

GCSE Chemistry Mock Paper 2

Max time allowed: 2 hours

Max Marks: 120

The Periodic Table of the Elements

1	2	3	4	5	6	7	0										
7 Li lithium 3	9 Be beryllium 4	11 Na sodium 11	12 Mg magnesium 12	13 Al aluminium 13	14 Si silicon 14	15 P phosphorus 15	16 S sulfur 16	17 Cl chlorine 17	18 Ar argon 18								
19 K potassium 19	20 Ca calcium 20	21 Sc scandium 21	22 Ti titanium 22	23 V vanadium 23	24 Cr chromium 24	25 Mn manganese 25	26 Fe iron 26	27 Co cobalt 27	28 Ni nickel 28	29 Cu copper 29	30 Zn zinc 30	31 Ga gallium 31	32 Ge germanium 32	33 As arsenic 33	34 Se selenium 34	35 Br bromine 35	36 Kr krypton 36
37 Rb rubidium 37	38 Sr strontium 38	39 Y yttrium 39	40 Zr zirconium 40	41 Nb niobium 41	42 Mo molybdenum 42	[98] Tc technetium 43	44 Ru ruthenium 44	45 Rh rhodium 45	46 Pd palladium 46	47 Ag silver 47	48 Cd cadmium 48	49 In indium 49	50 Sn tin 50	51 Sb antimony 51	52 Te tellurium 52	53 I iodine 53	54 Xe xenon 54
55 Cs caesium 55	56 Ba barium 56	57 La* lanthanum 57	72 Hf hafnium 72	73 Ta tantalum 73	74 W tungsten 74	75 Re rhenium 75	76 Os osmium 76	77 Ir iridium 77	78 Pt platinum 78	79 Au gold 79	80 Hg mercury 80	81 Tl thallium 81	82 Pb lead 82	83 Bi bismuth 83	84 Po polonium 84	85 At astatine 85	86 Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

1	H hydrogen 1
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relative atomic mass
atomic symbol
name
atomic (proton) number

Key

* The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

1 Jack investigates the reactions of some Group 1 and Group 2 metals with water.

He adds a small piece of each metal to water and measures how long it takes for the reaction to finish.

He uses the same amount of metal and the same amount of water each time.

The table shows his results.

Metal	Group	Time taken for reaction to finish in s
lithium	1	35
sodium	1	12
potassium	1	5
magnesium	2	not finished after 2 minutes
calcium	2	40
strontium	2	9

(a) What conclusions can you make from the data about the reactivity of Group 1 and Group 2 metals with water?

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..... [3]

(b) Which of the following statements about the reactions of the Group 1 metals with water are **true** and which are **false**?

Put a tick (✓) in one box in each row.

	True	False
The reactions make hydrogen gas.		
Each reaction makes a different metal oxide.		
The reaction mixture gains mass during every reaction.		
The pH of each solution is neutral at the end of the reaction.		

[2]

[Total: 5]

2 Abbi does some experiments with Group 7 elements.

Group 7	
F	fluorine
Cl	chlorine
Br	bromine
I	iodine

(a) Abbi does an experiment using chlorine.

She uses a fume cupboard.

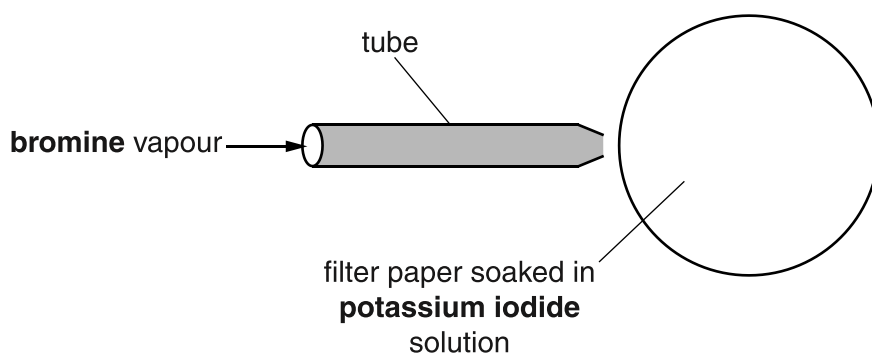
Explain why chlorine is hazardous.

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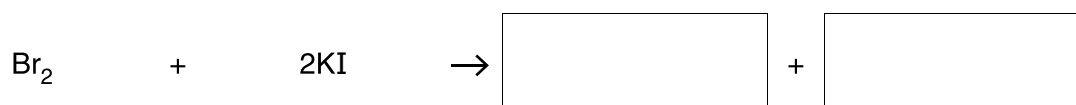
..... [2]

(b) Abbi passes bromine vapour over a filter paper soaked in potassium iodide solution. Bromine vapour is blown onto the filter paper down a tube.



A grey solid appears on the filter paper because **iodine** is made.

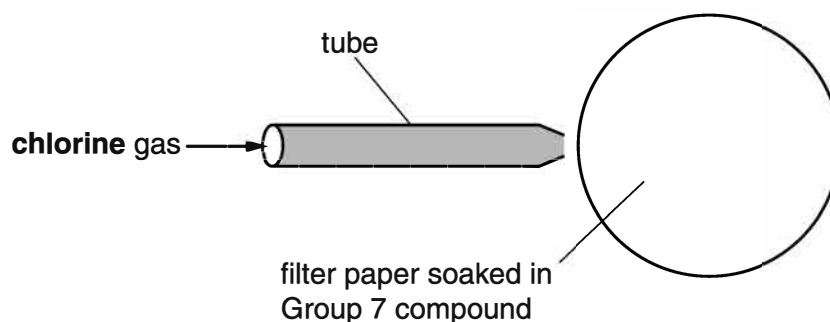
Complete the symbol equation for this reaction.



[2]

(c) Abbi repeats the experiment using chlorine gas.

She passes chlorine gas down a tube onto filter papers soaked in some other Group 7 compounds.



The table shows which compounds she uses.

Gas	Group 7 compound on filter paper
chlorine	potassium fluoride
chlorine	potassium chloride
chlorine	potassium bromide
chlorine	potassium iodide

Before the experiment the solutions of the compounds are all colourless.

State and explain what Abbi will **see** when chlorine gas passes over each Group 7 compound.



The quality of written communication will be assessed in your answer.

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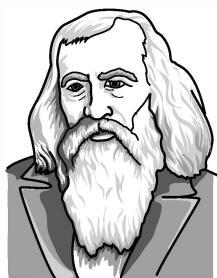
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[6]

[Total: 10]

3 Mendeleev developed the modern Periodic Table. Other scientists were involved.



Mendeleev

I have developed a new way of arranging the elements in a table.



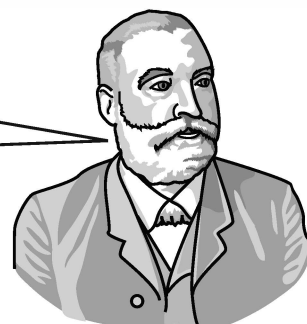
Scientist 2

There are gaps in the table and problems with the order of some elements. This does not work for all elements.



Scientist 3

I have discovered a new element. Its properties mean that it could go in one of the gaps in Mendeleev's table.



Scientist 4

I have discovered a different new element. The properties mean that it could go in a different gap.



Scientist 5

I am going to do the same experiments as Scientist 3 and Scientist 4, and look at the results.

(a) Which **two** scientists are doing a peer review?

Explain how what they say is peer review.

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..... [3]

(b) Mendeleev's ideas were supported by the discoveries of **Scientist 3** and **Scientist 4**.

Explain why.

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..... [2]

[Total: 5]

4 Lee looks up some data about gases in the air.

Gas in the air	Formula	Relative formula mass	Boiling point in °C	Percentage in air
nitrogen	N ₂	28	-196	78
oxygen	O ₂	32	-183	21
carbon dioxide	CO ₂	44	-57	0.04
water vapour	H ₂ O	18	100	variable

(a) All of the gases in the table are covalently bonded.

Which statements describe a covalent bond?

Put a tick (✓) in the boxes next to the **two** correct answers.

Ions attract together due to their opposite charges.

The electrons between the atoms are attracted to each nucleus.

Electrons are shared between atoms.

The electrons of two atoms are attracted to each other.

Electrons are transferred from one atom to another.

[2]

(b) Lee looks at the data and writes down this idea.

I think that there is a correlation between the relative formula mass of a gas and its boiling point.

Does the data in the table support Lee's idea?

Explain your reasoning.

.....

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..... [3]

- (c) Alex also notices that there is a correlation between the relative masses of gases in the air and their percentages in air.

Gas in the air	Relative mass	Percentage in air %
nitrogen	28	78
oxygen	32	21
argon	40	1
carbon dioxide	44	0.04

Use the data in the table to explain the difference between correlation and cause.

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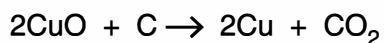
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..... [2]

[Total: 7]

5 Some metals can be extracted from metal oxides by heating with carbon.

(a) The equation shows what happens when copper oxide is heated with carbon.



(i) Which substance is oxidised and which substance is reduced in this reaction?

oxidised

reduced [1]

(ii) Name the waste gas that is made in this reaction.

..... [1]

(b) Large-scale metal extraction processes involve both costs and benefits.

(i) Companies choose metal extraction processes that use as little energy as possible.

Suggest why using less energy reduces both the **cost to the company** and the **cost to the environment**.

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..... [3]

(ii) Give **two** examples of the ways that people **benefit** from large-scale metal extraction processes.

.....
.....
..... [2]

(c) The table shows some data about the most cost-effective methods for extracting metals from metal oxides.

↑
more reactive metal

Metal oxide	Minimum temperature to make metal by heating with carbon in °C	Most cost-effective method of extraction
calcium oxide	2100	electrolysis
magnesium oxide	1600	electrolysis
aluminium oxide	2100	electrolysis
zinc oxide	900	heating with carbon
iron oxide	700	heating with carbon
lead oxide	400	heating with carbon
copper oxide	100	heating with carbon

Use the data to explain how the method chosen to extract a metal is related to its reactivity and the energy involved.



The quality of written communication will be assessed in your answer.

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..... [6]

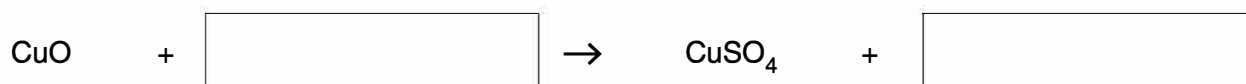
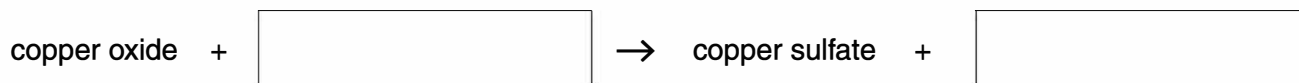
[Total: 13]

6 Sam works for a company that makes chemicals to kill fungi on plants.

One of the chemicals the company makes is copper sulfate.

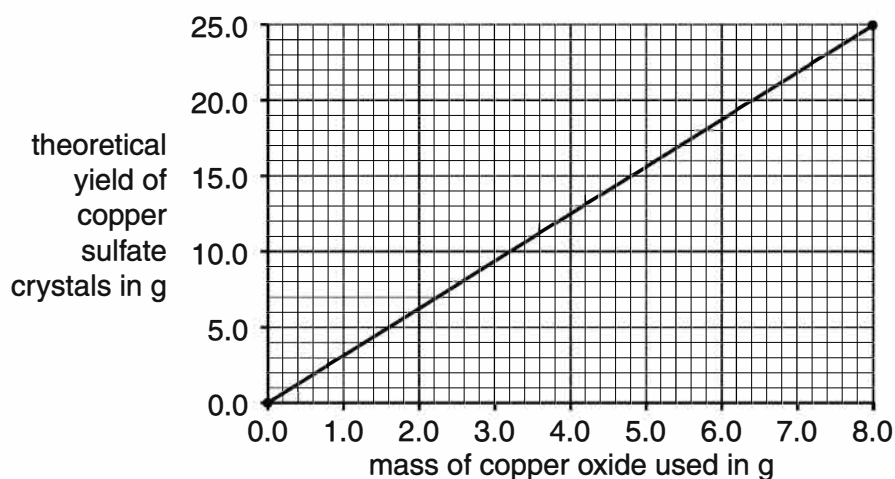
(a) Sam makes some copper sulfate by reacting copper oxide with an acid.

Complete the **word** and **symbol** equation for the reaction.



[2]

(b) Sam draws a graph to show the theoretical yield of copper sulfate crystals that can be made from copper oxide.



(i) What mass of copper oxide would Sam need to make 10g of copper sulfate crystals?

..... [1]

(ii) The company makes the fungicide in large quantities.

Use your answer to (i) to work out how much copper oxide would be needed to make 5kg of copper sulfate crystals.

..... [2]

(iii) Complete the table to show the relative formula masses of copper oxide and copper sulfate.

Compound	Formula	Relative formula mass
Copper oxide	CuO	
Copper sulfate	CuSO ₄	

[2]

(iv) Copper sulfate crystals do not only contain copper sulfate.
The crystals also contain water molecules in their structure.
The values on the graph take this into account.

Compare your answers to (iii) with the graph to show that the crystals do not **only** contain copper sulfate.

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..... [2]

[Total: 9]

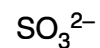
7 Acid rain contains a dilute solution of sulfuric acid.

Acid rain causes some lakes to become too acidic, killing fish and other wildlife.

Water companies can treat the lakes with calcium hydroxide to neutralise acidity.

(a) Which ion causes the acidity in the lake?

Put a (ring) around the correct answer.



[1]

(b) Which ion in calcium hydroxide reacts to neutralise the acidity in the lake?

Put a (ring) around the correct answer.



[1]

(c) The calcium hydroxide is dropped into the lakes from helicopters.

It is in the form of a fine powder to make sure that the reaction is as fast as possible.

Use ideas about collisions to explain why fine powders react faster than larger pieces.

..... [3]

[Total: 5]

8 Joe wants to find out how effective different compounds are when they are used as catalysts.

He does some experiments to find the time taken for a reaction to finish when different catalyst compounds are used.

The table shows some information about the catalysts he used and his results.

Experiment	Catalyst	Positive ion in catalyst	Negative ion in catalyst	Time taken for reaction to finish in s
1	none	none	none	45
2	sodium chloride	Na ⁺	Cl ⁻	45
3	iron chloride	Fe ²⁺	Cl ⁻	22
4	potassium chloride	K ⁺	Cl ⁻	45
5	magnesium chloride	Mg ²⁺	Cl ⁻	46
6	sodium nitrate	Na ⁺	NO ₃ ⁻	45
7	iron nitrate	Fe ²⁺	NO ₃ ⁻	22
8	potassium nitrate	K ⁺	NO ₃ ⁻	45
9	magnesium nitrate	Mg ²⁺	NO ₃ ⁻	46

Joe talks about his results with Eve and Jay.



Joe

I think that Group 1 and Group 2 elements do not work as catalysts.



Eve

I think the effectiveness of the catalyst depends on which positive ion it contains.



Jay

I think the effectiveness of the catalyst depends on which negative ion it contains.

Discuss whether or not the results in the table support the ideas of Joe, Eve and Jay.



The quality of written communication will be assessed in your answer.

..... [6]

[Total: 6]

9 Some 'green' buses use biodiesel fuel which is a fuel that has been made from waste fats and cooking oil.

The fats and oils are esters.



(a) Most oils are made by plants. Most fats are made by animals.

(i) What do plants use the oils for?

Put a **ring** around the best answer.

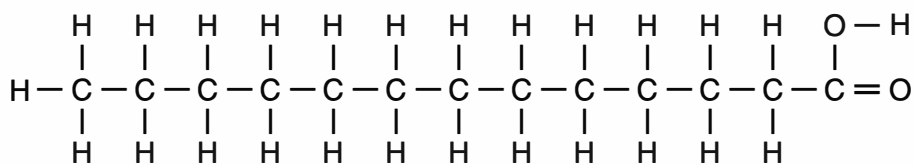
for energy **to fight disease** **for growth** **for repair**

[1]

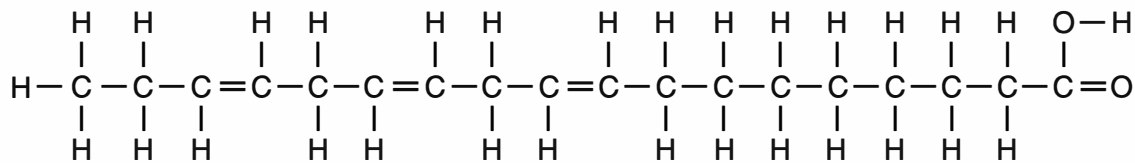
(ii) Animal fats are saturated.

Which of the molecules below is saturated?

Give a reason for your choice.



molecule A



molecule B

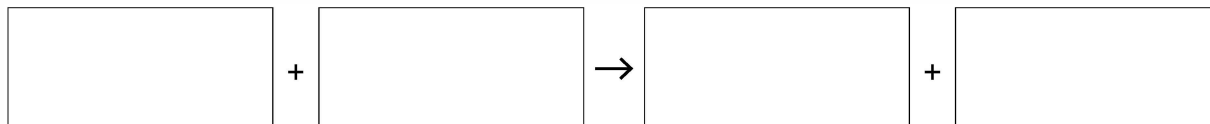
answer

reason

..... [2]

- (b) The process for making biodiesel requires heating. Heat can be provided by burning propane, C_3H_8 .
When propane burns it reacts with the oxygen, O_2 , in the air to make carbon dioxide and water.

Fill in the boxes to complete the **balanced symbol equation** for burning propane.



[2]

- (c) The conversion of fats and oils into biodiesel needs a catalyst. The usual catalyst is hot concentrated sodium hydroxide.

Scientists are investigating a new catalyst. The new catalyst is an enzyme.

Here is some information about both catalysts.

Feature of enzyme	Feature of hot concentrated sodium hydroxide
speeds up reaction a lot	speeds up reaction
easily damaged	not easily damaged
needs warm conditions	needs hot conditions
can be coated onto a solid surface	mixed in with the products at the end
speeds up this reaction only	speeds up other reactions of the esters as well as this reaction
expensive	very cheap

Evaluate both catalysts. Suggest which catalyst would be best and explain why.



The quality of written communication will be assessed in your answer.

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..... [6]

[Total: 11]

10 Fred investigates the acid CH_3COOH .

(a) (i) Which part of the formula shows you that CH_3COOH is a carboxylic acid?

Put a ring around the correct answer.

CH_3

CO

OH

COOH

[1]

(ii) The acid is a weak acid. What does this mean?

Put a tick (✓) in the box next to the correct answer.

Its formula contains carbon, hydrogen and oxygen.

It is more dilute than acids such as hydrochloric acid.

It is less reactive than acids such as hydrochloric acid.

It is more runny than acids such as hydrochloric acid.

[1]

(iii) Fred compares solutions of this weak acid with a strong acid of the same concentration.

How do the pH values of the two solutions compare?

Put a tick (✓) in the box next to the correct answer.

The weak acid has a higher pH.

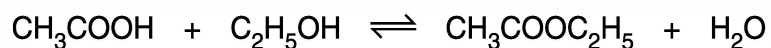
The weak acid has the same pH.

The weak acid has a lower pH.

The weak acid has a much lower pH.

[1]

(b) (i) Fred reacts the acid with ethanol.



What type of substance is made?

Put a tick (✓) in the box next to the correct answer.

- alcohol
- alkane
- ester
- fatty acid

[1]

(ii) Fred calculates the theoretical yield for the reaction when he uses 6.0 g of the acid. The table shows some of his working.

Complete his calculation.

[Relative atomic mass of H = 1, C = 12, O = 16]

	Relative formula mass	
CH ₃ COOH	60	Mass used = 6.0 g
CH ₃ COOC ₂ H ₅		Theoretical yield = g

[2]

(c) (i) The reaction between acid and alcohol needs a catalyst.

What catalyst is used?

..... [1]

(ii) Use ideas about energy to explain why a catalyst speeds up a reaction.

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..... [3]

[Total: 10]

11 In the Haber Process, nitrogen and hydrogen react to make ammonia, NH_3 .

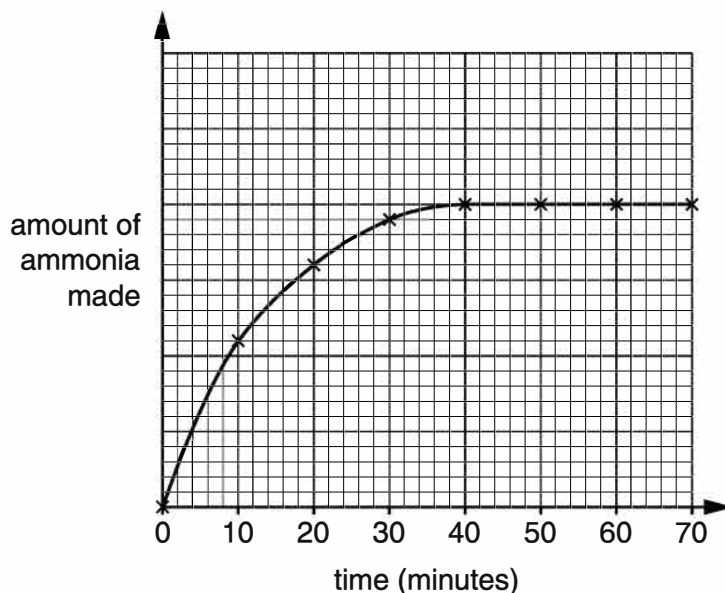
(a) Write a balanced symbol equation for this reaction.

..... [2]

(b) State and explain the main use of ammonia.

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..... [2]

(c) The reaction between nitrogen and hydrogen is reversible and can reach an equilibrium. Ann heats some nitrogen and hydrogen with a catalyst in a closed container. She plots a graph to show how the amount of ammonia made changes with time.



(i) At what time does the amount made stop increasing?

..... [1]

(ii) The amount made stops increasing when the reaction reaches equilibrium. At this time the reaction to make ammonia is still taking place.

Explain why the reaction to make ammonia is still taking place but the amount made is not increasing.

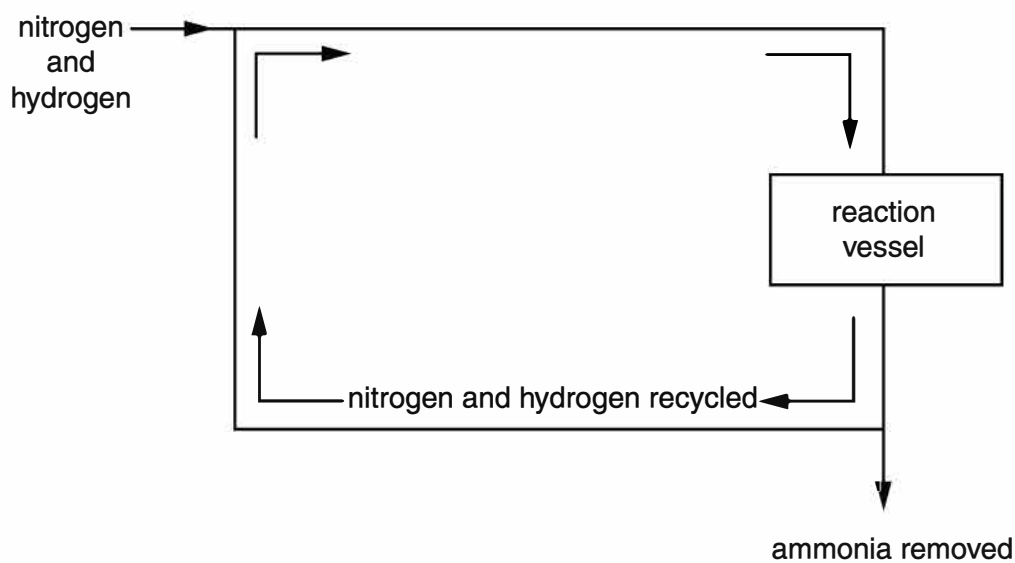
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..... [3]

(iii) Put a tick (✓) in the box next to the name of this type of equilibrium.

- active equilibrium
- dynamic equilibrium
- fixed equilibrium
- static equilibrium

[1]

(d) In the Haber Process, most of the nitrogen and hydrogen has to be recycled to make the process run efficiently.



Explain how and why this recycling affects the total yield of the reaction, and why so much has to be recycled.

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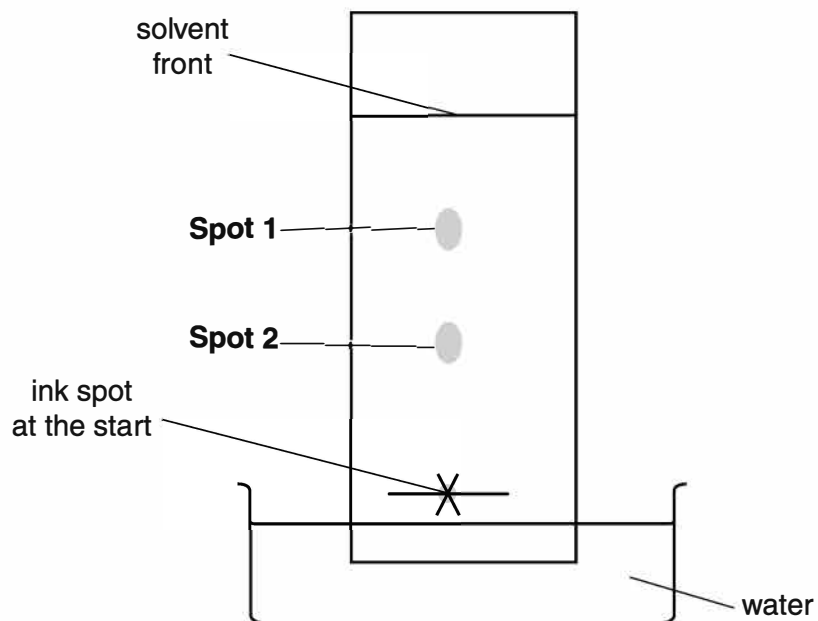
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..... [3]

[Total: 12]

- 12 Ben uses paper chromatography to analyse the ink from his pen. He puts the bottom of the paper in water and leaves it for a few hours. The diagram shows his result.



- (a) Calculate the *R_f* value for **Spot 1**. Show your working.

R_f for **Spot 1** = [3]

(d) A factory makes ink. The ink is made continuously throughout the day. Chromatography is used to test samples of the ink.

Jane and Mike discuss how to take the samples.



Explain who has the best approach.

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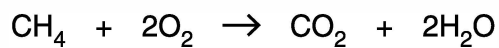
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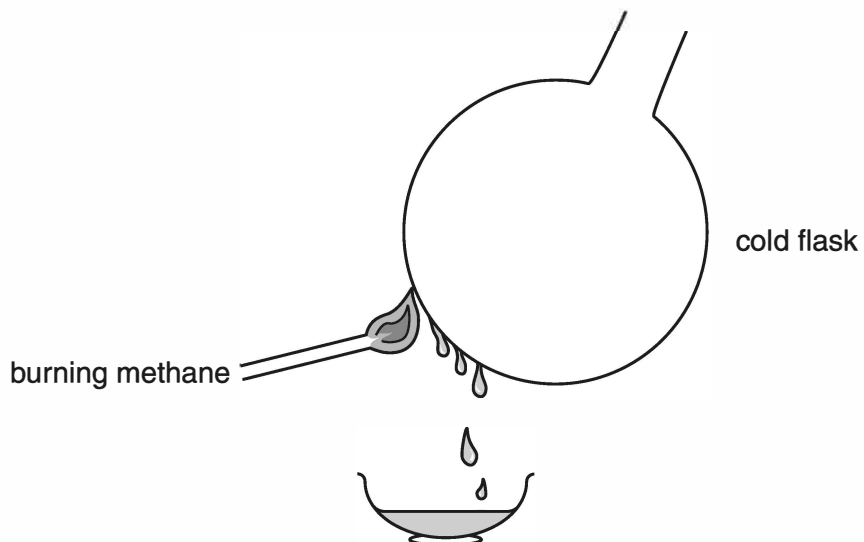
[Total: 14]

13 Mary investigates burning methane.



She directs the flame onto the surface of a cold flask.

(a) Where the flame touches the outside of the flask, droplets of liquid appear.



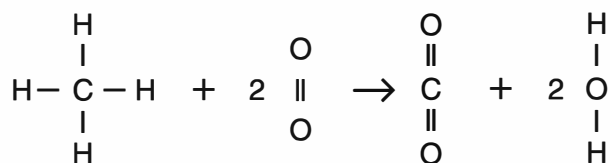
What is the liquid and where does it come from?

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..... [2]

(b) Mary wants to know the energy change when methane burns.

She writes out the equation to show all the chemical bonds.



(i) Complete the table to show how many of each type of bond are broken and how many are made when methane reacts with the oxygen in the air.

Bonds broken			Bonds made	
Type of bond	Number of bonds		Type of bond	Number of bonds
C-H				
O=O	2			

[2]

(ii) Use the table of bond energies to calculate the overall energy change when methane burns.

Bond	Energy to break the bond for a formula mass (kJ)
C-H	435
C=O	805
H-H	436
H-O	464
O=O	498

You must show your working.

..... kJ [3]

[Total: 7]

14 When chemical engineers design an industrial process, they make it as sustainable as possible.

To make a process more sustainable, chemical engineers use:

- **renewable** feedstock
- reactions with high **atom economy**.

Explain what the terms **renewable** and **atom economy** mean, and how each can make a process more sustainable.



The quality of written communication will be assessed in your answer.

..... [6]

[Total: 6]

END OF QUESTION PAPER

Question		Answer	Marks	Guidance
1	a	group 1 more reactive down the group / group 1 react faster down the group;(1) group 2 more reactive down the group / group 2 react faster down the group;(1) group 1 more reactive than group 2 / group 1 react faster than group 2;(1)	3	Accept for 2 marks 'In BOTH groups the reactivity increases going down the group' Ignore comparison between individual metals alone. Ignore answers which only mention time taken
	b	TFFF	2	All correct = (2) 2 or 3 correct = (1) 1 correct = 0
			5	

Question		Answer	Marks	Guidance
2	a	Toxic / corrosive / respiratory problems / irritates or damages lungs; gas;	2	Allow poisonous Ignore harmful / hazardous / dangerous / can kill Allow vapour
	b	$I_2 + 2KBr$; (2) For (1) mark at least one formula correct I_2 / KBr ;	2	Allow BrK Formulae and balancing fully correct = (2)
	c	[Level 3] Links two reactions with reactivity and correct observations. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) [Level 2] Links a reaction to either the correct observation or to	6	This question is targeted at grades up to A* Indicative scientific points may include: Observations <ul style="list-style-type: none"> • KF (and KCl) no change / accept yellow or green colour seen (due to chlorine) • KBr orange / brown / yellow-brown / red-brown (ignore yellow or red alone) • KI grey colour accept brown (ignore violet/purple) Ignore states, look for colours alone

Question	Answer	Marks	Guidance
	<p>reactivity. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>[Level 1] Makes a correct statement about observations, reactions or reactivity. Quality of written communication impedes communication of the science at this level. (1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>		<p>QWC is impeded if other incorrect observations given e.g. precipitates or incorrect colours for elements (ignore bromine red or yellow and iodine violet or purple)</p> <p>Reactions</p> <ul style="list-style-type: none"> • No reaction with KF (and KCl) • Reaction occurs with KBr (may be implied if observations are given) • Reaction occurs with KI (may be implied if observations are given) <p>Allow Level 1 only for no reaction between chlorine and potassium chloride</p> <p>Reactivity</p> <ul style="list-style-type: none"> • Cl₂ less reactive than F₂ / cannot displace F₂ • Cl₂ more reactive than Br₂ / can displace Br₂ • Cl₂ more reactive than I₂ / can displace I₂ • Reactivity gets less down the group <p>QWC is impeded if 'chlorine' is confused with 'chloride' etc.</p> <p>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</p>
	Total	10	

Question		Answer	Marks	Guidance
3	a	<p>Scientist 2 and scientist 5; (1)</p> <p>Scientist 2 is evaluating/judging/analysing /criticising Mendeleev's work;(1)</p> <p>Scientist 5 is checking/repeating another scientist's work/checking results/look for repeatability; (1)</p>	3	<p>Ignore 'reviewing' (in the Q)</p> <p>Allow 'give feedback'</p> <p>Ignore 'talking about' 'discussing' (not enough)</p> <p>Allow 'do the same experiment' / 'repeat the experiment'</p>
	b	<p>2 from</p> <p>Mendeleev: left gaps for undiscovered elements / made predictions about properties;</p> <p>Scientists: Idea of fitting/matching (in the gaps);</p> <p><u>Idea that properties</u> of new elements agree with or support Mendeleev's predictions;</p>	2	<p>Ignore 'goes in the gaps' (in the Q)</p> <p>Allow example of a property that matched</p>
			5	

Question		Answer	Marks	Guidance
4	a	box 2; (1) box 3; (1)	2	
	b	as the RFM increases the BP increases; but this works for 3 gases / N ₂ O ₂ and CO ₂ ; water does not fit; (because water BP is) too high / has a higher BP (than the others) / has the lowest formula mass has the highest BP;	3	Any 3 Ignore 'yes' or 'no' Ignore 'correlation' (in the Q)
	c	the relative masses and percentages follow a similar pattern / the bigger the mass the lower the percentage / relative masses and percentages are linked; but one is not a direct result of the other / it is a coincidence / no causal link / no mechanism is known;	2	MP1 refers to the data in the table Ignore masses and percentages show a correlation (in the Q) Accept one is not caused by the other / both could be caused by another (hidden) factor Allow general description of 'cause' for MP2
			7	

Question			Answer	Marks	Guidance
5	a	i	carbon is oxidised AND copper (oxide) is reduced;	1	both answers for 1 mark
		ii	carbon dioxide (must be name)	1	Do not allow CO ₂
	b	i	<p>Any 3</p> <p>Cost to company: saves or uses less fuel/electricity/ example of fuel;</p> <p>Environmental: energy comes from fossil fuels / non- renewable or finite fuels;</p> <p>reducing pollutant gases / reduces emissions / reduces named pollutant gas e.g. SO_x, NO_x, CO_x;</p> <p>named environmental effect of gases (e.g. acid rain, greenhouse effect/climate change);</p>	3	<p>Ignore 'less cost' or 'less pollution' alone.</p> <p>Ignore 'uses less power' Ignore 'reduces cost of fuel' (not enough)</p> <p>Allow: 'Saving fossil fuels' (2) marks for cost to company and environment</p> <p>Ignore 'gives out less gases' or 'less waste' but allow 'less waste gases'</p>
		ii	<p>any 2 from: jobs/ income;</p> <p>use of metals for products / example of metal use (e.g. cars/fridges etc);</p> <p>idea of local economy;</p> <p>idea of national economy;</p> <p>advantage of large scale: transport links to one area / control of waste is in one area / economy of scale idea / more economic to extract on a large scale / lower energy costs on a large scale / large scale can use continuous not batch processes;</p>	2	<p>Ignore 'to meet demand' or 'need metals' or 'use a lot of metals' alone (not enough)</p> <p>Allow 1 mark for 'economy' alone</p> <p>MP5 must be linked to idea of large scale extraction</p>

Question	Answer	Marks	Guidance
c	<p>[Level 3] Links reactivity with the method used and to energy. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p>[Level 2] Makes a link between trends. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>[Level 1] Makes a correct statement about the data. Quality of written communication impedes communication of the science at this level. (1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	6	<p>This question is targeted at grades up to C Indicative scientific points may include:</p> <p>Level 3: (Links reactivity and method and energy)</p> <ul style="list-style-type: none"> • More reactive metals use electrolysis which uses high energy / the more reactive a metal the more energy is needed and electrolysis is used • Less reactive metals use extraction with carbon which uses less energy / the less reactive a metal the less energy is needed and heating with carbon is used <p>Level 2: (Link between trends)</p> <ul style="list-style-type: none"> • Links reactivity to method of extraction • Links reactivity to temperature needed • Links reactivity to energy needed • Links temperature needed to method of extraction • Links temperature to energy • Links method used to energy <p>Level 1: (data)</p> <ul style="list-style-type: none"> • Ca/Mg/Al are most reactive metals • Zn/ Fe/ Pb/Cu are less reactive metals • Ca/Mg/Al need a high temperature (for extraction) • Zn/ Fe/ Pb/Cu need a lower temperature (for extraction) • Ca/Mg/Al use electrolysis • Zn/ Fe/ Pb/Cu use heating with carbon • Mg or Al does not fit the trend <p>Ignore references to melting point Statements about one metal alone indicate level 1</p>
	Total	13	

Question		Answer	Marks	Guidance	
6	a	sulfuric acid AND H_2SO_4 ; (1) water AND H_2O ; (1)	2	Ignore 'hydrogen sulfate'	
	b	i	3.2(g); (1)	1	Accept 3.2 alone
		ii	1600 g / 1.6 kg; (2) Uses 1000 in calculation / $1000 \text{ g} = 1 \text{ kg}$ / 1.6 or 1600 with no units or incorrect units (1)	2	Answer with units (2) Allow ecf for incorrect answer to b (i)
		iii	79.5 g; 159.5 g	2	
		iv	<i>refers to table:</i> (relative formula) mass of CuSO_4 approximately twice (relative formula) mass of CuO / mass of CuO is half mass of CuSO_4 / gives 2:1 ratio idea / gives example masses e.g. 8.0g CuO should make 16.0g CuSO_4 ; <i>refers to graph:</i> yield of copper sulfate on graph is too high / line on graph too high/ more than double / reads values from graph e.g. 25 g yield compared to 15.95g yield or 8.0 g gives 25 g / calculates ratio or gradient from graph to give approximately 3:1 ratio;	2	Allow ecf for incorrect formula masses in iii
				9	

Question		Answer	Marks	Guidance
7	a	H ⁺	1	
	b	OH ⁻	1	
	c	more surface area; idea that more collisions occur (between particles of acid and calcium hydroxide); (collisions are....) more frequent/ more per unit time / (collide) more often;	3	Allow 'more chance of collisions' for MP2 only Ignore 'faster collisions' Do not allow collisions between incorrect particles e.g. atoms / collisions between the same reactant alone 'more frequent collisions' OWTTE (2)
			5	

Question	Answer	Marks	Guidance
8	<p>Joe's idea: Gp1 and Gp2 do not work Eve's idea: depends on + ion Jay's idea: depends on – ion</p> <p>[Level 3] Correctly states that the ideas of Joe and Eve are correct and Jay is incorrect and gives reasons for two people and identifies control for Joe Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p>[Level 2] Correctly states that the ideas of Joe and Eve are correct and Jay is incorrect and gives a reasons for one person.</p>	6	<p>This question is targeted at grades up to A*</p> <p>Indicative scientific points may include:</p> <p>Level 3: Control</p> <ul style="list-style-type: none"> Joe: compares group 1 and group 2 to no catalyst /times or rate the same as no catalyst <p>Ideas and reasons (Level 1, level 2, level 3) Joe:</p> <ul style="list-style-type: none"> Joe's idea is correct/don't work at catalysts Group 1 and group 2 reaction times all the same/take 45s / gives same rate / does not speed up Na⁺/K⁺ and Mg²⁺ all the same / take 45/46s (accept that Mg²⁺ is slower at 46s idea).

Question	Answer	Marks	Guidance
	<p>Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>[Level 1] Correctly states that the ideas of Joe and Eve are correct and Jay is incorrect OR correctly states whether one person is correct and gives a reason. Quality of written communication impedes communication of the science at this level. (1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>		<p>Eve</p> <ul style="list-style-type: none"> • Eve's idea is correct / iron acts as a catalyst • Using Fe²⁺ reduces reaction time / gives faster reaction <p>Jay</p> <ul style="list-style-type: none"> • Jay's idea is incorrect /chloride and nitrate don't work as catalysts • chlorides the same as nitrates <p>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</p>
	Total	6	

Question			Answer	Marks	Guidance
9	a	i	energy	1	
		ii	A [no marks] discusses bonds between carbons = 1 Only single bonds between carbons = 2 No double bonds between carbons = 2 Maximum number of hydrogens to carbons = 2	2	If they choose B, max 1 mark Ignore comments about 'saturation' [stem] Ignore 'double bonds'
	b		$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ Formulae correct [1 mark] [Correct formulae] balanced [1 mark]	2	accept multiples Ignore state symbols
	c		Level 3 Discusses properties from the table. Explains advantages or disadvantages, including one correct level 3 response, and comes to a conclusion. <i>Quality of written communication does not impede communication of the science at this level.</i> (5 – 6 marks) Level 2 Discusses properties from the table. Explains at least one advantage or disadvantage, and comes to a conclusion. <i>Quality of written communication partly impedes communication of the science at this level.</i> (3 – 4 marks) Level 1 Answers in terms of the properties from the table, and comes to a conclusion. <i>Quality of written communication impedes communication of the science at this level.</i> (1 – 2 marks)	6	This question is targeted at grades up to A* Indicative scientific points may include: From the point of view of lipase Level 3 <ul style="list-style-type: none"> [coated on solid] – can be recovered / separated [speeds up this reaction only] – fewer side reactions, less waste, less purification needed Level 2 <ul style="list-style-type: none"> [damage] - nature of damage [enzyme denatured] [damage] –consequence [needs more tightly controlled conditions / enzyme doesn't last as long / needs to be replaced more often] [warm] – lower energy / costs Ignore more risky / Ignore more easily made [enzyme speeds up this reaction only] – realises this is an advantage [cost] – justified by greater productivity Level 1 <ul style="list-style-type: none"> [speed] -- enzyme very fast

Question			Answer	Marks	Guidance
			Level 0 <i>Insufficient or irrelevant science. Answer not worthy of credit.</i> (0 marks)		<ul style="list-style-type: none"> • [damage] – enzyme easily damaged • Enzyme warm conditions • etc <p>If one correct L3 and one incorrect L3, QWC impeded If one correct L3 and then L1 responses only, level 2</p> <p>incorrect L1&2 responses, ignore, only mark the correct material</p> <p>Accept reverse arguments for sodium hydroxide Conclusion must be present to gain the higher mark in any level.</p> <p>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</p>
Total				11	

Question			Answer	Marks	Guidance
10	a	i	COOH	1	
		ii	its formula contains carbon, hydrogen and oxygen it is more dilute than acids such as hydrochloric it is less reactive than acids such as hydrochloric it is more runny than acids such as hydrochloric	1	
		iii	a weak acid has a higher pH a weak acid has the same pH a weak acid has a lower pH a weak acid has a much lower pH	1	
	b	i	alcohol alkane ester ether	1	

Question		Answer	Marks	Guidance
	b	ii	88, 8.8	2 ecf if second number is 1/10 th of first
	c	i	'strong acid' / named strong acid	1 accept 'dilute' named strong acid as the concentration is not on the spec ignore 'acid' or 'concentrated acid' ignore 'enzyme'
	c	ii	lower [energy / energy hump] this energy is the <i>activation</i> energy alternative pathway	3 'means less activation energy needed for reaction' = 2 marks 'more energy' is CON for first mark ignore comments about surface area or increased rate of collision, catalysts
			Total	10

Question		Answer	Marks	Guidance								
11	a	$\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ Formulae correct = 1 [Correct formulae] balanced = 1	2	equilibrium sign optional, accept '=' as alternative to \rightleftharpoons accept multiples								
	b	fertiliser detail – for plants / crops/ food supply	2	'to help growth and kill pests' CON for 2 nd mark Ignore as a source of nitrates Ignore other uses								
	c	i 38-40 [minutes]	1									
		ii Discusses reverse reaction [1] Understands that both reactions happen at the same time [1] at same rate/speed = 1	3	the reaction is reversible / ammonia is broken down = 1 The "same time" point may be by implication Forward and backward reaction occur = 2 ammonia is made and broken down = 2 both reactants and products are reacting = 2 Forward and backward reactions cancel out = first 2 marking points only Ignore 'dynamic equilibrium'								
		iii <table border="1" style="margin-left: 20px;"> <tr><td>active equilibrium</td><td><input type="checkbox"/></td></tr> <tr><td>dynamic equilibrium</td><td><input type="checkbox"/></td></tr> <tr><td>fixed equilibrium</td><td><input type="checkbox"/></td></tr> <tr><td>static equilibrium</td><td><input type="checkbox"/></td></tr> </table>	active equilibrium	<input type="checkbox"/>	dynamic equilibrium	<input type="checkbox"/>	fixed equilibrium	<input type="checkbox"/>	static equilibrium	<input type="checkbox"/>	1	
active equilibrium	<input type="checkbox"/>											
dynamic equilibrium	<input type="checkbox"/>											
fixed equilibrium	<input type="checkbox"/>											
static equilibrium	<input type="checkbox"/>											
	d	not all nitrogen and hydrogen react / so more can react; comment on how little reacts / low efficiency / initial yield low; increase [yield] / more ammonia	3	ignore 'recycled' [stem] 'only a small amount reacts' = 2 If % yield quoted, accept anything below 50%								
Total			12									

Question		Answer	Marks	Guidance
12	a	0.7 [3 marks]	3	<p>If not correct, maximum of 2 marks from</p> <p>$R_f = \text{spot distance/solvent distance} = 1$ mark</p> <p>Look for the numbers 5 AND 3.2 to $3.7 = 1$ mark</p> <p>$\frac{3.2 \text{ to } 3.7}{5}$ [2 marks]</p> <p>Special case one mark answer $\frac{3.5}{5.4}$ [1 mark]</p> <p>Accept measurements in mm</p>
	b	<p>Level 3 Makes suitable comparison of attractions of both spots with both phases Links that comparison to movement of spots. <i>Quality of written communication does not impede communication of the science at this level.</i> (5 – 6 marks)</p> <p>Level 2 Makes suitable comparison of attractions of each spot with one phase only. Links that difference to movement of spot. OR Makes suitable comparison of attractions of only one spot with each phase. Links that difference to movement of spot. <i>Quality of written communication partly impedes communication of the science at this level.</i> (3 – 4 marks)</p> <p>Level 1</p>	6	<p>This question is targeted at grades up to A *</p> <p>Indicative scientific points may include:</p> <p>Level 3 minimum response</p> <ul style="list-style-type: none"> [Spot 1] more attracted to mobile phase AND [spot 2] more attracted to stationary phase therefore [Spot 1] moves further <p>Level 2 minimum response</p> <ul style="list-style-type: none"> [Spot 1] more attracted to mobile phase therefore moves further [Spot 1] more attracted to stationary phase therefore moves less <p>Level 1</p> <ul style="list-style-type: none"> [spot 1] is attracted to the mobile phase [spot 2] is attracted to the stationary phase <p>At level 2&3 if not linked to movement, QWC impeded</p>

Question	Answer	Marks	Guidance
	<p>Discusses attractions of at least one spot with at least one phase. <i>Quality of written communication impedes communication of the science at this level.</i></p> <p style="text-align: right;">(1 – 2 marks)</p> <p>Level 0 <i>Insufficient or irrelevant science. Answer not worthy of credit.</i></p> <p style="text-align: right;">(0 marks)</p>		<p>Accept 'the spot that moves further' = Spot 1 Accept 'moves faster' instead of 'moves further'</p> <p>Accept 'solvent' or 'liquid' instead of 'mobile phase' and 'paper' instead of 'stationary phase'</p> <p>Spot 1 may like/ prefer/ favours / has affinity for the mobile phase more – QWC impeded Ignore spends more time in the mobile phase Ignore reference to attractions between the spot and the ink Ignore equilibrium arguments, the question is about attractions</p> <p>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</p>
c	<p>simple similarity Both use a liquid / solvent [as the mobile phase] / same mobile phase</p> <p>simple difference idea that a different solid/ stationary phase is used [tlc] solid is mounted on a glass or plastic plate [tlc] quicker</p>	2	<p>Ignore 'uses the same method' Ignore 'both have a mobile phase and a stationary phase' [ie this is a general statement about chromatography.]</p> <p>Accept '[tlc] uses silica gel'</p>
d	<p>Any three points from</p> <p>[Jane] gives feedback on the technique idea of accurate / reproducible / reliable can take an average remove outliers</p>	3	<p>Marks for arguments only</p> <p>Arguments may be in reverse e.g. Jane's method does not show up changes as soon as they happen</p>

Question		Answer	Marks	Guidance
		[Mike] Gives checks throughout the day / regular check/ continuous Shows up if a drift / pattern / change with time Shows up if a sudden change / problem		Ignore 'Sample taken every hour' [stem]
Total			14	

Question		Answer	Marks	Guidance
13	(a)	Water / H ₂ O [made in] the reaction of methane / burning methane/ methane contains hydrogen	2	water comes from the methane = 1 [for the water point] water, because hydrogen reacts with oxygen = 1 accept hydrocarbon as alternative to methane ignore 'condensation'
	b	i C-H = 4 C=O = 2 [O=O = 2] O-H = 4	2	Left hand column = 1 Right hand columns = 1 bonds can be written either way round, eg C-H or H-C Right hand bonds in either order [but numbers must match!]
		ii Answer = -730 [3 marks]	3	If not correct, look for Answer = 730 [2 marks] Use of 2736 or 3466 [1 mark]
Total			7	

Question	Answer	Marks	Guidance
14	<p>Level 3 Explains each term and links at least one to sustainability <i>Quality of written communication does not impede communication of the science at this level.</i> (5 – 6 marks)</p> <p>Level 2 Explains each term without reference to sustainability, or explains one term and links it to sustainability <i>Quality of written communication partly impedes communication of the science at this level.</i> (3 – 4 marks)</p> <p>Level 1 Explains either 'renewable' or 'atom economy' or 'sustainability'. <i>Quality of written communication impedes communication of the science at this level.</i> (1 – 2 marks)</p> <p>Level 0 <i>Insufficient or irrelevant science. Answer not worthy of credit.</i> (0 marks)</p>	6	<p>This question is targeted at grades up to A</p> <p>Indicative scientific points may include:</p> <p>renewable</p> <ul style="list-style-type: none"> • replaces itself • detail – eg plants regrow • so does not run out / infinite <p>Ignore can be renewed/used again</p> <p>Sustainability links for renewable</p> <ul style="list-style-type: none"> • idea of long term use of process • doesn't use up finite resources • available for future generations <p>atom economy</p> <ul style="list-style-type: none"> • measure of the amount of useful product • 'Helpful' = QWC impeded • high atom economy means little by-product NOT 'waste' • mass [desired] product divided by mass reactants Don't confuse with % yield <p>sustainability links for atom economy</p> <ul style="list-style-type: none"> • desire to limit waste • reduce damage to environment <p>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</p>
	Total	6	