activation energy labelled from level of reagents to highest point of curve

ignore arrowheads

1

enthalpy change labelled from reagents to products



*arrowhead **must** go from reagents to products only*

1

(ii) $2\ O_2$

1

$2\ H_2O$

*if not fully correct, award **1** mark for all formulae correct.*

ignore state symbols

1

(iii) carbon monoxide is made

1

this combines with the blood / haemoglobin **or** prevents oxygen being carried in the blood / round body **or** kills you **or** is toxic **or** poisonous

dependent on first marking point

1

(iv) energy is taken in / required to break bonds

accept bond breaking is endothermic

1

energy is given out when bonds are made

accept bond making is exothermic

1

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the energy given out is greater than the energy taken in

this mark only awarded if both of previous marks awarded

1

(d) (i) energy to break bonds = 1895

calculation with no explanation max = 2

1

energy from making bonds = 1998

1

1895 − 1998 (= −103)
or
energy to break bonds = 656
energy from making bonds = 759
656 − 759 (= −103)

allow:

bonds broken − bonds made =

413 + 243 − 327 − 432 = -103 for 3 marks.

1

(ii) The C — Br bond is weaker than the C — Cl bond

1

[15]

Q26.

(a) sodium loses (electron)

sharing / covalent / metallic = max 2

1

chlorine gains (electron)

1

1 **or** an (electron)

1

(b) (i) Have no overall electric charge

1

(ii) Should iodine be added to salt?

1

reason
any **one** from:

- cannot be done by experiment

  accept difficult to get / not enough evidence
- based on opinion / view

  allow must be done by survey
- ethical **or** economic issue.

1

(c) (i) nitric (acid)

1

(ii) an alkali

1

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(iii) indicator

accept any named acid base indicator

1

(d) (i) Crystallisation

1

(ii) fertiliser

allow to help crops grow

1

(iii) any **one** from:

- pressure

  allow concentration
- temperature

  ignore heat
- catalyst.

1

[12]

Q27.

(a) any **one** from:

- protection / improve lifespan
- improve appearance.

1

(b) (i) Bleach

1

(ii) Hydrogen is less reactive than sodium

1

(iii) 1 bonding pair of electrons 6 unbonded electrons on Cl

accept dot, cross or e or − or any combination

1

(iv) Covalent

1

(v) Hydrogen chloride has a low boiling point.

1

Hydrogen chloride is made of simple molecules.

1

(c) (i) oxygen

accept carbon dioxide

1

(ii) aluminium ions are positive

1

so are attracted (to the negative electrode)

allow opposites attract

1

(iii) Reduction

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1

(iv) slide

allow move

1

(d) (i) C

1

(ii) strong covalent bonds

1

[14]

Q28.

(a) giant structure / lattice / layers / close packed

first 3 marks can be obtained from a suitably labelled diagram

incorrect structure or bonding or particle = max 3

1

made up of atoms / <u>positive</u> ions

1

with delocalized / free electrons

1

so electrons can move / flow through the metal

accept so electrons can carry charge through the metal

accept so electrons can form a current

1

(b) an alloy (is a metal which) has different types / sizes of atoms

accept converse for pure metal throughout

both marks can be obtained from suitable diagrams

allow made of different metals

allow mixture of metals / atoms / elements

ignore particles

ignore properties

*do **not** accept compound*

1

alloy has distorted layers

allow layers are unable to slide

1

(c) (i) can return to its original shape

accept shape memory alloy

accept smart alloy

ignore other properties

1

(ii) (pure copper is too) soft

accept converse

accept malleable or bends

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accept copper is running out

ignore references to strength and weakness

1

(iii) aluminium oxide

accept alumina

accept Al_2O_3

ignore bauxite / aluminium ore

1

(iv) any **one** from:

- different conditions
- different catalyst
- different pressure

allow different concentration

- different temperature.

*do **not** accept different monomers*

1

(d) any **two** from:

- accurate
- sensitive
- rapid
- small sample.

both needed for 1 mark

1

[11]

Q29.

(a) (i) silver nitrate

allow $AgNO_3$

1

(ii) potassium carbonate **or**

allow K_2CO_3

sodium carbonate

allow Na_2CO_3

1

(b) base

allow ionic

ignore insoluble or soluble

ignore alkali

1

(c) (i) evaporate

or

crystallise

allow heat or boil or leave (to evaporate)

allow cool

ignore filtration unless given as an alternative

*do **not** accept freeze or solidify*

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1

(ii) 2 (HNO_3)

accept multiples

1

(iii) 9

accept nine

1

(d) 6.21 / 207 0.72 / 16

***1** mark for dividing mass by A_r*

1

= 0.03 = 0.045

***1** mark for correct proportions (allow multiples)*

1

2 3

***1** mark for correct whole number ratio (allow multiples). Can be awarded from formula.*

1

Pb_2O_3

allow O_3Pb_2

***ecf** allowed throughout if sensible attempt at step 1*

*correct formula with no working gains **1** mark*

1

[10]

Q30.

(a) lattice / giant structure

*max **3** if incorrect structure or bonding or particles*

1

ionic **or** (contains) ions

1

Na^+ **and** Cl^-

accept in words or dot and cross diagram: must include type and magnitude of charge for each ion

1

electrostatic attraction

allow attraction between opposite charges

1

(b) hydrogen

allow H_2

1

sodium hydroxide

allow NaOH

1

(c) any **one** from, eg:

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- people should have the right to choose
- insufficient evidence of effect on individuals
- individuals may need different amounts.

allow too much could be harmful

ignore religious reasons

ignore cost

ignore reference to allergies

1

(d) (i) one bonding pair of electrons

accept dot, cross or e or − or any combination, eg



1

6 unbonded electrons on each atom

1

(ii) simple molecules

*max **2** if incorrect structure or bonding or particles*

accept small molecules

accept simple / small molecular structure

1

with intermolecular forces

accept forces between molecules

must be no contradictory particles

1

which are weak **or** which require little energy to overcome − must be linked to second marking point

reference to weak covalent bonds negates second and third marking points

1

(iii) iodine has no delocalised / free / mobile electrons or ions

1

so cannot carry charge

*if no mark awarded iodine molecules have no charge gains **1** mark*

1

[14]

Q31.

(a) magnesium <u>loses electrons</u>

there are four ideas here that need to be linked in two pairs.

1

<u>two electrons</u>

1

<u>chlorine gains electrons</u>

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*magnesium <u>loses</u> electrons and chlorine <u>gains</u> electrons scores **2** marks.*

1

<u>two atoms of chlorine</u>

magnesium <u>loses</u> <u>two</u> electrons and <u>two chlorines</u> each <u>gain</u> one electron will score full marks.

1

(b) 95

*correct answer with or without working gains **2** marks*
*if answer incorrect, allow 24 + 35.5 + 35.5 for **1** mark*

2

[6]

Q32.

(a) (i) two

1

(ii) a molecule

1

(iii) one pair of electrons between nitrogen and each of 3 hydrogens

1

rest correct
second mark dependent on first

1

(b) (i) (g) (s)

1

(ii) chloride
ignore formulae

1

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

- wear goggles
- wear gloves
- do not breathe in fumes
- wipe up spills immediately
- work in a fume cupboard

1

(ii) (particles of) ammonia move faster than (particles of) hydrogen chloride
allow diffuses faster
allow hydrochloric acid

1

(iii) particles / molecules have more energy
*do **not** accept atoms / ions*

1

so they move faster
ignore references to rate of reaction

1

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[10]

Q33.

(a) Sulfur dioxide causes acid rain.

1

(b) red / orange / yellow

*do **not** accept any other colours*

1

because sulfur dioxide (when in solution) is an acid

1

(c) (there are) <u>weak</u> forces (of attraction)

*do **not** accept any reference to covalent bonds breaking*

1

between the molecules

*do **not** accept any other particles*

1

(these) take little energy to overcome

award third mark only if first mark given

1

(d) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.

0 marks
No relevant content

Level 1 (1 – 2 marks)
A relevant comment is made about the data.

Level 2 (3 – 4 marks)
Relevant comparisons have been made, and an attempt made at a conclusion.

Level 3 (5 – 6 marks)
Relevant, detailed comparisons made and a justified conclusion given.

examples of the points made in the response

effectiveness

- W removes the most sulfur dioxide
- D removes the least sulfur dioxide

material used

- Both W and D use calcium carbonate
- Calcium carbonate is obtained by quarrying which will create scars on landscape / destroy habitats
- D requires thermal decomposition, this requires energy

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- D produces carbon dioxide which may cause global warming / climate change
- S uses sea water, this is readily available / cheap

waste materials

- W product can be sold / is useful
- W makes carbon dioxide which may cause global warming / climate change
- D waste fill landfill sites
- S returned to sea / may pollute sea / easy to dispose of

6

[12]

Q34.

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

*four points = **2** marks*

*three points = **1** mark*

Max 2

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

1

(ii) any **one** from:

must explain why the point is below the line

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

allow not enough sodium chloride added

allow smaller amount of sodium chloride

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

ignore the student may have misread the conductivity meter

1

(iii) any **one** from:

- the volume of pure water

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

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

  ignore current
- stirred

1

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

1

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

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

1

(ii) because there are ions in sodium chloride

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

Ignore particles other than ions for MP1.

1

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

MP2 must be linked to ions only.

1

(iii) Hydrogen

allow H_2 / H

1

[10]

Q35.

(a) (i) high

1

(ii) hundred

1

(b) hard

1

(c) (i) carbon

1

(ii) four

1

(iii) covalent

1

(iv) all

1

[7]

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