

Mark schemes

- 1** (a) s 1
- l
- Answers **must** be in the correct order.*
- 1
- (b) A gas was lost from the flask 1
- (c) **Level 3 (5–6 marks):**
 A coherent method is described with relevant detail, and in correct sequence which demonstrates a broad understanding of the relevant scientific techniques and procedures. The steps in the method are logically ordered. The method would lead to the production of valid results.
- Level 2 (3–4 marks):**
 The bulk of the method is described with mostly relevant detail, which demonstrates a reasonable understanding of the relevant scientific techniques and procedures. The method may not be in a completely logical sequence and may be missing some detail.
- Level 1 (1–2 marks):**
 Simple statements are made which demonstrate some understanding of some of the relevant scientific techniques and procedures. The response may lack a logical structure and would not lead to the production of valid results.
- 0 marks:**
 No relevant content.
- Indicative content**
- sulfuric acid in beaker (or similar)
 - add copper carbonate one spatula at a time
 - until copper carbonate is in excess or until no more effervescence occurs *
 - filter using filter paper and funnel
 - filter excess copper carbonate
 - 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)
 - wear safety spectacles / goggles
- *Students. may choose to use a named indicator until it turns a neutral colour, record the number of spatulas of copper carbonate added then repeat without the indicator.
- 6
- (d) Total mass of reactants = 221.5 1

159.5

221.5

allow ecf from step 1

1

72.0 (%)

allow 72.0 with no working shown for 3 marks

1

(e) any **one** from:

- Important for sustainable development
- Economic reasons
- Waste products may be pollutants / greenhouse gases

1

[13]**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

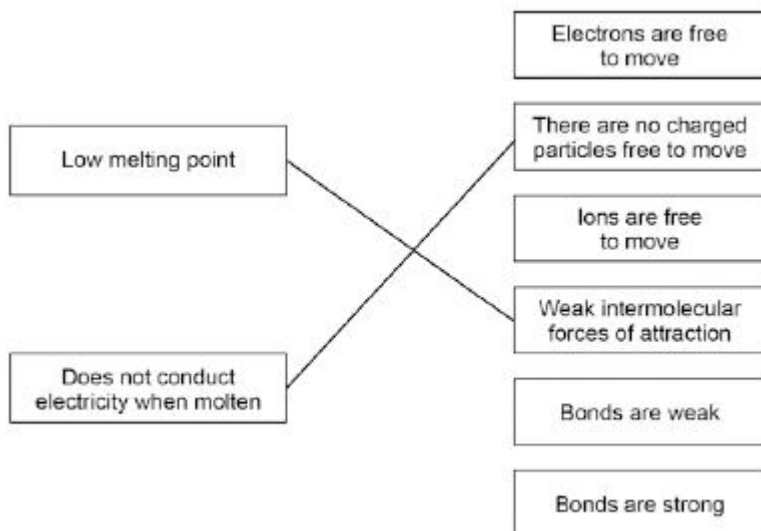
1

(d) 342

2

allow 1 mark for evidence of $(2 \times 27) + 3[32 + (16 \times 4)]$

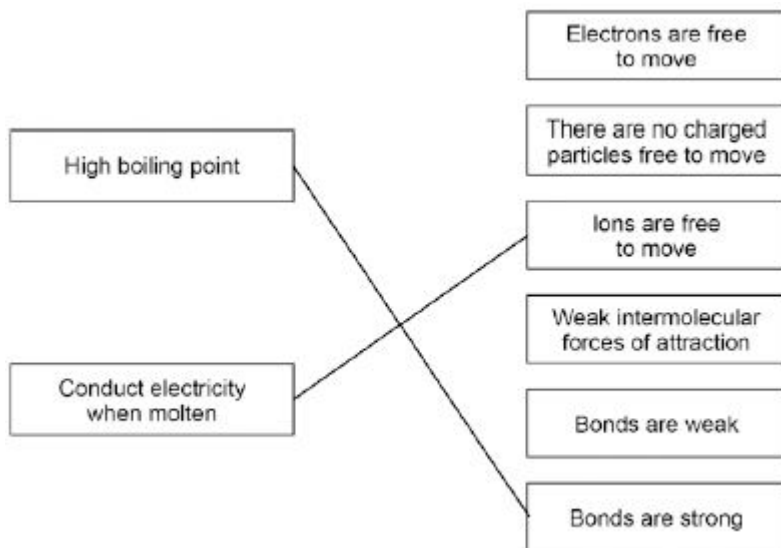
(e) **Property** **Explanation of property**



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) The forces between iodine molecules are stronger

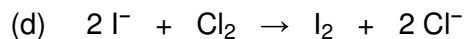
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(b) anything in range +30 to +120

1

(c) Brown

1



1

(e) It contains ions which can move

1

(f) hydrogen iodine

1

[6]**4**

(a) 50

1

(b) 5%

1

(c) any **two** from:

- cost (9 carat is cheaper)
- pure gold is soft
- or**
- 24 carat gold is soft
- or**
- 9 carat gold is harder
- allow 9 carat gold is stronger*
- allow gold is an alloy in 9 carat gold*
- can change the colour

2

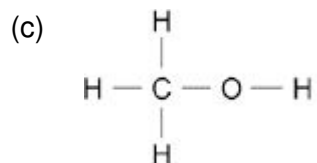
[4]**5**

(a) Propanol

1

(b) Butanol has the highest boiling point

1



1

(d) ethene + water (\rightarrow ethanol)

allow answers in either order

allow steam for water

1

(e) goes back to reactor

allow is recycled

1

(f) air contains oxygen

1

which oxidises ethanol

allow ethanol reacted with oxygen

1

to produce ethanoic acid

1

[8]**6**

(a) both water vapour and ethanol will condense

allow steam for water vapour

allow they both become liquids

allow ethane condenses at a lower temperature

allow some of the steam hasn't reacted

allow it is a reversible reaction / equilibrium

1

(b) amount will decrease

1

because the equilibrium will move to the left

1

(c) more ethanol will be produced

1

because system moves to least / fewer molecules

1

[5]**7**

(a) (i) C

1

(ii) B

1

(iii) A

1

(iv) D

1

(b) (i) SO₂

1

(ii) shared

1

(iii) covalent

1

[7]

8

- (a) because sulfur dioxide causes acid rain

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) electrons are lost

1

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

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

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 ₃ FeS ₃ | | |

award **4** marks for Cu₃FeS₃ with some correct working

award **3** marks for Cu₃FeS₃ with **no** working

if the answer is not Cu₃FeS₃ 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 CuFe₃S

4

[16]

9

- (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) lower activation energy

allow weakens bonds

allow idea of increased successful collisions.

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

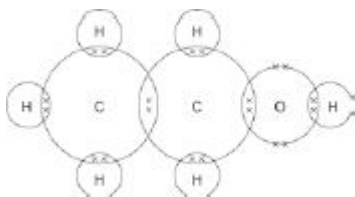
1

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

allow any combination of dots, crosses or other symbols

1

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



gains **2** marks

1

(c) (i) ± 3024 (J)*correct answer with or without working gains 3 marks**if the answer is incorrect, award up to 2 marks for the following steps:*

- $\Delta T = 14.4(^{\circ}\text{C})$
- $50 \times 4.2 \times 14.4$

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) $\pm 198\,720$ (J / mole)*c(i) \div 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]**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
- made up of atoms / positive ions
- with delocalized / free electrons
- so electrons can move / flow through the metal
accept so electrons can carry charge through the metal
accept so electrons can form a current
- (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*
- alloy has distorted layers
allow layers are unable to slide

1

1

1

1

1

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
- 13** (a) (i) silver nitrate
allow $AgNO_3$ 1
- (ii) potassium carbonate **or**
allow K_2CO_3
- sodium carbonate
allow Na_2CO_3 1
- [11]

(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 (HNO₃)

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

Pb₂O₃allow O₃Pb₂

ecf allowed throughout if sensible attempt at step 1
correct formula with no working gains 1 mark

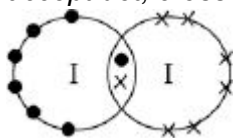
1

[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 H₂ 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) (i) iron
either order

1

carbon dioxide

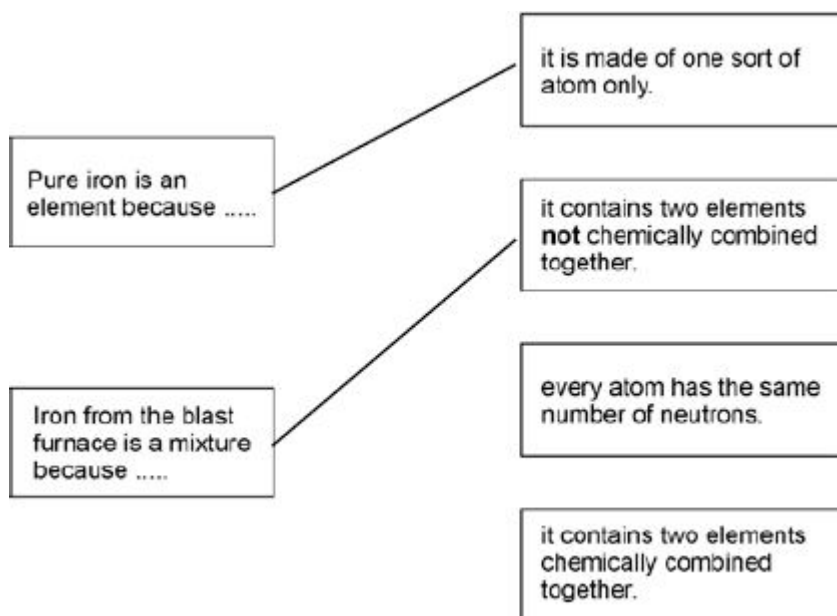
1

- (ii) reduced

1

(b) (i) **Statement**

Explanation



*each correct line gains 1 mark
extra lines from statement negate the mark*

max. 2

(ii) the layers / rows are distorted / disrupted **or** it doesn't occur in layers **or** the atoms are different

1

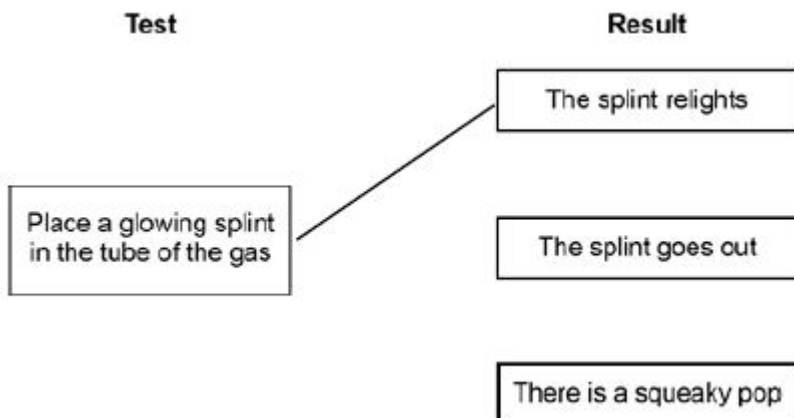
so cannot **slide** over one another **or slide** less easily

1

[7]

16

(a)



more than one line from test negates the mark

1

(b) (i) place a lighted splint at the mouth of the tube

1

there is a squeaky pop

dependent on correct test

1

(ii) hydrogen is less reactive than magnesium

accept converse

accept magnesium is too reactive

1

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

- to improve appearance or make it look nice
- to prevent corrosion
- to make it more durable
- cheaper than solid silver

1

(ii) solution must be silver nitrate **or** contain silver ions

1

otherwise copper will be deposited **or** silver will not be deposited

1

spoon must be the negative electrode / cathode

1

because silver ions have a positive charge **or** go to negative electrode **or** are discharged at the negative electrode.

1

(iii) because (plastic is an) insulator **or** does not conduct electricity

accept does not contain mobile electrons

1

[10]

17

(a) (i) ionic (bonding)

1

(ii) ions cannot move in solid **or** are in fixed positions

*do **not** accept electrons / atoms / molecules*

ignore particles

must mention ions

1

but can move in solution

1

(b) silver chloride formed

1

which is insoluble

1

(c) (i) aluminium

1

calcium

accept other metal ions that also give white precipitates (such as lead and zinc)

1

(ii) add excess sodium hydroxide solution

the second mark of each pair is dependent on the first mark being awarded.

1

precipitate remains

1

carry out a flame test

1

not red / orange

accept any colour that is not orange / red

give full credit for answers that correctly eliminate other cations in (c)(i) that would give white precipitates with a few drops of NaOH

1

[11]

18

- (a) *weaker bonds*
allow (other substances) react with the silicon dioxide

or

fewer bonds
ignore weaker / fewer forces

or

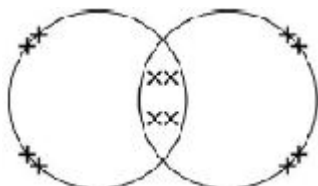
disruption to lattice
*do **not** accept reference to intermolecular forces / bonds*

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]

19

- (a) Will help 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) $2 I^{-} \rightarrow I_2 + 2 e^{-}$

1

- (v) hydrogen is formed

1

because sodium is more reactive (than hydrogen)

1

[11]

20

high melting point

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

accept will not melt (at high temperatures)
ignore withstand high temperatures

1

because a lot of energy needed to break bonds

1

because it is covalent **or** has strong bonds

accept bonds are hard to break

1

and because it is a giant structure **or** a macromolecule **or** a lattice
ignore many bonds

1
[4]

21

(a) (Chromium =) 20
in correct order

1

(Nickel =) 8
*accept Chromium = 8 **and** Nickel = 20 for 1 mark*

1

(b) (i) (because iron is made up of only) one type of atom

1

(ii) not strong
*allow too soft **or** too flexible*
*accept it rusts / corrodes **or** that it could wear away*
accept could change shape / bend
accept layers / atoms could slide (over each other)

1

(iii) structure is different / distorted / disrupted
*accept not in layers **or** not regular*

1

so it is difficult for layers / atoms / particles to slip / slide (over each other)
accept layers cannot slip / slide

1

[6]

22

(a) because atoms / ions / particles in alloy are different (sizes)
*do **not** allow reference to molecules*
ignore reference to compounds

1

so layers distorted

(and layers / atoms / ions / particles) don't slide **or** slide less easily
accept all marking points in a suitably labelled or annotated diagram

1

*if no other mark awarded accept an alloy is a mixture **or** contains
different metals / elements for 1 mark*

1

(b) giant structure **or** lattice **or** macromolecule
max 3 marks if incorrect bonding

1

strong bonds (between carbon / atoms)

1

covalent (bonds)

1

each carbon / atom forms 4 bonds

accept tetrahedral

if no other marks awarded, allow carbon (atoms) for 1 mark

1

(c)

reference to incorrect bonding = max 3

reference to 'weak covalent bonds' = max 2

allow correctly drawn diagram for first two marking points eg. (tangled) lines with no cross-links

chains **or** large molecules

ignore layers

1

with intermolecular forces **or** forces between chains

allow bonds for forces accept no cross-links

1

that are weak

must relate to 2nd marking point

1

and are easily overcome/ broken (when heated)

accept molecules / chains can flow / move

1

[11]

23

(a) has simple / small molecules

accept molecular covalent

1

the intermolecular forces / intermolecular bonds (are weak)

*do **not** accept weak covalent bonds **or** reference to incorrect bonding*

1

only need a small amount of energy to be overcome

accept only need a small amount of energy to separate the molecules

if no other mark awarded, allow it has a low boiling point for 1 mark

1

(b) (i) any pH value from 0 to 6.9

1

(ii) hydrogen

allow H⁺

ignore H / H₂ / H⁻

1

(c) any **three** from:

- same number of protons
*accept same atomic number
numbers if given must be correct*
- ^2H has one neutron
- ^1H has no neutrons
*accept different mass number **or** different number of neutrons for 1
mark
ignore relative atomic mass*
- same number of electrons
numbers if given must be correct

3

[8]

24

(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]

25

(a) (i) *mention of molecules / intermolecular / ionic / covalent = **max 2***

atoms / positive ions

1

any **two** from:

- (atoms / positive ions) in regular pattern / lattice / layer / giant structure (or diagram)
- delocalised electrons
accept electrons move within / through the structure
allow free (moving) electrons
allow sea of electrons
- (atoms / positive ions) held together by strong / electrostatic attractions
allow strong (metallic) bonds

2

- (ii) delocalised electrons
accept electrons move within / through the structure
allow free electrons

1

- (b) (i) smaller / very small
accept converse
accept 1 - 100 nanometres in size
accept a few hundred atoms
*accept larger surface area **or***
large surface area for their size

1

- (ii) nanoparticles / more can fit into (tiny) gaps
allow nanosize particles have large(r) surface area

1

[6]**26**

- (a) Aluminium has a low density

1

Aluminium is resistant to corrosion

1

- (b) (i) (an alloy) is a mixture of metals
*accept (an alloy) can be a metal mixed with another metal **or** iron*
mixed with carbon / a non-metal

1

(ii) pure metals are soft

allow weak

or

alloys are hard

allow strong / keep their shape

ignore rust / corrosion

1

(c) (i) crude oil

1

(ii) hydrocarbons

1

(iii) oxygen

1

(d) (i) hydrogen

allow H₂ or H

1

(ii) only water is produced (from the fuel)

or

no carbon dioxide is produced (from the fuel)

*allow less carbon dioxide produced **or** less global warming*

allow carbon dioxide causes global warming

1

[9]

27

(a) (i) covalent

two different answers indicated gains 0 marks

1

(ii) carbon

two different answers indicated gains 0 marks

1

(iii) 3

two different answers indicated gains 0 marks

1

(b) layers can slide / slip

1

because there are no bonds between layers

accept because weak forces / bonds between layers

or so (pieces of) graphite rubs / breaks off

or graphite left on the paper

1

[5]**28**

(a) 118

1

(b) it loses / transfers electrons

it = Au / gold atom

1

three electrons

sharing / covalency = max 1 mark

1

(c) (i) O₂

1

2 CO and 2 CO₂

or

correct balancing of equation from O

accept correct multiples / fractions throughout

1

(ii) *reference to incorrect bonding = 1 mark max*

because carbon dioxide is simple molecular / small molecules

1

there are intermolecular forces (between the molecules)

allow intermolecular bonds

1

so a small amount of energy needed (to separate molecules) **or** (*intermolecular forces*) are weak

1

(d) any **three** from:

- gold is the only catalyst for some reactions
- catalysts are not used up
- improves speed of reaction

reduces amount of energy **or** process needs low(er) temperature

*if no mark awarded, allow catalyst reduce costs (of the process) for
1 mark*

- only small quantities (of catalyst) needed

3

[11]

29

(a) gases

1

white

1

solid

1

ammonium chloride

1

(b) reversible

allow phonetic spelling

allow goes both / two / either way(s)

1

[5]

30

(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 through the structure
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 through the structure

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

1

[6]

31

- (a) (i) conducts electricity

1

- (ii) mixture (of metals)
(it = alloy)

1

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

ignore pollution without qualification

- noise
- dust
- allow dirt*
- traffic
- eyesore

2

[4]

32

(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) CH₄O

1

(ii) covalent

1

(c) it is made of small molecules

1

[5]

33

(a) diagram **A**

1

(b) the atoms can slide over each other.

1

the atoms are in layers

1

(c) (i) sulfuric

1

(ii) bubbles are produced

1

the magnesium disappears

1

(iii) crystallisation

1

[7]

34

- (a) high melting point 1
- not flammable 1
- (b) (i) all 1
- (ii) two 1
- (iii) covalent 1
- (iv) very strong 1

[6]**35**

- (a) • made of layers / rows (atoms / ions / particles)
ignore free / delocalised electrons 1
- which can slide / slip (over each other)
reference to incorrect particles / covalency / intermolecular forces = max 1
- or**
- particles / ions / atoms can slide over each other
ignore malleable / ductile / weak bonds 1
- (b) (i) sulfuric
accept sulphuric
ignore formula
ignore hydrogen sulfate 1

(ii) any **two** from:

list principle applies for incorrect observations

- (hydrogen) gas produced (or any indication of a gas such as bubbles etc.)

ignore just hydrogen produced

ignore cloudiness / colour changes

- magnesium / solid disappears / goes into solution

accept magnesium / magnesium sulfate / solid / it dissolves

accept forms a liquid / solution

- gets hot

allow exothermic

ignore floats

2

(iii) crystallisation

accept detailed answers such as: evaporate to half volume and then allow the solution to crystallise.

or

evaporation / heating / boiling / cooling

ignore any references to filter

1

[6]

36

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 bonds / 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]

37

(a) gives out heat / energy

*allow more energy given out in making bonds than is used in
breaking bonds*

or

energy / heat transferred to surroundings

ignore light

1

(b) activation

allow phonetic spelling

1

(c) (i) 2 crosses on inner circle **and**

8 crosses on outer circle

accepts dots / e / - for electrons

1

- (ii) opposite charges (attract)
 allow electrostatic forces (attract)
 do **not** accept intermolecular attraction / shared electrons

1

[4]

38

(a)

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

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

1

$$= 0.03 \qquad = 0.04$$

1 mark for correct proportions

1

$$3 \qquad 4$$

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

1



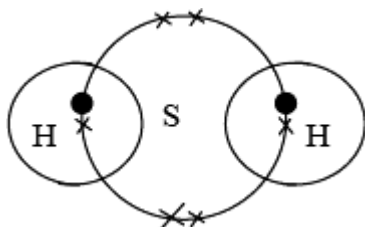
1 mark for correct formula

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 between molecules are weak (owtte)
*do **not** accept intramolecular forces / covalent bonds are weak*
*do **not** accept reference to ions*

or

intermolecular 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]

39

the atoms are in layers

1

the atoms can slide over each other

1

[2]

40

- (a) (i) 48

1

- (ii) 3

1

- (b) heat / energy

1

given out / transfers to surroundings

the mark for given out / transfers to cannot be awarded without heat / energy

allow given off

1

(c) it has a low boiling point

1

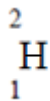
it is made of small molecules

1

[6]

41

(a)



2 and 1 must be on the left

2 must be above half-way on the H and the 1 below half-way

accept diagram with 2 different particles in centre and 1 particle on circle

1

(b) (i) 18

ignore working

ignore units

1

(ii) forces (of attraction) between molecules **or**
bonding between molecules **or**
intermolecular forces /intermolecular bonds

1

are weak **or** not much energy needed to break them **or** easily overcome

must be linked to first mark

if no other mark awarded allow small molecules / small M_r for 1 mark

allow forces / bonds are weak for 1 mark

*do **not** allow covalent bonding is weak*

1

(c) *any reference to more protons = 0 marks*

H-2 atoms have 1 proton and 1 neutron

allow H-2 has more neutrons / particles for 1 mark

1

H-1 atoms have one proton

allow H-2 has two particles and H-1 has one particle for 1 mark

or

H-2 atom has one neutron (1)

allow H-2 atom has one more neutron for 2 marks

H-1 atom has no neutrons (1)

NB heavy water (molecule) has 2 more neutrons = 2 marks

heavy water (molecule) has more neutrons / particles = 1 mark

if no other mark awarded then heavy water molecule has M_r of 20 = 1 mark

ignore reference to electrons

1

[6]

42

(a) any **four** from:

*max 3 marks if any reference made to covalent / ionic bonding / molecules or intermolecular forces **or** graphite / diamond **or** forces of attraction between electrons and then ignore throughout*

- giant structure / lattice
ignore layers
- positive ions
- sea of electrons **or** delocalised / free electrons
ignore electrons can move
- awareness of outer shell / highest energy level electrons are involved
- (electrostatic) attractions / bonds between electrons and positive ions
- bonds / attractions (between atoms/ ions) are strong
allow hard to break for strong
ignore forces unqualified
- a lot of energy / heat is needed to break these bonds / attractions
ignore high temperature

4

- (b) (i) that they are very small
accept tiny / really small / a lot smaller / any indication of very small
eg microscopic, smaller than the eye can see
- or**
- 1–100 nanometres **or** a few (hundred) atoms
ignore incorrect numerical values if very small is given
- 1
- (ii) any **2** from:
- one (non-bonded) electron from each atom
 - delocalised / free electrons
allow sea of electrons
ignore electrons can move
 - electron carry / form / pass current / charge
ignore carry electricity
- 2

[7]

43

- (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]

44

(a) atoms

1

| | | |
|-----|-----------|---|
| (b) | mixture | 1 |
| | metal | 1 |
| | structure | 1 |
| | smart | 1 |

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

- saves raw materials / iron ore
- saves energy / fuels
accept cheaper / saves money
- make new / useful items
- make money / it is economic
- reduces pollution
allow less harmful for the environment
- decreases cost of steel cans
- reduces carbon dioxide emissions
- decreases waste materials / use of landfill

2

(ii) any **one** from:

- provide information / education of the need to recycle
- legislate against / charge for waste
- reward / pay people to recycle
accept fine people for not recycling
- put labels on the cans
- provide recycling bags / bins / areas

1

[8]

45

(a) (Chromium =) 20

1

in correct order

(Nickel =) 8

accept Chromium = 8 and Nickel = 20 for 1 mark

1

(b) (i) (because iron is made up of only) one type of atom

1

(ii) not strong

*ignore soft / corrosive / flexible**accept it rusts / corrodes or that it could wear away**accept could change shape / bend**accept layers / atoms could slide (over each other)*

1

(iii) has different sized atoms / particles**or**

structure is different/distorted / disrupted

accept not in layers or not regular

1

so it is difficult for layers / atoms / particles to slip / slide (over each other)

accept layers cannot slip / slide

1

[6]

46

(a) C₃H₈*capital letters for symbols numbers must be halfway or lower down the element symbol**allow H₈C₃**do not allow 3:8 or C₃ and H₈*

1

(b) (i) electron

1

(ii) covalent

1

(c) low **and** small*both for 1 mark*

1

[4]

47

- (a) (i) increase
- (ii) high melting point
- (b) (i) decreases
- increases
- (ii) it gives the particles more energy
- it makes the particles move faster

1

1

1

1

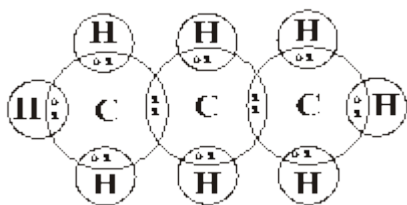
1

1

[6]

48

(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]**

49

- (a) any **two** from:
- outer shell electrons / electrons in highest energy level (in metals)
 - electrons are delocalised / sea of electrons
 - electrons are free **or** electrons move around **or** electrons are free to flow **or** electrons attracted to positive terminal
 - electrons carry charge / current **or** electrons form the current / electrons transfer charge / electrons pass charge
ignore electrons carry electricity
ignore reference to positively charged atoms / ions
if they state electrons have +ve charge = max 1 mark
if they state covalent bonding then max 1 mark
- 2

(b) ions can move / are attracted to electrode

accept ions are free

allow 'they' for ions

or

attracted to named electrode

or

ions are charged **or** ions form / carry
the current **or** ions form the charge

1

(c) (i) electron gain

ignore hydrogen reduces charge

1

(ii) sodium hydroxide **or** NaOH **or** caustic soda

*do **not** allow hydroxide alone*

1

(iii) $2\text{Cl}^- - 2\text{e}^- \rightarrow \text{Cl}_2$

or

$2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$

*allow fractions **or** multiples*

*allow e **or** e⁻*

*do **not** allow e⁺*

1

[6]

50

(a) conducts (electricity) **or**

accept flexible

allows electrons / current to flow

ignore conducts heat

1

(b) electron

1

(c) (i) lithium>copper>tungsten **or**

Li>Cu>W

all correct

*allow **1** mark for one metal in the correct position*

2

- (ii) has high / highest melting point
accept has high / highest boiling point

or

can withstand the highest temperature

1

- (d) unreactive

1

[6]

51

- (a) (i) reacts with carbon / C

accept burns / oxidises carbon

1

carbon dioxide / CO₂ / gas is formed / given off

accept carbon monoxide / CO

accept correctly balanced equation for 2 marks

ignore state symbols

1

- (ii) change / improve properties

accept any specific property

accept to make alloys / special steels

ignore brittle

1

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

- to conserve ores / iron
accept ores / iron are non-renewable / non-sustainable
allow less quarrying / mining
- to prevent the use of landfills
allow reduce waste
- to conserve energy / fuel
accept fossil fuels are non-renewable
- to reduce carbon / carbon dioxide emissions
- to meet EU / International targets
ignore costs / demand

2

[5]

52

| | | | | |
|-----|-------------|-------------|-------------|---|
| (a) | C | H | O | |
| | <u>0.60</u> | <u>0.15</u> | <u>0.40</u> | |
| | 12 | 1 | 16 | 1 |
| | = 0.05 | = 0.15 | = 0.025 | 1 |
| | 2 | 6 | 1 | 1 |



1 mark for dividing the correct amount or multiples of correct amount by A_r

1 mark for proportions

1 mark for whole number ratio – accept any multiple

1 mark for correctly written simplest formula

correct formula without working gets only 2 marks

correct formula gains full marks

provided steps 1 and 2 are correct.

*ecf can be allowed from step 2 to 3 **or** step 3 to 4*

formula can be in any order eg OH_6C_2

1

- (b) intermolecular forces / bonds 1

are weak

(covalent) bonds are weak = 0

or

forces between molecules **or** bonds between molecules (1)

(attractive) forces are weak = 1

are weak (1)

*if no marks awarded, allow low boiling point **or** small M_r for 1 mark*

1

- (c) (i) to check the safety of the perfume (owtte)
- accept references to possible harmful / dangerous effects of perfume **or** possible reactions on skin*
- eg to show it does not damage skin / cause cancer etc.*
- allow to see what it smells like on the skin*
- allow so the company do not have to test on animals*
- 1

(ii) any **two** from:

idea from text **linked with** an explanation

- the company claim to have tested the product:
but we cannot be certain they have **or** how thorough they are **or** how accurately reported
- companies did not disclose how they did their tests:
so they could not be checked **or** so they could not be shown to be reliable / valid **or** so they could not be repeated
or converse
eg companies should disclose how they did their tests so that results can be checked etc.
- companies may not have repeated their tests:
so they may not be reliable
- companies do their own tests:
so they may be biased **or** so they may not be truthful about their results **or** so they may not be reliable
or converse
eg independent tests should be done so as to ensure there is no bias etc.
- the companies are using different tests:
so the results cannot be compared **or** so results will be different **or** so results will not be fair / valid / reliable
or converse
eg companies should do the same tests so that the results will be fair etc.
- companies would not give false information because of damage to reputation **or** it might lead to litigation

2

[9]

53

(a) good (electrical) conductor

allow low reactivity / resistance to corrosion
*do **not** accept heat conductor*

1

(b) a mixture of metals

accept contains more than one type of metal

1

- (c) (i) any **one** from:
- eyesore
 - destruction of habitats
 - pollution of water
 - dust pollution
 - noise
 - traffic pollution
- 1
- (ii) acid rain
allow sulfur dioxide is a pollutant
- 1
- (d) (i) running out of copper (ores)
- 1
- (ii) any **two** from:
- any specific example of using less copper
 - reuse / recycle
*allow do **not** throw copper / brass away*
 - use low-grade copper ores
 - use other metals / materials in place of copper
- 2

[7]

54

(a) any **three** from:

- resources / aluminium / ores are conserved
accept converse argument
- less / no mining **or** less associated environmental problems
eg quarrying / eyesore / dust / traffic / noise / loss of land / habitat
ignore just pollution
- less / no waste (rock) / landfill
*do **not** accept 'wastes 50% of the ore'*
- no purification / separation (of aluminium oxide)
- (aluminium extraction / production) has high energy / electricity / heat / temperature requirements
- less carbon dioxide produced
accept no carbon dioxide produced
ignore references to cost

3

(b) statement

ignore density

1

linked reason

*eg**(pure) Al / it is weak / soft (1)**as layers / rows can slide (over each other) (1)***or***alloy / other metals / they make it stronger / harder (1)**stops layers / rows sliding over each other (1)**accept disrupts the structure owtte if no other mark awarded**accept to form an alloy **or** to change properties for **1** mark*

1

[5]