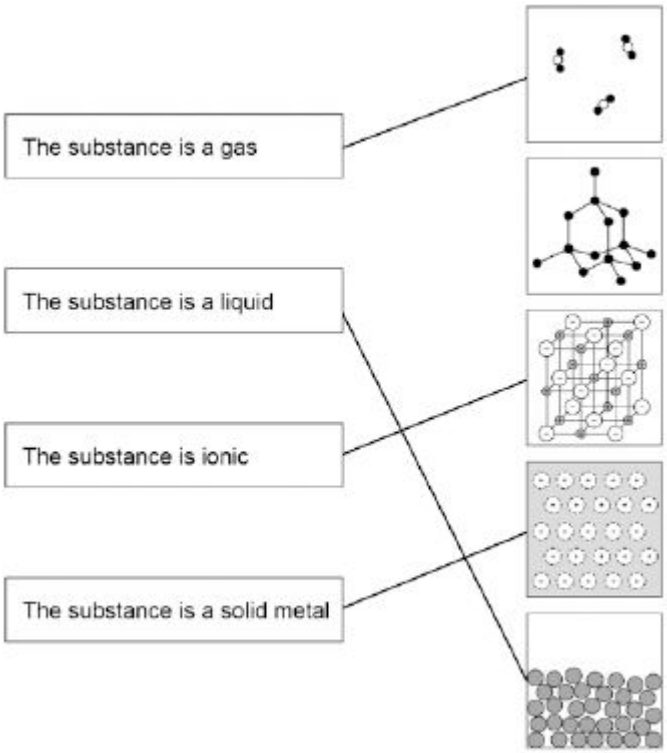
Mark schemes

1

(a)



more than one line drawn from a variable negates the mark

4

(b) Carbon

1

(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]

2

(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**
Low melting point	There are no charged particles free to move
Does not conduct electricity when molten	Weak intermolecular forces of attraction

Electrons are free to move

Ions are free to move

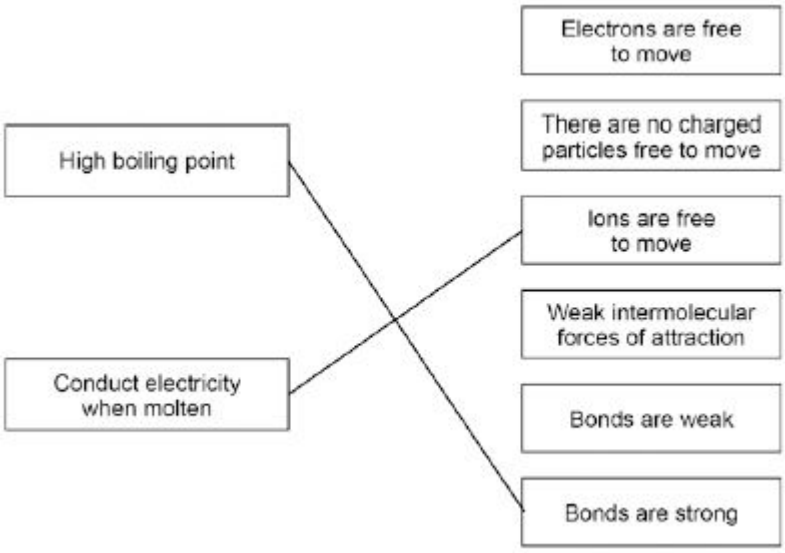
Bonds are weak

Bonds are strong

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]

3 (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

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 then Br–Br
- C–Cl bond stronger that 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 more, 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]

4 (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]

5 (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

*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]**

6 (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

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*

*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]

7 (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

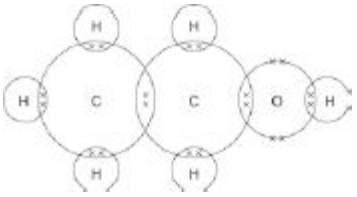
1

(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:*

- *ΔT = 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.

- *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]

8 (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

(forms a) blue precipitate

second mark dependent on suitable reagent being added

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

1

[9]

9 (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

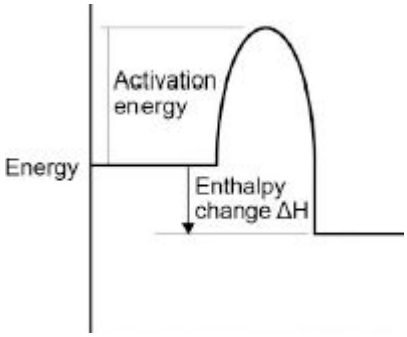
1

(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

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]

10 (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

(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]

11 (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

1

(iv) slide

allow move

1

(d) (i) C

1

(ii) strong covalent bonds

1

[14]

12 (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
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]

13 (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*

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]

14 (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:

- 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

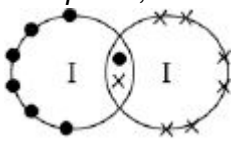
ignore cost

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]

15 (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>

*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]

16 (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

[10]

17 (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) weak 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
- 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]

18 (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

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]

19 (a) (i) high

1

(ii) hundred

1

(b) hard

1

(c) (i) carbon

1

(ii) four

1

(iii) covalent

1

(iv) all

1

[7]

20 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]

21 (a) nanotubes can slide (over each other)

allow nanotubes can roll (over each other)

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]

22 (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*

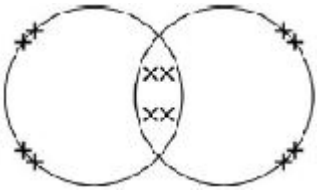
1

(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*

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]

23 (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]

24 (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
- 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]

25 (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]

26 (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
- 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]

27 (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]

28 (a) layers

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]

29 (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 **two** iodine (atoms)
- 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
- oppositely charged ions attract
- a giant structure / lattice is formed

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

4

[9]

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

giant structure / lattice

ignore many bonds

1

made up of positive ions surrounded by delocalized / free electrons

allow positive 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 very small

or

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

accept tiny / really small / a lot 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 non-bonded electron from each atom

accept electron(s) moving through the structure / nanotube

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

1

[7]

31 (a) (i) lead nitrate

accept $Pb(NO_3)_2$

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]

32 (a) 1 / one

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]

33 (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

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]

34 (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]

35 (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

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

[12]

36 (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]

37 (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

(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]

38 (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]

39 (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

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]

40 (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

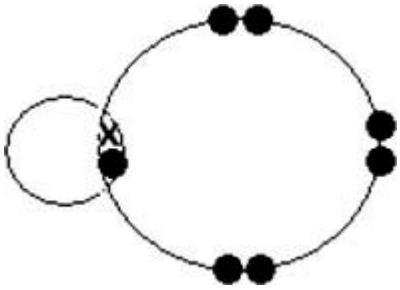
(c) hydroxide (ions) / OH^-

ignore OH

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

1

(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]

41 (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

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

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

1

[6]

42

(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]

43

(a) high melting point

1

not flammable

1

(b) (i) all

1

(ii) two

1

(iii) covalent

1

(iv) very strong

1

[6]

44

(a) (i) 65

*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]

45

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*

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

3

[3]

46

(a) carbon

1

(b) layers

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]

47

(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]

48

(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

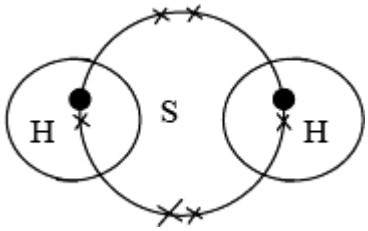
1 *mark for correct formula*

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*

(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]

49

(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

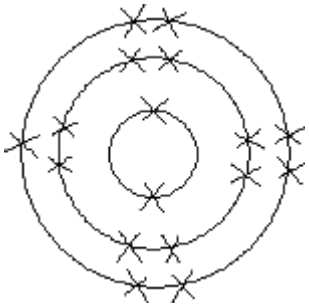
(c) H^+

1

[6]

50

(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

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 attracted 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

ignore more accurate / fair test

1

[8]

51

(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]

52

(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
- 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]

53 (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 loses **2** electrons

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
all four underlined ideas must be present

2

iodine gains **1** / **an** electron

*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 strong **or** lot of energy needed to break bonds
- oppositely charged ions attract **or** electrostatic attraction between ions
- giant structure **or** lattice

  allow many bonds
  ignore ionic bonding unqualified

2

[9]

54 (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

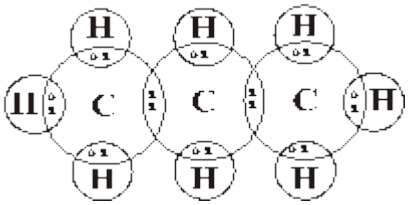
(c) low **and** small

both for ***1*** *mark*

1

[4]

55 (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) • intermolecular forces / bonds **or** forces / bonds between molecules

1

- bonds / forces are weak

***covalent** 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]

56 (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]

57 (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

(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]

58 (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]