AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.3.2 USE OF AMOUNT OF SUBSTANCE IN RELATION TO MASSES OF PURE SUBSTANCES

SCORE	PERCENTAGE
/208	%

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Q1.

(a) sodium oxide

allow Na_2O

1

(b) oxidation

1

(c) 13

1

(d) sodium hydroxide

1

(e) OH^-

1

(f) $(\text{volume} =)\frac{250}{1000}$ or $\frac{1}{4}$

or 0.25 (dm^3)

1

or

$(\text{mass per } cm^3 =)\frac{40}{1000}$ (g)

or 0.04 (g)

$(\frac{250}{1000} \times 40 =)$ 10 (g)

1

*an answer of 10 (g) scores **2** marks*

(g) all points correct

allow a tolerance of ±½ a small square
*allow **1** mark for 3 points correct*
ignore any attempt at a line of best fit

2

(h) 39 °C

allow any value from 34 to 46 (°C)

1

[10]

Q2.

(a) chlorine is toxic

allow carbon monoxide is toxic
allow poisonous for toxic
ignore harmful / deadly / dangerous
allow a poisonous gas is used / produced

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allow titanium chloride is corrosive

1

(b) any **one** from:

- very exothermic reaction

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

- produces a corrosive solution

  allow caustic for corrosive
  ignore alkaline

- produces hydrogen, which is explosive / flammable

  allow flames produced
  ignore sodium burns

1

(c) argon is unreactive / inert

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

1

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

allow elements / reactants / products for sodium / titanium

1

(d) metal chlorides are usually ionic

allow titanium chloride is ionic

1

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

allow titanium chloride for metal chlorides

1

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

ignore strong ionic bonds

or
(but) must be a small molecule or covalent

allow molecular

1

allow alternative approach:

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

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

(but) metal chlorides are usually ionic (1)

(e) sodium (atoms) lose electrons

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

1

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

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

1

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

$$(\text{moles Na} = \frac{20\,000}{23} =) \ 870 \text{ (mol)} *$$

1

$$(\text{moles } TiCl_4 = \frac{40\,000}{190} =) \ 211 \text{ (mol)} *$$

1

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

allow use of incorrectly calculated M_r from step 1

either

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

or

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

the mark is for correct application of the factor of 4

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

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

1

alternative approaches:

approach 1:

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

(40 kg $TiCl_r$ needs)

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

(=) 19.4 (kg) (1)

so 20 kg is an excess (1)

approach 2:

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

(20 kg Na needs)

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

(=) 41.3 (kg) (1)

so 40 kg is not enough (1)

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

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or
(actual mass =) 0.923 × 13.5

1

= 12.5 (kg)

allow 12 / 12.46 / 12.461 / 12.4605 (kg)

1

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

[15]

Q3.

(a) (strong because) completely ionised (in aqueous solution)

ignore pH

allow dissociated for ionised

*do **not** accept hydrogen is ionising*
*do **not** accept H^+ are ionised*

1

(dilute because) small amount of acid per unit volume

ignore low concentration

1

(b) 5.0

allow 5

1

(c) (titre):
chooses titrations 3, 4, 5

1

average titre = 22.13 (cm^3)

allow average titre = 22.13(3…) (cm^3)
allow a correctly calculated average from an incorrect choice of titrations

1

(calculation):
(moles NaOH =
$\frac{22.13}{1000} \times 0.105 = 0.002324$)

allow use of incorrect average titre from step 2

1

(moles H_2SO_4 =
½ × 0.002324 =) 0.001162

allow use of incorrect number of moles from step 3

1

(concentration =
$\frac{0.001162}{25} \times 1000$)
= 0.0465 (mol/dm^3)

allow use of incorrect number of moles from step 4

1

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alternative approach for step 3, step 4 and step 5

$$\frac{2}{1} = \frac{22.13 \times 0.105}{25.0 \times \text{conc. } H_2SO_4} \text{ (1)}$$

(concentration H_2SO_4 =)

$$\frac{22.13 \times 0.105}{25.0 \times 2}$$

= 0.0465 (mol/dm^3) (1)

an answer of 0.046473 ***or*** *0.04648 correctly rounded to at least 2 sig figs scores marking points 3, 4 and 5*

an answer of 0.092946 ***or*** *0.09296* ***or*** *0.185892* ***or*** *0.18592 correctly rounded to at least 2 sig figs scores marking points 3 and 5*

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

(d) pipette measures a fixed volume (accurately)

1

(but) burette measures variable volume

allow can measure drop by drop

1

(e) $(\text{moles} =) \frac{30}{1000} \times 0.105$

or 0.00315 (mol)

or
(mass per dm^3 =) 0.105 × 40
or 4.2 (g)

1

$(\text{mass} = \frac{30}{1000} \times 0.105 \times 40)$

= 0.126 (g)

1

an answer of 0.126 (g) scores ***2*** *marks*

an answer of 126(g) scores ***1*** *mark*

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

[12]

Q4.

(a) enzyme

1

(b) 2.0 × 10^3 moles

1

(c) smaller yield

allow less methanol is produced

1

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(because) favours endothermic reaction

allow (because) favours reverse reaction
allow equilibrium / reaction shifts to the left
allow equilibrium / reaction shifts to reduce the temperature

ignore reference to forward reaction is exothermic
ignore references to rate

1

(d) (yield)
equilibrium position moves to the product side

allow equilibrium / reaction moves to the right
allow equilibrium / reaction shifts to reduce the pressure

1

(because) fewer molecules / moles / particles on product side

allow (because) fewer molecules / moles / particles on the right
allow (because) smaller volume on product side

1

(rate)
more collisions per unit time

allow increases collision frequency / rate

ignore more collisions alone
ignore faster collisions
*do **not** accept any indication of more energetic / forceful collisions*

1

(because) more molecules / particles per unit volume

allow (gas) molecules / particles closer together

ignore more molecules / particles alone

1

allow converse arguments

(e) provides different reaction pathway

allow provides a different mechanism / route

1

(which has a) lower activation energy

1

ignore references to collisions

(f) less energy is needed

allow reduces the temperature required
allow reduces costs

ignore references to pressure
ignore references to rate or time

1

(g) no effect / change

1

[12]

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Q5.

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

1

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

1

reference to transfer of one electron

1

to form positive and negative ions

allow to form noble gas electronic structures

or

allow to form stable electron arrangements

or

allow to form full outer shells

or

allow reference to ionic bonding

1

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

1

= 89.944134

1

= 89.9 (%)

1

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

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

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

1

(d) 50 / 1000 (dm^3) or 0.05 dm^3

or

80 / 1000 (g / cm^3) or 0.08 g / cm^3

1

= 4(.00) (g)

1

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

[10]

Q6.

(a) mass number

allow the number of protons + neutrons

1

(b) 6.02×10^{23}

1

(c) **Level 2 (3-4 marks):**

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Scientifically relevant features are identified; the ways in which they are similar / different is made clear.

Level 1 (1-2 marks):
Relevant features are identified and differences noted.

Level 0
No relevant content.

Indicative content

similarities
- both have positive charges
- both have (negative) electrons
- neither has neutrons

differences

plum pudding model	**nuclear model**
ball of positive charge (spread throughout)	positive charge concentrated at the centre
electrons spread throughout (embedded in the ball of positive charge)	electrons outside the nucleus
no empty space in the atom	most of the atom is empty space
mass spread throughout	mass concentrated at the centre

4

(d) $\frac{(24 \times 78.6) + (25 \times 0.1) + (26 \times 11.3)}{100}$

or
(24 × 0.786) + (25 × 0.101) +
(26 × 0.113)

1

= 24.3

1

*an answer of 24.3 scores **2** marks*

[8]

Q7.

(a) heat with a water bath
or
heat with an electric heater
or
allow to evaporate / crystallise at room temperature

1

(b) to make sure that all the iodine reacts

allow so can see the reaction is complete

1

(as) excess iodine would remain in solution

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1

(so) iodine could not be filtered off

allow (whereas) excess zinc could be filtered off

or

(so) the zinc iodide would not be pure

allow (so) would have to separate iodine from zinc iodide

1

(c) $\text{moles } I_2 = \frac{0.5(00)}{254} = (0.00197)$

allow moles I_2 = 0.00197

allow 65 g Zn: 254 g I_2

1

mass Zn = 0.00197 × 65 (g)

1

mass = 0.128 (g)

1

allow an expression $\frac{0.5(00) \times 65}{254}$ *(g) for the first **2** marks*

(d) $92.0 = \frac{12.5}{\text{maximum mass}} \times 100$

1

$(\text{maximum mass}=) \frac{100}{92.0} \times 12.5$

1

= 13.6 (g)

allow 13.5869... (g)

1

(e) some product lost on separation

allow incomplete reaction

1

(f) M_r ZnI_2 = 319

1

moles needed

$\left(= 0.1 \times \frac{250}{1000}\right) = 0.025$

or

mass per dm^3 = 31.9 (g)

1

(mass) = 7.98 (g)

allow 7.975 / 8.0 (g)

1

*an answer of 7.975, 7.98 or 8.0 (g) scores **3** marks*

[14]

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Q8.

(a) sodium chloride

or

salt

allow dissolved salts

1

(b) expensive

1

(c) to remove solids

1

(d) to sterilise the water

allow to kill microorganisms

1

(e) test: (damp) litmus paper

1

result: bleached

or

turns white

1

(f) pH: 7.0

1

mass of dissolved solid: 0.0 (g)

1

(g) 0.05 g

1

(h) did not immerse the thermometer (bulb)

1

[10]

Q9.

(a) add excess copper carbonate (to dilute hydrochloric acid)

accept alternatives to excess, such as 'until no more reacts'

1

filter (to remove excess copper carbonate)

reject heat until dry

1

heat filtrate to evaporate some water **or** heat to point of crystallisation

accept leave to evaporate or leave in evaporating basin

1

leave to cool (so crystals form)

until crystals form

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1

*must be in correct order to gain **4** marks*

(b) M_r $CuCl_2$ = 134.5

*correct answer scores **4** marks*

1

moles copper chloride = (mass / M_r = 11 / 134.5) = 0.0817843866

1

M_r $CuCO_3$= 123.5

1

Mass $CuCO_3$ (=moles × M_2= 0.08178 × 123.5) = 10.1(00)

1

*accept 10.1 with no working shown for **4** marks*

(c) $\frac{79.1}{100} \times 11.0$

or

11.0 × 0.791

1

8.70 (g)

1

*accept 8.70(g) with no working shown for **2** marks*

(d) Total mass of reactants = 152.5

1

134.5

152.5

allow ecf from step 1

1

88.20 (%)

1

*allow 88.20 with no working shown for **3** marks*

(e) atom economy using carbonate lower because an additional product is made **or** carbon dioxide is made as well

allow ecf

1

[14]

Q10.

(a) (delivery) tube sticks into the acid

1

the acid would go into the water **or** the acid would leave the flask or go up the delivery
tube

ignore no gas collected

1

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(b) any **one** from:

- bung not put in firmly / properly
- gas lost before bung put in
- leak from tube

1

(c) all of the acid has reacted

1

(d) take more readings in range 0.34 g to 0.54 g

1

take more readings is insufficient

ignore repeat

(e) $\frac{95}{24000}$

1

0.00396

or

3.96×10^{-3}

1

*accept 0.00396 or 3.96×10^{-3} with no working shown for **2** marks*

(f) use a pipette / burette to measure the acid

1

because it is more accurate volume than a measuring cylinder
or
greater precision than a measuring cylinder
or
use a gas syringe to collect the gas

so it will not dissolve in water

or
use a flask with a divider

accept description of tube suspended inside flask

so no gas escapes when bung removed

1

(g) they should be collected because carbon dioxide is left in flask at end

1

and it has the same volume as the air collected / displaced

1

[11]

Q11.

(a) (i) (thermal) decomposition

allow decomposes or endothermic

1

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(ii) copper oxide

1

(b) (i) the (potassium) carbonate did not decompose/change/react (when heated)

allow temperature not high enough

*do **not** allow potassium did not decompose*

ignore references to reactivity

1

the mass did not change or the limewater did not go cloudy

1

because no carbon dioxide produced

1

(ii) the less reactive the metal the more (easily) its carbonate will decompose/react or vice versa

needs to be a relative comparison

2

*allow max **1** mark where the distinction between a metal and its carbonate is not clear*

*allow **1** mark for carbonates of reactive metals do not decompose or vice versa*

(c) (i) make it economical (to extract the metal/iron)

allow make it worth extracting

allow so they can make money/profit

1

(ii) Fe

1

balanced correctly (2,3,4,3)

not ecf

allow correct balanced equation but with $2Fe_2$ on right for one mark

1

(iii) **iron** from the blast furnace is brittle

1

steel produced is strong / flexible

allow steel has more/specific uses

allow steel is rust-resistant

1

"it" = iron

(iv) (recycling) is used to conserve iron (ore) **or** energy **or** resources **or** minimise pollution **or** reduce the need to quarry

allow reverse arguments.

1

(not reuse) because of damage, paint removal, rusting/corrosion, metal fatigue/weaker

1

(not landfill) because sites have limited space **or** loss of habitats

allow to reduce the use of landfill

1

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[15]

Q12.

(a) **X:**

Fe^{2+} / iron(II), SO_4^{2-} / sulfate

allow iron(II) sulfate
or *$FeSO_4$*

1

Y:

Na^+ / sodium, I^- / iodide

allow sodium iodide
or *NaI*

1

Z:

Fe^{3+} / iron(III), Br^- / bromide

allow iron(III) bromide
or *$FeBr_3$*

correct identification of any two ions = one mark

correct identification of any four ions = two marks

1

(b) any **five** from:

allow converse arguments

method 1

- weighing is accurate
- not all barium sulfate may be precipitated
- precipitate may be lost
- precipitate may not be dry
- takes longer
- requires energy

allow not all the barium hydroxide has reacted

method 2

- accurate
- works for low concentrations

allow reliable / precise

5

[8]

Q13.

(a) because this lithium atom has

3 protons

1

and 4 neutrons

1

mass number is total of neutrons and protons

accept protons and neutrons have a mass of 1

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accept number of neutrons = 7 - 3(protons)
ignore mass of electron is negligible

1

(b) grams

accept g

1

^{12}C

allow carbon-12 ***or*** *C-12*
ignore hydrogen ***or*** *H*

1

(c) any **three** from:

max ***2*** *if no numbers given*
numbers if given must be correct

- both have 8 protons
  accept same number of protons
- ^{18}O has 10 neutrons
- ^{16}O has 8 neutrons
  accept different number of neutrons or ^{18}O has two more neutrons for ***1*** *mark*
- both have 8 electrons.
  accept same number of electrons

3

[8]

Q14.

(a) (i) lit splint **or** ignite the gas

1

(squeaky) pop / explosion

1

(ii) because it provides energy (for the reaction)

1

to break bonds (in the reactants) **or** so the particles collide successfully
ignore reference to frequency or rate of collisions
because it provides the activation energy gains ***2*** *marks*

1

(b) (i) 1.67(g)

allow 1.66-1.68
correct answer (to 3 significant figures) with or without working gains ***3*** *marks*
if answer incorrect allow up to ***2*** *marks for the following steps:*
24 → 40
1.00 → 40 / 24
or
moles magnesium = 1 / 24 ***or*** *0.04(17)*

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multiply by 40

*allow ecf from incorrect ratio **or** incorrect number of moles*

3

(ii) **if correct answer from part (b)(i) used**

allow ecf from part (b)(i)

89.8 or 90

if 1.82 g used

82.4 or 82

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

*if answer incorrect, allow the following for **1** mark:*

1.50 / 1.67 (or their answer from part (b)(i))

if 1.82 g used: 1.50 / 1.82

2

(iii) any **one** from:

ignore measurement errors

- not all the magnesium reacted

  allow the reaction may be reversible
- some of the magnesium oxide / product may have been left in the tube **or** may have been lost

  ignore magnesium lost
- different / unexpected reaction
- magnesium not pure

1

[10]

Q15.

(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

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- sensitive
- rapid / quicker
- small amount of sample

1

(d) any **two** from:

allow concentration

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

2

[6]

Q16.

(a) copper has delocalised electrons

accept copper has free electrons
*ignore sea of electrons **or** mobile electrons*

1

(electrons) which can move through the metal / structure

allow (electrons) which can carry a charge through the metal / structure

1

(b) (i) (M_r $FeCl_3$ =) 162.5

*correct answer with or without working gains **3** marks*
*can be credited from correct substitution in step **2***

1

or

2 (moles of) $FeCl_3$ = 325

or

112 → 325

$$\frac{11.20}{56} \times 162.5$$

allow ecf from step 1

accept $\frac{325}{112} \times 11.2$

1

= 32.5

accept 32.48

1

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(ii) 74.8

accept 74.77 – 75

accept ecf from (b)(i)

if there is no answer to part(i)

or

if candidate chooses not to use their answer then accept 86.79 – 87

1

[6]

Q17.

(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]

Q18.

(a) (i) hydrochloric

1

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(ii) insoluble

1

filtration

1

(iii) crystallisation

1

(b) any **four** from:

any reference to incorrect bonding = max 3

- calcium atom reacts with **2 chlorine atoms**
- calcium atoms lose electrons

  accept calcium ion is formed
- lose **two** electrons

  accept calcium has a 2+ charge / calcium ion has a 2+ charge

  allow Ca^{2+}
- chlorine atoms **gain** electrons

  accept chloride ion formed
- gain one electron

  accept chlorine / chloride has a negative charge / is a negative ion/ is a negative particle

  allow Cl^-

  *if no other marks awarded allow ionic bonding **or** complete outer shell for **1** mark*

4

[8]

Q19.

(a) because they are gases

ignore vapours / evaporate / (g)

allow it is a gas

1

(b) (i) 80 / 79.5

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

ignore units

*if no answer **or** incorrect answer then evidence of 64 / 63.5 + 16 gains **1** mark*

2

(ii) 80 / 79.87 / 79.9 / 79.375 / 79.38 / 79.4

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

*if no answer **or** incorrect answer*

then

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evidence of $\frac{64}{80}$ ***or*** $\frac{63.5}{79.5}$ *(x100) gains **1** mark*

accept (ecf)

$\frac{64 or 63.5}{answer(b)(i)}(\times 100)$ *for **2** marks if correctly calculated*

if incorrectly calculated

evidence of $\frac{64 or 63.5}{answer(b)(i)}(\times 100)$

*gains **1** mark*

2

(iii) 3.2

*correct answer with or without working = **1** mark*

allow (ecf)

*4 x ((b)(ii)/100) for **1** mark if correctly calculated*

1

(c) (i) 3.3

accept 3.33…….. or $3\frac{1}{3}$ *or 3.3 · or 3.3 r*

1

(ii) measure to more decimal places
or use a more sensitive balance / apparatus

allow use smaller scale (division)

***or** use a smaller unit*

ignore accurate / repeat

1

(iii) any **two** from:

- ignore systematic / human / apparatus / zero / measurement / random / weighing / reading errors unless qualified
- different balances used **or** faulty balance
  ignore dirty apparatus
- reading / using the balance incorrectly **or** recording error
  accept incorrect weighing of copper / copper oxide
- spilling copper oxide / copper
  allow some copper left in tube
- copper oxide impure
  allow impure copper (produced)
- not all of the copper oxide was reduced / converted to copper
  or not enough / different amounts of methane used
  accept not all copper oxide (fully) reacted
- heated for different times

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- heated at different temperatures
  accept Bunsen burner / flame at different temperatures
- some of the copper made is oxidised / forms copper oxide
- some of the copper oxide / copper blown out / escapes (from tube)
  ignore some copper oxide / copper lost
- some water still in the test tube

2

[10]

Q20.

(a) (i) straight line through the 'points' and extended to C_8H_{18}
*do **not** accept multiple lines*

1

(ii) 5500
range 5400 to 5600
accept ecf from their graph

1

(iii) it is a straight line graph
allow directly proportional
accept constant difference between (energy) values
accept C_5H_{12} close to values on the graph
***or** C_5H_{12} comes in middle of the graph*
ignore 'fits the pattern' unqualified
ignore 'line of best fit'
ignore 'positive correlation'

1

(iv) expected ranges for working are:
accept correct numerical answer as evidence of working

(5400 to 5600) – (2800 to 2900) = (2500 to 2800)

or

their value from (a)(ii) – a value from 2800 to 2900

or

(5400 to 5600) / their (a)(ii) divided by 2

or

a value from 2800 to 2900 - 2

1

no / not quite / almost / yes
this mark is only awarded on evidence from their correct working

1

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(b) (i) incorrect / no **or** partially correct

ignore references to hydrogen

1

bio-ethanol produces least energy

mark independently

or

bio-ethanol produces 29 kJ

1

(ii) *ignore incorrect / correct*

any **two** from:

- hydrogen produces <u>only</u> H_2O
  accept hydrogen does not produce harmful gases / CO_2 / SO_2
- coal produces SO_2
  allow coal causes acid rain / respiratory problems
- coal produces smoke
  allow coal causes global dimming
- both renewable <u>and</u> non-renewable fuels produce CO_2
  accept bio-ethanol <u>and</u> natural gas / coal produce CO_2 / global warming
- (both) the non-renewable fuels produce CO_2
  accept coal <u>and</u> natural gas produce CO_2 / global warming
- (both) renewable fuel<u>s</u> produce no smoke
  accept hydrogen <u>and</u> bio-ethanol do not produce smoke / global dimming
- (both) renewable fuel<u>s</u> produce no SO_2
  accept hydrogen <u>and</u> bio-ethanol
  do not produce SO_2 / acid rain

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[9]

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