AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.2.1 CHEMICAL BONDS: IONIC, COVALENT AND METALLIC (PACK 3)

SCORE	PERCENTAGE
/221	%

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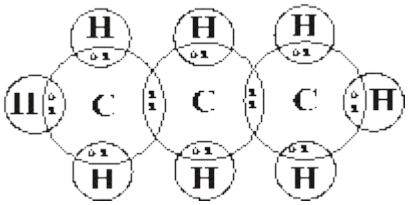
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Q1.

(a)



allow all dots
or
all crosses
or
combination
or
all e / e⁻
or –
or *other suitable symbols*

*centre of symbols must be on **or** inside overlapping areas within reason*

1

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

- no change initially **or** stays constant at the beginning
- increase
- slowly at first and then more rapidly

accept converse arguments

*allow vapour pressure is 0 at any temperature <–100°C for **1** mark*

accept positive correlation

accept explanation based on kinetic theory eg particles have more kinetic energy

allow reasonable attempt at using numbers

2

(ii) –44 (using graph) accept –43 to –45

1

(c) • <u>intermolecular</u> forces / bonds **or** forces / bonds <u>between molecules</u>

1

- bonds / forces are weak

<u>covalent</u> *bonds are weak = **0** marks*

*if they do not gain either of the marks on the left then allow simple covalent / molecular / made of small molecules for **1** mark*

1

[6]

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Q2.

(a) covalent

1

(b) (i) liquid

1

(ii) fluorine

accept F / F_2

*do **not** accept fluoride*

1

(c) (i) should fluoride ions be added to drinking water?

1

(ii) any **one** from:

- not enough reliable/valid evidence
- may be other factors involved
- it is an opinion / choice / belief / ethics issue
- it can't be scientifically investigated

allow can't do an experiment

ignore test

mark independently of (c) (i)

1

[5]

Q3.

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

- they are positive / cations
- they are H^+
- opposite charges attract

ignore atom

1

(ii) potassium is more reactive (or reverse)

assume 'it' refers to hydrogen

allow potassium reacts <u>with</u> water

*allow potassium is very reactive **or** most reactive metal / element*

allow hydrogen gains electrons more easily / is reduced more easily

accept potassium is higher up the reactivity series

1

(b) 6 **and** 2

accept correct multiples and fractions

1

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(c) (i) the reaction / it is reversible **or** a description of a reversible reaction

allow 'it is an equilibrium'

allow reversible symbol drawn correctly

allow 'the reverse / back reaction'

1

(ii) **lithium nitride**

assume that 'it' or if they do not specify means lithium nitride

assume lithium / lithium nitrate refers to lithium nitride

- hydrogen is bonded / held / absorbed / has formed a compound / reacted with lithium nitride

1

plus **one** of:

- does not explode / cause a fire
- is not free / less hydrogen
- is not under pressure
- does not leak
- is only released slowly

1

- compound of hydrogen with lithium nitride / product is (more) stable / less reactive / less chance of a reaction

accept converse for hydrogen as below

assume that gas / hydrogen means gas in the cylinder

- *hydrogen (in cylinder) / gas is not bonded / held absorbed / in a compound / reacted with lithium nitride*

1

*plus **one** of:*

- *can explode / cause a fire*
- *is free*
- *is under pressure*
- *can leak*
- *releases quickly*

1

(d) (i) loss of an electron **or** loses electrons

do not accept any ref. to oxygen

1

(ii) full outer shell of 8 electrons on circle

need not be paired

can be ×, dot or e

*do **not** accept if extra electrons added to inner shell*

1

[10]

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Q4.

(a) CH_4

4 should be below halfway up H / tail of 4 below the dotted line

1

(b) molecule

1

(c) covalent

1

[3]

Q5.

(a) gives out (heat)

1

(b) D

1

(c) L

1

(d) magnesium chloride

1

[4]

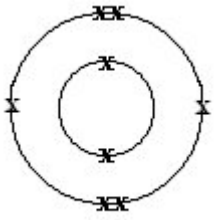
Q6.

(a) $2Mg + O_2 \rightarrow 2MgO$

accept correct multiples / fractions

1

(b)

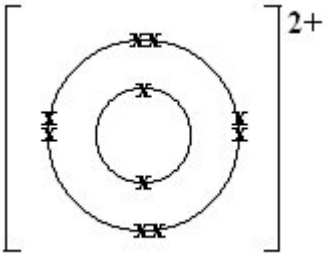


electrons do not need to be paired
accept dots / circles / e instead of crosses
*do **not** allow 2.6 without diagram*

1

(c)

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electrons do not need to be paired
allow without bracket s/ must have the charge
accept dots / circles / e instead of crosses
ignore extra empty outer shells
ignore nucleus
*do **not** allow [2.8]$^{2+}$ without diagram*

1

(d) oppositely charged (ions / atoms)

allow positive and negative(ions / atoms)

1

(they) attract

must be in correct context
accept held by electrostatic forces
ignore ionic bonding
***maximum 1** if they refer to intermolecular forces / attractions / covalent bonds*

1

(e) magnesium chloride

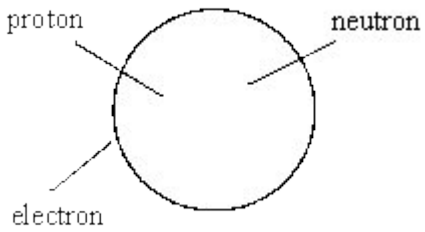
accept $MgCl_2$ (if correctly written)

1

[6]

Q7.

(a) (i)



*all three correct **2** marks*
*one correct **1** mark*

2

(ii) 14

1

(b) A

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1

[4]

Q8.

(a) 157

*correct answer with **or** without working*
*(2 × 19 + 119) for **1** mark only*
*allow (119 + 19 =) 138 for **1** mark only*
ignore units

2

(b) 24.2

accept answers in the range 24 to 24.2038.....
ignore incorrect rounding after correct answer
*25 only without working gains **1** mark **or***
*38/157 × 100 gains **1** mark **or***
*(19/157 × 100 =) 12 to 12.1 gains **1** mark*
allow error carried forward from part(a)
*38/(a) × 100 gains **2** marks if calculated correctly*
*(19/138 × 100 =) 13.8 gains **1** mark*

2

(c) 0.29

accept answers in the range 0.28 to 0.3
allow error carried forward from part (b)
(b)/100 × 1.2 correctly calculated
ignore units

1

(d) an electron

allow electrons
*allow electron shared / lost for **1** mark*
apply list principle for additional particles

1

is gained owtte

must be linked to electron
accept can hold / take in if in correct context
*eg it can hold another electron (in its outer shell) = **2** marks*
*it can take an electron (from another atom) = **2** marks*
ignore reference to fluoride ions
*incorrect number of electrons gained does **not** gain the second mark*

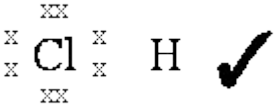
1

[7]

Q9.

(a) bonding pair in the overlap **and** 6 other electrons arranged around the chlorine

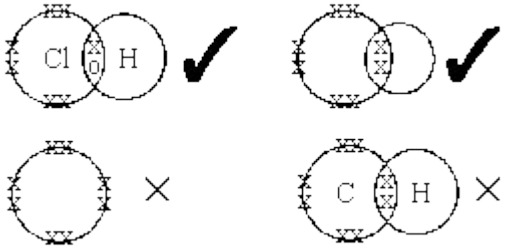
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✓

must have either circles or symbols

need not be pairs but must not be in the overlap region
accept without H and Cl if clear
accept all x's or all o's



✓ ✓ × ×

1

(b) H_2 + Cl_2 → 2HCl

accept multiples or fractions
accept correct formulae but not balanced for 1 mark

correctly balanced equation containing
'correct' lower / upper case symbols gets 1 mark

2

(c) $MgCl_2$

accept $Mg^{2+}(Cl^-)_2$

1

(d) because magnesium chloride is made of ions **or** is ionic

accept there are strong forces of attraction between the ions / particles in $MgCl_2$ or strong electrostatic attractions
accept more energy to separate particles in $MgCl_2$

*do **not** accept $MgCl_2$ molecules*
*do **not** accept reference to breaking bonds*

1

hydrogen chloride is made of molecules **or** is covalent

accept there are only weak forces of attraction (between the particles / molecules) in HCl

*do **not** accept weak covalent bonds*
*do **not** accept reference to breaking bonds*
*do **not** accept $MgCl_2$ is a solid and HCl is a gas*

1

[6]

Q10.

(a) (i) **Quality of Written Communication**

The answer to this question requires ideas in good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme.

maximum 2 marks if ideas not expressed well

layers / lattice / giant structure / regular pattern of atoms (diagram)

allow layers / lattice / giant structure / regular pattern of ions

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*do **not** accept particles*

1

outer (shell) electrons

accept valence electrons

1

(free to) move (through whole structure)

accept delocalised / mobile / free

1

(ii) the free electrons (allow the metal to conduct electricity)

accept electrons move / mobile / delocalised

1

(iii) atoms / ions / layers can slide / slip / move over each other

1

(b) (i) copper oxide formed **or** Cu reacts with oxygen **or** Cu is oxidised

1

this is a poor conductor **or** gets in the way of free moving electrons **or** fewer mobile electrons

*do **not** accept electricity*

1

or

oxygen atoms / oxygen molecules / oxide ions in metal

do not accept oxygen pockets / bubbles

prevents / disrupts flow of electrons /
current or fewer mobile electrons (1)

*do **not** accept macro explanations*
*do **not** accept electricity*

(ii) hydrogen reacts with oxygen or water is formed **or** hydrogen reduces copper oxide etc.

1

[8]

Q11.

(a) (i) correct number of electrons (18)

accept any combination of dots and crosses

1

2, 8, 8

*2, 8, 8 written on rings = **1** mark*

1

(ii) loses 2 electrons **or** loses both electrons

*loses electrons = **1** mark*
*any answers about gaining electrons = **0** marks*

2

(b) (i) 5

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accept multiples if all correct

1

(ii) 6

accept multiples if all correct

1

[6]

Q12.

(a) all electrons correct (inner shell need not be shown)

three bond pairs and two electrons anywhere else
can use dots, crosses or e's in any combination

1

(b) covalent

accept phonetic spelling
*do **not** accept convalent*

1

[2]

Q13.

answers apply to:

accept diagrams and/or descriptions

carbon dioxide CO_2

ammonia NH_3

methane CH_4

water H_2O

*outer electronic structure of one atom correct **or** needs correct number of electrons to complete outer shell

1

*outer electronic structure of other atom correct **or** needs correct number of electrons to complete outer shell

1

*one shared **pair** of electrons (as one covalent bond)

use of ions or reference to ionic bonding negates this mark

1

*outer electronic structure of compound correct **or** each atom now has a full outer shell/noble gas electron structure

1

[4]

Q14.

(i) reversible (reaction)

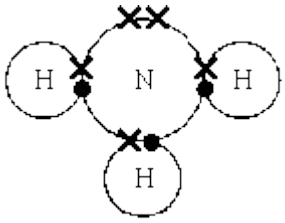
1

(ii) (yield of ammonia) increases

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1

(iii)



1

[3]

Q15.

(i) can be from diagram chlorine (2.8).7.

accept chlorine needs one more electron

1

can be from diagram shares a pair of electrons

1

shared pair of electrons is a covalent bond

*do **not** accept ionic bond*

1

(ii) can be from diagram and appropriately annotated sodium (2.8). 1. and chlorine (2.8).7

1

sodium loses one electron and chlorine gains one electron

1

Na^+ and Cl^- formed

1

bond formed between oppositely charged ions **or** ionic bond is formed

*do **not** accept covalent bond*

1

[7]

Q16.

(a) (i) 78-80%

1

(ii) proteins

accept amino acids

1

(b) (i) natural gas

accept methane (CH_4)

accept water (H_2O)

1

(ii) carbon dioxide

1

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(c) (i) $N_2 + H_2$

1

correct balancing $1 + 3 \rightarrow 2$

award only if reactants are correct

1

(ii) iron

accept Fe

1

(iii) at low temperatures rate of reaction is too slow

accept very few collisions at low temperatures

accept converse

particles need enough (activation) energy to react

accept particles need enough energy for bonds to break

accept converse

1

(d) all three covalent bonds displayed correctly as electron pairs

1

two lone electrons displayed not necessarily as a pair

1

[11]

Q17.

(a) (i) H_2SO_4 **or** red (acidic) pH < 7

accept names of compounds

accept correct use of acidic

1

NaOH **or** purple (alkaline) pH > 7

*alkaline and neutral without any mention of pH for **1** mark only*

1

NaCl **or** green (neutral) pH 7

*ignore high **or** low pH*

1

(ii) hydrogen (ion)

accept proton

accept hydroxonium ion

1

H^+

accept H_3O^+ for hydroxonium ion

1

(b) (i) neutralisation

1

(ii) NaOH + HCl

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ignore state symbols

1

$NaCl + H_2O$

ignore state symbols

*maximum of **1** mark if incorrectly balanced*

1

(c) (i) sodium – 2 . 8 . 1

accept 2.8.1 written

1

chlorine – 2 . 8 . 7

accept 2.8.7 written

1

(ii) ion(s)

1

(iii) attraction between oppositely charged particles (ions)

accept attraction between + and – particles (ions)

accept electrostatic attraction

1

(d) chloride ions lose electrons to form chlorine

$Cl^- - e^- \rightarrow Cl$

1

hydrogen ions gain electrons to form hydrogen

$H^+ + e^- \rightarrow H$

1

sodium hydroxide remains in solution

Na + and OH^- remain in solution to form sodium hydroxide

1

[15]

Q18.

(a) (i) pair of electrons shared (for one covalent bond) or (shown in diagram)

1

complete bonding **or** electron configurations described **or** drawn

*if candidate states 'ionic' then maximum mark is **1***

1

(ii) transfer of one electron from sodium to chlorine

*accept diagrams **or** electron arrangements showing this transfer*

1

Na^+ and Cl^- formed

*if candidate states 'covalent' then maximum mark is **2***

1

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opposite ions attract

'opposite' required if charges on ions not shown

1

(b) each has 17 protons

accept same number of protons

1

each has 17 electrons

accept same number of electrons

1

18 and 20 neutrons or neutron numbers differ by 2

accept different number of neutrons

*for full marks must mention all numbers of particles otherwise maximum mark is **2***

1

[8]

Q19.

(a) 2 2 multiples of ½ allowed

for 1 mark

1

(b) (i) 2. 8. 1 and 2. 8. 7

gains 3 marks

1 mark for 2 electrons in each inner shell
1 mark for 8 electrons in each second shell
1 mark for 1 electron in sodium outer shell
and 7 in chlorine outer shell

3

(ii) sodium atom loses;
electron;
chlorine atom gains;
electron

for 1 mark each

inversion = 2 marks
lose negative charge = 1 mark

4

(c) (i) KCl (accept 2KCl)

for 1 mark

1

(ii) both have on electron in outer shell/same number of electrons/
lose same number of electrons in compound formation/
both lose one electron

for 1 mark

1

(d) 0 amps;
the ions;
cannot move in the solid
solid Na chloride does not conduct

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for 1 mark each

3

(e) (i) water (H_2O)

for 1 mark

1

(ii) (1) chlorine;
(2) hydrogen

for 1 mark

1

[15]

Q20.

(a) any (must be named)

1

(b) F_2

1

(c) –/F^-

1

(d) (i) covalent

1

(ii) made of molecules etc.
type of bonding when non-metals react.

1

[5]

Q21.

(i) electrons 1

for 1 mark

(ii) covalent 1

for 1 mark

(iii) made of small molecules:
usually gas or liquid) dependent on
have low melting points) having first
have low boiling points) point above
forces between molecules are weak

any 1 for 1 mark

3

[5]

Q22.

(a) 8 marks Particularly well structured answer with most points mentioned.

7-6 marks Well structured answer. The two metals will have been compared rather than simply listing advantages/disadvantages. Most of the advantages and disadvantages of each metal have been mentioned.

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5-3 marks Some structure to the answer. An attempt to compare the metals by giving some advantages and disadvantages.

2-1 marks Little structure or attempt to compare. Marks gained by listing a few advantages or disadvantages.

Advantages of Nickel:
Relatively low cost which makes the sparking plugs cheaper to produce.
Quite high melting point which is needed because the temperature in the engine is very high.
Good conductor of electricity needed to carry electricity into combustion chamber to produce spark.

Disadvantages of Nickel:
Subject to corrosion in engine which means they only last a short time *because nickel is higher in reactivity than platinum.*
Idea that this leads to reduced efficiency, unburnt petrol and air pollution.

Advantages of Platinum:
Less susceptible to corrosion (not corroded) because platinum is very low in reactivity.
Idea that this improves efficiency and reduces pollution.-
Higher melting point than nickel to withstand the high temperatures in the combustion chamber.
Last a lot longer than nickel electrodes due to low reactivity.
(Sensible extension here could be longer service intervals etc.)-
Good conductor of electricity as for nickel.
Extension here could be linked to the idea that the conductivity does not deteriorate as quickly as nickel.)

Disadvantages of Platinum:
Cost *which will make the sparking plug more expensive.*
A good candidate might justify cost by longer life, better fuel consumption and less pollution.

8

(b) (i) giant structure/lattice/regular arrangements of atoms
any for 1 mark

of atoms/of ions (provided free electrons mentioned)
either for 1 mark

delocalised or free electrons
for 1 mark

3

(ii) electrons free/can move
for 1 mark each

2

[13]

Q23.

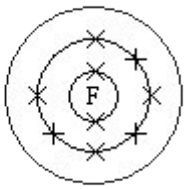
(a) 2, 8, 8, 1
for 1 mark

1

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(b)

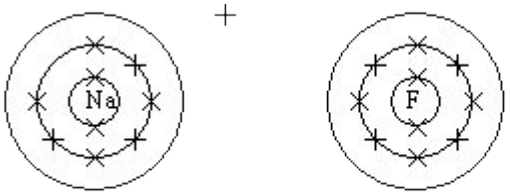
(i)



for 1 mark

Ignore symbol in middle but structure must be drawn NOT 2,7

(ii)



(1) for charges

(1) for each structure

If covalent; can score mark for changes but not for diagram
Arrow showing electron transfer from metal atom to non-metal atom = 2 marks
If the ions are not identified then cannot score mark for changes

4

[5]

Q24.

(a) $C_{16}H_{34}$

for 1 mark

1

(b) electron

gains 1 mark

but shared electrons

gains 2 marks

2

[3]

Q25.

(a) potassium / K

for 1 mark

1

(b) carbon dioxide / CO_2

for 1 mark

1

(c) losing
electrons
gaining
electrons

for 1 mark each

4

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(d) (i) power supply, (not mains)
beaker containing solution,
(inert) electrodes and circuit
ammeter or bulb/
(or see bubbling etc. at electrodes written by drawing)
for 1 mark each

4

(ii) reading on ammeter/bulb lights / (solution) conducts (electricity)
bubbling / gas produced
hydrogen produced
chlorine / oxygen produced
ions move
to electrodes (must be linked to ions move)
negative ions move to the positive electrode
<u>and/or</u> positive ions move to the negative electrode
negative ions lose electrons
<u>and/or</u> positive ions gain electrons
any 3 for 1 mark each

3

[13]

Q26.

(a) Group 2 / Alkaline Earth Metals
for 1 mark

1

(b) (i) $MgCl_2/Mg^{2+}(Cl^-)_2$
(or equation with correct answer)
for 1 mark

1

(ii) ionic / electrovalent
for 1 mark

1

[3]

Q27.

(a) covalent/description of covalent
for 1 mark

1

(b) forces/bonds between the molecules/particles (<u>not</u> atoms) are weak
for 1 mark each

2

(c) non-flammable so it will not burn etc.
extremely unreactive so it will not react with materials in the transformer,
does not conduct electricity so it can insulate the transformer
gas so it has freedom to move and insulate whole area
for 1 mark each

3

[6]

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Q28.

(a) gas

for 1 mark

1

(b) AlX_3

for 1 mark

1

(c) 7 / halogens

for 1 mark

1

[3]

Q29.

(a) some electrons from outer shells
(some electrons) free to move/mobile
through whole structure/between atoms/sea of electrons
hold atoms together

for 1 mark each

<u>or</u> positive ions in a sea of electrons (owtte)

2 marks

atoms in regular structure/layers
giant structure
close packed
credit diagrams – look for labels

for 1 mark each any 4

4

(b) (i) electrons,
free to move (reference to electrons)

for 1 mark each

2

(ii) layers/atoms can slide over each other

for 1 mark

1

(iii) free electrons hold atoms strongly together/strong forces of attraction/bonds (between atoms)/tight packing of atoms

for 1 mark

1

[8]

Q30.

(i) B **or** 2, 8, 1

for one mark

1

(ii) A **or** 2, 8

for one mark

1

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[2]

Q31.

8 electrons in outer shell

accept anywhere in outer shell
accept dots or crosses

1

negative sign outside bracket

1

[2]

Q32.

(a) (i) $2 Mg + O_2 \rightarrow 2 MgO$

both 2s needed

*allow O_2 **or** any correct multiple* $\frac{1}{2}$

1

(ii) solid

1

gas

1

(b) $MgCl_2$ / $C1_2Mg$

*do **not** accept MG mg mG CL cl cL*
ignore charges

1

[4]

Q33.

(a) LHS lithium + water

accept Li and H_2O
accept hydrogen oxide for water

1

RHS hydrogen + lithium hydroxide

accept H_2 and LiOH

ignore attempts at balancing
ignore charges

1

(b) ***Quality of written communication***

One mark for the correct use of any **three** of the terms atom, covalent, bond(ing), saturated, hydrocarbon or alkane

1

any **three** from*:*

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one / the carbon (atom)

reject molecules once

four hydrogen (atoms)

shape / properties neutral

CH_4

hydrocarbon

saturated / single bond

covalent bond / shared electrons

alkane

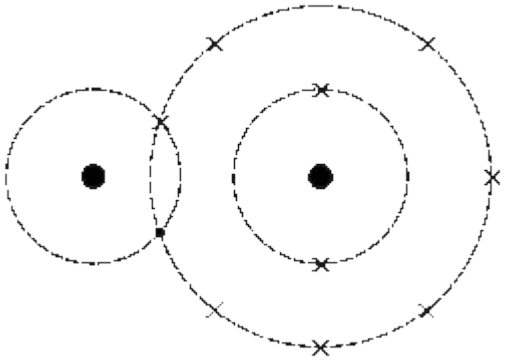
reject ionic bond

3

[6]

Q34.

(i) 1



(ii) weak forces

accept weak bonds

1

between molecules / intermolecular

reject intramolecular

1

[3]

Q35.

(a) (i) gas

accept they are all gases

1

(ii) reversible (reaction)

accept can go either way
accept ammonia can be decomposed (to nitrogen and hydrogen)
accept could be (an) equilibrium
do not credit just 'equilibrium'

1

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(iii) (liquid) air **or** atmosphere

1

(iv) same number **or** amount **or** weight (of atoms) on each side (of the equation)

accept "sums" for each side

accept same amounts of elements on each side
*do not credit molecules **or** compounds*
do not credit both sides are the same unless explained

1

of the same type

***or** gives a correct example 'e.g. six hydrogen atoms' (on each side)*

1

(b) (i) nitrate **or** sulphate **or** phosphate

if first left blank, second may be awarded

do not credit chloride

nitric **or** sulphuric **or** phosphoric

1

(only if correct above, exception is for ammonium chloride followed by hydrochloric acid (1 mark))

as appropriate if only the formula is given this should be credited only if it is correct in every detail i.e. NH_4NO_3 HNO_3 $(NH_4)_2SO_4$ H_2SO_4
accept correct name with an incorrect version of the formula
do not credit a correct formula with an incorrect version of the name e.g. 'nitrate/sulphite' etc

1

any **one** of

* (solution) can be sprayed (on the fields **or** crops)

accept more even distribution

* dissolves in <u>soil</u> water **or** rain (water)

accept soaks into soil (because soaks implies water)

* can be taken up by (plant) roots

do not credit can be added to water to "feed" the plants

1

(c) (i) elements **or** <u>different</u> atoms are bonded or joined **or** combined **or** reacted

do not credit just 'atoms'

*do not credit added **or** mixed*

1

(ii) (pairs of) electrons are shared

do not credit <u>an</u> electron is shared

1

[10]

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