AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.2.1 CHEMICAL BONDS: IONIC, COVALENT AND METALLIC (PACK 2)

SCORE	PERCENTAGE
/255	%

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Q1.

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response.

0 marks
No relevant content

Level 1 (1–2 marks)
*There is a statement about the bonding and / or structure **or** melting / boiling point of chlorine **or** sodium chloride.*

Level 2 (3–4 marks)
*There are statements about the bonding and / or structure of chlorine **or** sodium chloride.*

Level 3 (5–6 marks)
*There are statements about the bonding and / or structure of chlorine **and** sodium chloride.*

*There is an explanation of why chlorine is a gas **or** sodium chloride is a solid.*

Examples of chemistry points made in response:

Chlorine:

covalent bonds between atoms

forming (simple) molecules

no / weak attraction / bonds between molecules

low boiling point

Sodium chloride:

*ionic bonds **or** electrostatic attraction*

strong bonds

in all directions

between oppositely charged ions

forming giant lattice

large amounts of energy needed to break bonds

high melting point

[6]

Q2.

(a) nanotubes can slide (over each other)

allow nanotubes can roll (over each other)

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1

because no (covalent) bonds between the nanotubes

*accept weak forces between the nanotubes **or** weak intermolecular forces*

allow layers for nanotubes throughout

1

(b) delocalised electrons

accept free electrons

1

so (delocalised) electrons can move <u>through the graphite</u>

accept so (delocalised) electrons can carry charge <u>through the graphite</u>

1

[4]

Q3.

(a) *weaker bonds*

allow (other substances) react with the silicon dioxide

or

fewer bonds

ignore weaker / fewer forces

or

disruption to lattice

*do **not** accept reference to intermolecular forces / bonds*

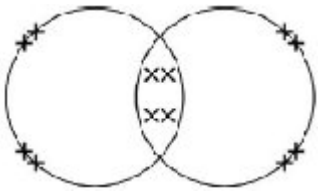
1

(b) (i) Na_2O

*do **not** accept brackets or charges in the formula*

1

(ii)



electrons can be shown as dots, crosses, e or any combination

2 bonding pairs

accept 4 electrons within the overlap

1

2 lone pairs on each oxygen

accept 4 non-bonding electrons on each oxygen

1

(c) *lattice / regular pattern / layers / giant structure / close-packed arrangement*

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1

(of) positive ions **or** (of) atoms

1

(with) delocalised / free electrons

*reference to incorrect particles **or** incorrect bonding **or** incorrect structure = max **2***

1

[7]

Q4.

(a) four

1

covalent

1

(b) because it has a high melting point

accept it won't melt

accept it won't decompose or react

allow withstand high temperatures

ignore boiling point

1

(c) thin

1

[4]

Q5.

(a) exothermic

1

(b) 'Should people use kelp instead of oil as an energy source?'

1

'Will kelp be more popular than coal in the next 10 years?'

1

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

*If atom or ion omitted = max **3***

*sharing / covalent / metallic = max **3***

ignore reference to full outer shells

- potassium (atom) loses (an electron) and iodine (atom) gains (an electron)
- 1 electron
- iodide (ion) has negative charge

  allow iodine ion
- potassium (ion) has positive charge

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- electrostatic attraction **or** ionic bonding
  *accept stable (structure) **or** noble gas (structure)*

4

(ii) because a solid is formed (from two aqueous solutions)

1

(iii) filtering **or** centrifuging **or** decanting

1

[9]

Q6.

(a) would melt

accept they have a low melting point
allow lose their shape
ignore would soften when hot
ignore boiling point

1

(b) to speed up the reaction

accept can use a lower temperature
accept less energy needed

1

(c) (i) mass spectrometer

allow mass spectroscopy

1

(ii) any **one** from:

ignore reliable
ignore more precise

- accurate
- sensitive
- rapid / quicker
- small amount of sample

1

(d) any **two** from:

allow concentration

- pressure
- temperature
- catalyst **or** initiator
- solvent

2

[6]

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Q7.

(a) (i) because they are positively charged

accept they are positive / H^+

*accept oppositely charged **or** opposites attract*

ignore they are attracted

1

(ii) gains one / an electron

accept $H^+ + e^- \rightarrow H$ or multiples

allow gains electrons

1

(b) 3 bonding pairs

1

1 lone pair

accept 2 non-bonding electrons on outer shell of nitrogen

1

(c) (i) hydroxide / OH^-

*do **not** accept sodium hydroxide*

1

(ii) $H^+ + OH^- \rightarrow H_2O$

ignore state symbols

ignore word equation

1

(d) 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 also refer to the information in the Reference material.

0 marks
No relevant content.

Level 1 (1-2 marks)
There are basic descriptions of advantages or disadvantages of the electrolysis cells.

Level 2 (3-4 marks)
There are clear descriptions of environmental or economic advantages or disadvantages of the electrolysis cells. Comparisons may be implied.

Level 3 (5-6 marks)
There are detailed descriptions of environmental and economic advantages and disadvantages, comparing the electrolysis cells.

Examples of chemistry points made in the response:

Accept converse where appropriate.

- mercury cell is more expensive to construct
- mercury is recycled but membranes must be replaced

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- mercury is toxic but membrane / polymer is not
- removing traces of mercury from waste is expensive
- mercury cell uses more electricity
- mercury cell produces chlorine that is purer
- mercury cell produces higher concentration / better quality of sodium hydroxide (solution)

6

[12]

Q8.

(a) Will kelp last longer than coal as an energy source?

1

(b) any **two** from:

- cannot be determined by experiment
  allow can't predict how long kelp / coal will last
  allow more testing needed
- based on opinion
- ethical **or** environmental **or** economic reason
  allow could damage ecosystem allow reference to cost

2

(c) (i) 7

1

(ii) sodium (atom) loses (electron) **and** iodine (atom) gains (an electron)
*reference to incorrect bonding **or** incorrectly named particle = max **2***
any or all marks can be obtained from a labelled diagram
ignore inner shell electrons if shown

1

1 electron

1

(electrostatic) attraction **or** forms ionic bond(s)

1

(iii) ions can move (in the solution)

1

(iv) $2\,I^- \rightarrow \mathbf{I_2} + \mathbf{2}\,e^-$

1

(v) hydrogen is formed

1

because sodium is more reactive (than hydrogen)

1

[11]

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Q9.

(a) <u>layers</u>

which have weak forces / attractions / bonds between them
second mark must be linked to layers

1

or

which can slide over each other **or** separate
ignore references to rubbing

1

(b) covalent

1

[3]

Q10.

(a) (i) nucleus

1

(ii) neutron

1

(iii) electron

1

(b) (i) 12

1

(ii) 24

1

(c) any **four** from:
*sharing / covalent / metallic = max **3***

- magnesium (atom) reacts with **<u>two</u>** <u>iodine (atoms)</u>
- magnesium (atom) loses electrons
- **2** electrons (from each atom)
- Iodine (atom) gains electron(s)
- **1** electron or an electron (to each atom)
- iodide ion formed
  allow iodine ion
- iodide has negative charge / is a negative ion / particle
  allow iodine
  ignore I^{2-}
- magnesium ion formed
- magnesium has positive charge

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- oppositely charged ions attract
- a giant structure / lattice is formed

  *allow **1** mark for unqualified reference to ion formation or ionic bonding*

4

[9]

Q11.

(a) *reference to incorrect bonding **or** incorrect structure **or** incorrect particles = max **3***

giant structure / lattice

ignore many bonds

1

made up of <u>positive</u> ions surrounded by delocalized / free electrons

allow <u>positive</u> ions surrounded by a sea of electons

1

with strong bonds / attractions

allow hard to break for strong

1

so a lot of energy is needed to break these bonds / attractions / forces

ignore high temperature

ignore heat

1

(b) (i) that they are <u>very</u> small

or

1-100 nanometres **or** a few(hundred) atoms

accept tiny / really small / a <u>lot</u> smaller / any indication of very small eg. microscopic, smaller than the eye can see

ignore incorrect numerical values if very small is given

1

(ii) delocalised / free electrons

allow sea of electrons

1

one <u>non-bonded</u> electron from each atom

accept electron(s) <u>moving through the structure / nanotube</u>

allow electron(s) carry / form / pass current / charge

1

[7]

Q12.

(a) (i) lead nitrate

accept $Pb(NO_3)_2$

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do not accept nitride
ignore (all) nitrate(s)

1

(ii) sodium iodide / potassium iodide

accept NaI / KI

accept other correct soluble iodides eg HI, MgI_2

do not accept sodium iodine / potassium iodine

1

(b) *metallic / sharing / covalent **or** molecule = max **3***

magnesium <u>loses **2** electrons</u>

all three underlined ideas must be present

*two underlined ideas = **1** mark eg magnesium loses electrons*
or
magnesium gains 2 electrons
or
magnesium loses 2 ions

*nb magnesium **ion** loses 2 electrons = **1** mark*

*2 errors = **0** marks eg magnesium gains electrons*

2

<u>iodine gains **1** / **an** electron</u>

all four underlined ideas must be present

*three underlined ideas = **1** mark eg iodine gains electron(s)*
or
iodine loses 1 / an electron
or
iodide gains 1 / an ion
or
iodide (ion) gains 1 / an electron

*2 errors = **0** marks*

2

(c) attractions / forces (of attraction) / bonds are <u>strong</u> **or** lot of energy needed to break bonds / forces / attractions

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

1

because oppositely charged ions <u>attract</u> **or** electrostatic <u>attraction</u> between ions

1

in giant structure **or** lattice

ignore many bonds

ignore ionic bonding unqualified

1

[9]

Q13.

(a) 1 / one

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1

(b) (i) protons

1

(ii) neutrons

1

(iii) 7

1

(c) (i) losing

1

(ii) a positive

1

(iii) electrostatic

1

(d) high melting points

1

strong bonds

1

(e) (i) 58.5

1

(ii) mole

1

(f) very small (particles) **or**

ignore tiny / small / smaller / microscopic etc.

1-100nm in size **or**

(particle with a) few hundred atoms

1

[12]

Q14.

(a) (alloy) atoms / ions / particles not in layers

accept layers are distorted

accept different (size) particles / atoms

1

so, (alloy) layers / atoms / ions / particles can't slide

*if no other mark awarded allow (an alloy) is a mixture of metals for **1** mark*

1

(b) diamonds have a giant covalent structure

1

diamonds have strong bonds between carbon atoms

1

(c) (i) a compound

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1

(ii) CH_4

1

(iii) covalent

1

(d) methane has a low boiling point
or boiling point less than 20°C molecules

1

because it has small molecules

accept it has forces between molecules

*accept weak forces between molecules for **2** marks*

1

[9]

Q15.

(a) (i) was well qualified

1

(ii) check the results of the experiment

1

(b) (i) cannot move

1

(ii) melt it / make it a liquid

allow heat it

allow dissolve (in water) / make a solution

1

(iii) they are positive

*allow opposites attract **or** opposite charges*

1

(iv) atoms

1

[6]

Q16.

(a) (i) M_r of NH_3 = 17

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

accept correct rounding of intermediate answers

can be credited from correct substitution from step 2

1

or

2 (moles of) NH_3 = 34

or

14 → 17

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or

28 → 34

(28/34) × 6.8

allow ecf from step 1

1

or

(14/17) × 6.8

= 5.6

allow ecf from step 1

1

(ii) 61.8

accept 61.76 ***or*** *62* ***or*** *61.76…*

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

if answer is not correct evidence of 4.2 / 6.8 × 100 gains ***1*** *mark*

if answer not correct 0.618 or 0.62 gains ***1*** *mark*

2

(iii) reaction is reversible

accept reaction reaches equilibrium

allow reaction does not reach completion

ignore some is lost

1

(b) 3 bonding pairs

do ***not*** *accept extra electrons on hydrogen*

1

1 lone pair

accept 2 non-bonding electrons on outer shell of nitrogen

1

(c) (i) hydroxide / OH^-

accept phonetic spelling

1

(ii) neutralisation

accept acid-base

allow exothermic

1

(iii) nitric (acid)

allow HNO_3

ignore incorrect formula

1

(iv) $(NH_4)_2 SO_4$

allow $(NH_4^+)_2 SO_4^{2-}$

1

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[12]

Q17.

(a) (iron (steel) is) strong

*allow abundant **or** easy to extract **or** cheap*
ignore other correct properties

1

(b) less dense

allow low mass

1

more abundant

accept copper is 'running out'
allow copper is more expensive
ignore other correct statements

1

(c) (i) C_2H_4

1

(ii) double bond

1

(iii) poly(ethene)

1

[6]

Q18.

(a) (i) A

1

(ii) E

1

(b) (i) insoluble

precipitation

2

(ii) filtration

*accept decant **or** centrifuge*

1

(iii) hydrochloric acid

1

(c) (i) melt

allow add to / dissolve in water
allow heat until liquid
allow turn it to liquid / make it molten
ignore heat

1

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(ii) they are positive

or

opposite charges **or** opposites attract

*do **not** accept electrodes attracting*

*do **not** accept positive electrons*

1

(iii) chlorine

accept Cl_2

*do **not** accept chloride*

1

[9]

Q19.

(a) (i) C

1

(ii) C **or** D

1

(iii) A

1

(b) covalent

1

(c) layers

1

can slide / move over each other

accept are weakly bonded (owtte)

allow no bonds between layers

ignore slip / rub

1

[6]

Q20.

(a) oxygen **and** water

both needed for mark

allow hydrogen oxide for water

in any order

ignore formulae

1

(b) (i) best fit line, omitting point at 10s

straight line drawn through all correct points

1

(ii) circle around point at 10 s

allow any indication

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1

(iii) 7.5

allow ecf from candidate's line

1

(iv) increases (with time)

accept goes from 0 to 12.5

1

(c) (i) higher

1

(ii) more concentrated

1

(d) (i) share

1

(ii) covalent

1

(iii) simple molecules

1

(e) Water has a boiling point of 100°C

1

Water has a melting point lower than room temperature

1

[12]

Q21.

(a) any **one** from:

- they are negative / anions

  allow Cl^-

  ignore atoms / chlorine

  *do **not** accept chloride ions are negative electrodes*

- they are attracted
- they are oppositely charged

1

(b) hydrogen is less reactive than sodium

1

(c) hydroxide (ions) / OH^-

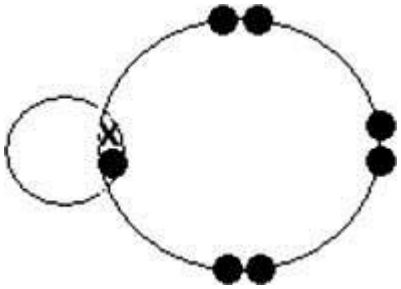
ignore OH

*do **not** accept NaOH / sodium hydroxide*

1

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(d) (i)



allow any combination of dots or crosses
ignore chemical symbols

1

(ii) covalent
allow close spelling errors
apply list principle

1

(iii) hydrogen (ion) / H^+
ignore (aq) / H
do not accept hydrochloric acid / HCl
apply list principle

1

[6]

Q22.

(a) (i) *mention of molecules **or** any reference to incorrect bonding = max 2*

giant structure / lattice or particles arranged in a regular pattern
allow close packed / layers

1

sea of electrons / delocalised electrons
allow free electrons

1

positive ions and electrons attract each other
ignore metallic bonds
appropriately labelled diagrams can gain first two marks

1

(ii) (sea of) electrons can move <u>through the structure</u>
allow free / roaming / mobile electrons

or delocalised electrons

1

(b) (metal) oxide / ionic compound formed

1

ions not free to move

or

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electrons cannot move <u>through the structure</u>

allow no / fewer delocalised / free / roaming / mobile electrons

1

[6]

Q23.

(a) any **two** from

assume it = methanol

allow converse for water

- shorter / quicker soaking time

  allow it is quicker

- takes less time / quicker to dry

  or faster evaporation

- dissolves quicker / better in methanol

2

(b) (i) CH_4O

1

(ii) covalent

1

(c) it is made of small molecules

1

[5]

Q24.

(a) high melting point

1

not flammable

1

(b) (i) all

1

(ii) two

1

(iii) covalent

1

(iv) very strong

1

[6]

Q25.

(a) (i) 65

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*correct answer with or without working = **2** marks*
if answer incorrect
*evidence of (81 - 16) for **1** mark*
ignore units

2

(ii) zinc

accept error carried forward from (a)(i)
allow correct symbol
answer given should be element / metal closest to their answer
*do **not** allow compounds*

1

(b) (i) • it loses electrons

*sharing / covalency = max **1** mark*

1

• three electrons

1

(ii) 8 electrons shown in second shell.

accept dots / crosses / mixture of dots and crosses / e
electrons do not need to be paired
*do **not** allow extra electrons in first shell*

1

[6]

Q26.

three from:

*reference to ionic / metallic / intermolecular / (small) molecules = max **2***

structure: (max 2)

- giant structure / macromolecule / all the atoms are joined together

  allow (giant) lattice
  ignore large structure
  ignore diamond structure

- covalent (bonds)
- strong bonds / bonds difficult to break
- each silicon atom forms 4 bond sand / or each oxygen atom forms 2 bonds

explanation: (max 2)

- a lot of energy needed to break the bonds
- high melting point

  *if neither point given accept high temperature needed to break bonds for **1** mark*

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- does not burn **or** react with oxygen

3

[3]

Q27.

(a) carbon

1

(b) <u>layers</u>

1

have weak forces / attractions / bonds between them **or** are only held together weakly

second mark must be linked to layers

or

can slide over each other **or** separate (1)

1

(c) covalent

1

[4]

Q28.

(a) gives out / releases / transfers to surroundings heat / energy

ignore light / burns

ignore the wire gets hot

1

(b) activation energy

1

(c) (aluminium +) oxygen (→) aluminium oxide

accept correct formulae

1

(d) C

1

(e) (i) a negative

1

(ii) loses

1

(iii) gains

1

two

1

[8]

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Q29.

(a)

$\frac{6.21}{207}$ $\frac{0.64}{16}$

1 *mark for dividing mass by* A_r
max ***2*** *if* A_r *divided by mass*

1

= 0.03 = 0.04

1 *mark for correct proportions*

1

3 4

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

1

Pb_3O_4

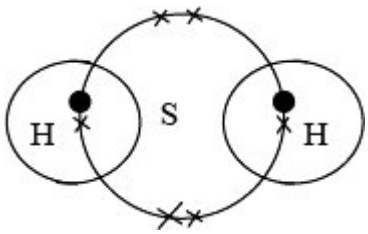
1 *mark for correct formula*

ecf *allowed from* ***step 2 to step 3*** *and* ***step 3 to step 4*** *if sensible attempt at* ***step 1***

correct formula with no working gains ***2*** *marks*

1

(b) (i)



allow all dots ***or*** *all crosses* ***or*** *e* ***or*** e^-

ignore inner shells and any inner electrons

allow 4 non-bonded electrons anywhere on shell as long as not in overlap – need not be paired

1

(ii) forces of attraction / bonds <u>between</u> molecules are weak (owtte)

do ***not*** *accept intramolecular forces / covalent bonds are weak*

do ***not*** *accept reference to ions*

or

<u>intermolecular</u> forces / bonds are weak (owtte)

or

it is made of small molecules with weak forces of attraction

if ***2*** *marks not awarded*

made of small molecules / simple molecular gains ***1*** *mark*

forces of attraction are weak (without specifying between molecules / intermolecular) gains ***1*** *mark*

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(accept easily broken / not much energy needed to break instead of weak)

bonds are weak without specifying intermolecular would not gain a mark and would be ignored

2

(iii) 4

1

[8]

Q30.

(a) (i) mix (owtte)

accept to allow more collisions / helps particles to collide (owtte)

idea of more efficient heat transfer

*do **not** allow heat is a catalyst*

1

(ii) higher **and** more

1

powder **and** big

1

concentrated **and** more

1

(b) electrons

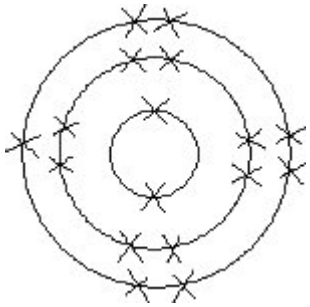
1

(c) H^+

1

[6]

Q31.

(a) 

accept dots / crosses / e

must be drawn on diagram

electrons do not need to be paired

ignore brackets or + or -charges

ignore 2,8,7

1

(b) (one) electron

recognition that electrons are involved

1

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lost / given away / transferred from sodium / transferred to chlorine owtte

must be linked to electrons

*accept loses electron(s) for **2** marks*

*NB loses 2 or more electrons gains **1** mark*

*reference to sharing / covalent max **1** mark*

ignore charges on ions formed

1

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

- ions / atoms / they are / it is negatively charged / anions
  accept they are negative
- opposite (charges) attract
  accept they are <u>attracted</u> or it is oppositely charged
  ignore opposite forces attract

1

(ii) hydrogen

accept H_2

ignore H or H^+

1

(d) (i) poisons released into environment (owtte)

accept any sensible idea of harm / harmful / poisons / poisonous / pollution / damaging

*do **not** accept answers such as global warming / ozone layer etc.*

ignore safety unless qualified

1

(ii) any **one** sensible idea eg

- loss of work / unemployment
  eg shops / house prices etc.

  or
  company goes out of business
- any adverse effect on local economy (owtte)
- any adverse effect on paper production / cost of paper / cost of water (treatment)
  allow less expensive to use chlorine or converse
- chlorine (compounds) have been used (for many years) without causing harm owtte
- only a tiny amount of chlorine is released so it would not cause harm
  ignore uses of chlorine to treat drinking water unless qualified

1

(iii) ideas related to bias

accept more reliable or valid or fair

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ignore more accurate / fair test

1

[8]

Q32.

(a) (i) nucleus

1

(ii) neutron

1

(iii) electron

1

(b) (i) 6

1

(ii) 12

1

(c) $^{14}_{6}C$

1

(d) (i) CH_4

1

(ii) compound

1

(iii) covalent

1

[9]

Q33.

(a) (i) precipitation

1

(ii) filtration

1

(iii) lead nitrate

1

sodium iodide

1

(b) *sharing / covalent / metallic = max **3***

any **four** from:

- magnesium (atom) reacts with **two** iodine (atoms)
- magnesium (atom) loses
- **2** electrons

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- iodine (atom) gains
- **1** electron **or** an electron
- iodide ion formed
  allow iodine ion
  allow iodine
  ignore I^{2-}
- iodide has negative charge / is a negative ion / particle
- magnesium ion formed
- magnesium has positive charge
- oppositely charged ions attract
- a giant structure / lattice is formed
  *if reference to ions being formed is made unqualified, allow **1** mark*

4

[8]

Q34.

(a) (i) lead nitrate
accept $Pb(NO_3)_2$
*do **not** accept nitride*

1

sodium iodide / potassium iodide
accept NaI / KI
accept other correct soluble iodides
*do **not** accept sodium iodine / potassium iodine*

1

(ii) filter / filtration / filtering
accept decant / decanting etc.
accept centrifugation
*ignore evaporation **or** heating if after filtration*

1

(b) *metallic / sharing / covalent **or** molecule = max **3***

magnesium <u>loses</u> <u>**2**</u> <u>electrons</u>
all three underlined ideas must be present
*two underlined ideas = **1** mark*
eg magnesium loses electrons
or
magnesium gains 2 electrons
or
magnesium loses 2 ions
*nb magnesium **ion** loses 2 electrons = **1** mark*

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*2 errors = **0** marks*
eg magnesium gains electrons
all four underlined ideas must be present

2

<u>iodine</u> <u>gains</u> <u>**1** / **an**</u> <u>electron</u>

*three underlined ideas = **1** mark*
eg iodine gains electron(s)
or
iodine loses 1 / an electron
or
iodine gains 1 / an ion
or
iodide (ion) gains 1 / an electron
*2 errors = **0** marks*

2

(c) any **two** from:

*mention of molecules / intermolecular / covalent / atoms = max **1***

- forces (of attraction) / bonds are <u>strong</u> **or** lot of energy needed to break bonds
- oppositely charged ions <u>attract</u> **or** electrostatic <u>attraction</u> between ions
- <u>giant</u> structure **or** <u>lattice</u>

  allow many bonds
  ignore ionic bonding unqualified

2

[9]

Q35.

(a) C_3H_8

capital letters for symbols numbers must be halfway or lower down the element symbol
allow H_8C_3
*do **not** allow 3:8 **or** C_3 and H_8*

1

(b) (i) electron

1

(ii) covalent

1

(c) low **and** small

*both for **1** mark*

1

[4]

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