OCR
Oxford Cambridge and RSA

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Wednesday 17 June 2015 – Morning

GCSE TWENTY FIRST CENTURY SCIENCE
CHEMISTRY A / FURTHER ADDITIONAL SCIENCE A

A173/01 Module C7 (Foundation Tier)

Candidates answer on the Question Paper.
A calculator may be used for this paper.

OCR supplied materials:
None

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: 1 hour

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with a pencil (✎).
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- The Periodic Table is printed on the back page.
- This document consists of **16** pages. Any blank pages are indicated.

Answer **all** the questions.

1 Large amounts of nitrogen gas in the air are turned into nitrogen compounds every year.
This is called 'fixing' the nitrogen.
It happens by different routes.

The table shows how much nitrogen is fixed every year by each route.

Route for fixing nitrogen	Amount of nitrogen fixed in million tonnes per year
burning fuels	20
making chemicals in industry	50
lightning in thunderstorms	10
growing crops on farms	90
trees growing	50
plankton in the sea	35

(a) Which route fixes the most nitrogen in a year?

.... **[1]**

(b) One of these routes is the Haber process for making ammonia.

Use the table to suggest how much nitrogen is fixed each year by the Haber process.

.... million tonnes **[1]**

(c) In the Haber process, nitrogen and hydrogen react. Ammonia is the only substance made.

Write a word equation for this reaction.

.... **[1]**

(d) The hydrogen needed for the Haber process is made in a separate reaction.

Which **two** substances are needed for this reaction?

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

hydrogen and steam ☐

natural gas and steam ☐

nitrogen and steam ☐

water and steam ☐

[1]

(e) The UK makes 3000 tonnes of ammonia every day.
For every tonne of ammonia, 1.6 tonnes of carbon dioxide are made.
Half of this carbon dioxide can be captured.

How much carbon dioxide can be captured each day?

.... tonnes **[2]**

(f) Most of the ammonia is used to make fertilisers.
Fertilisers are very useful, but can cause pollution.

Suggest why fertilisers are useful and how they might cause pollution.

....

....

.... **[2]**

(g) Nitrogen is also fixed by some plants.
They use bacteria in their roots.
These bacteria need different conditions from the Haber process.

Finish the sentences about the conditions for bacteria to fix nitrogen in plants.

Put ticks (✓) in the boxes next to the correct terms.

The bacteria work best at

high temperature	
room temperature	
low temperature	

and

high pressure.	
room pressure.	
low pressure.	

The bacteria use

acids	
alkalis	
enzymes	
iron	

as the catalyst.

[3]

(h) The table shows some chemicals which are manufactured.
Chemicals such as ammonia are made on a large scale.
Some other chemicals are made on a small scale.

Put ticks (✓) in the boxes to complete the table.

Chemical	**Large scale**	**Small scale**
food additives		
phosphoric acid		
sodium hydroxide		
fragrances for perfumes		

[2]

[Total: 13]

2 Some 'green' buses use biodiesel 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.

How do plants use the oils that they make?

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

to give them energy ☐

to make them slippery ☐

to make them taste nasty ☐

to make them float in water ☐ **[1]**

(b) Most fats are made by animals.
The esters in animal fats are different from the esters in plant oils.

What is the difference between these esters?

Use words from the list to complete the sentence.

glycerol
saturated
fatty acid
unsaturated

Animal fats have mostly .... molecules and oils have mostly

.... molecules. **[2]**

(c) A catalyst is used to turn the fats and oils into biodiesel.
The usual catalyst is hot concentrated sodium hydroxide.

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

Here is some information about both catalysts.

Features of enzyme	**Features of hot concentrated sodium hydroxide**
needs gentle heating	needs strong heating
easy to remove from the reaction mixture	dissolves in reaction mixture
speeds up this reaction only	speeds up other reactions which produce waste material
expensive	very cheap

Identify the **advantages** and **disadvantages** of using the enzyme, and explain which catalyst is best.

....

....

....

....

....

....

....

....

....

.... **[6]**

(d) Scientists draw energy level diagrams for the reactions.

Diagram **A** – using enzyme catalyst

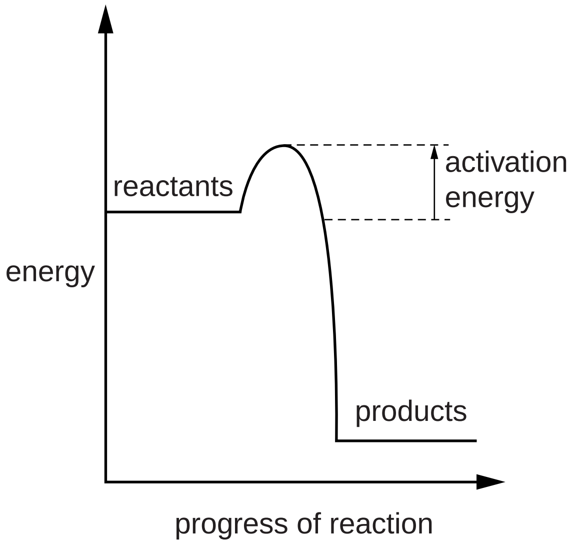
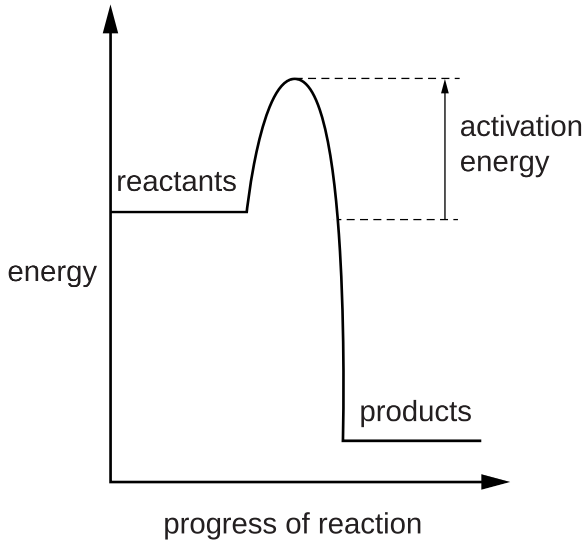


Diagram **B** – using sodium hydroxide catalyst



Give **one** similarity and **one** difference between the changes shown in these diagrams.

....

....

.... **[2]**

(e) The formula of one substance in biodiesel is $C_{19}H_{38}O_2$.

Biodiesel burns completely if there is plenty of air.

Suggest the **two** substances which are produced.

.... and .... **[2]**

[Total: 13]

3 Fred investigates ethanoic acid.

(a) The formula of ethanoic acid is CH_3COOH.

(i) How many different elements are there in CH_3COOH?

.... **[1]**

(ii) How many atoms of carbon are there in the formula CH_3COOH?

.... **[1]**

(iii) 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]

(iv) This 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]

(v) 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) Fred reacts the acid with ethanol to make an ester.

(i) Which of these is a property of esters?

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

They are all solids. ☐

They give off purple fumes. ☐

They have distinctive smells. ☐

They have a distinctive colour. ☐

[1]

(ii) The equation for the reaction is

ethanoic acid + ethanol $\rightleftharpoons$ ester + water

What does the symbol $\rightleftharpoons$ tell you?

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

The reaction is fast. ☐

The reaction is reversible. ☐

The reaction is exothermic. ☐

The reaction is hard to control. ☐

[1]

(iii) This type of reaction can reach equilibrium.

What happens when it is at equilibrium?

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

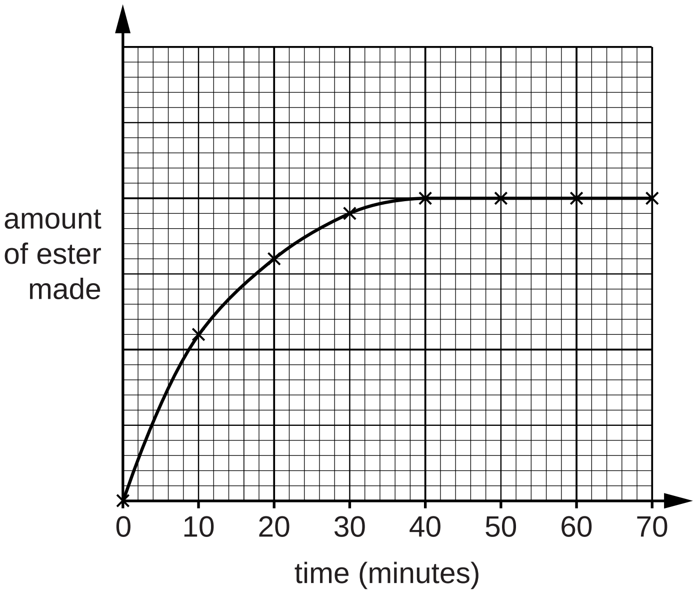
Only reactants are present. ☐

Only products are present. ☐

Reactants and products are both present. ☐

[1]

(iv) Fred measures the amount of ester made in the reaction to see how it changes with time.



Use the graph to describe how the amount of ester changes.

....

....

.... **[3]**

(c) Fred needs to calculate the relative formula mass of ethanol to work out the overall yield of the reaction.

Calculate the relative formula mass of ethanol, C_2H_5OH.

In your answer, use the relative atomic masses from the Periodic Table.

.... **[1]**

[Total: 12]

4 When chemical engineers design an industrial process, they make it as sustainable as possible. One of the things that they consider is the energy changes during the chemical reaction.

(a) During a reaction, chemical bonds are broken and new bonds are made.

Put ticks (✓) in the boxes to complete these sentences.

When chemical bonds are broken, energy is

taken in	
given out	
not needed	

.

When chemical bonds are made, energy is

taken in	
given out	
not needed	

.

If more energy is taken in than is given out the reaction is

endothermic	
exothermic	

.

Some energy is usually needed to start the reaction.

This energy is the

activation energy	
green energy	
geothermal energy	
energy output	

.

[3]

(b) The industrial processes are more likely to be sustainable if:

- renewable chemicals are used
- there are few by-products.

Explain what '**renewable**' and '**by-products**' mean, and how they affect the sustainability of the process.

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

....

....

....

....

....

....

....

....

....

.... **[6]**

[Total: 9]

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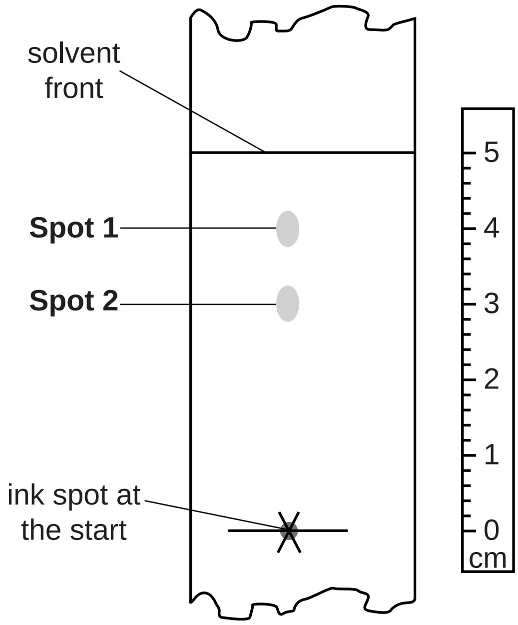
PLEASE DO NOT WRITE ON THIS PAGE

Turn over for the next question

5 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) Explain why there are two spots, and why **Spot 1** is higher than **Spot 2**.

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

....

....

....

....

....

....

....

....

....

.... **[6]**

(b) Use this formula to calculate the *Rf* value for **Spot 1**.

$$Rf = \frac{\text{distance travelled by spot}}{\text{distance travelled by solvent}}$$

Show your working.

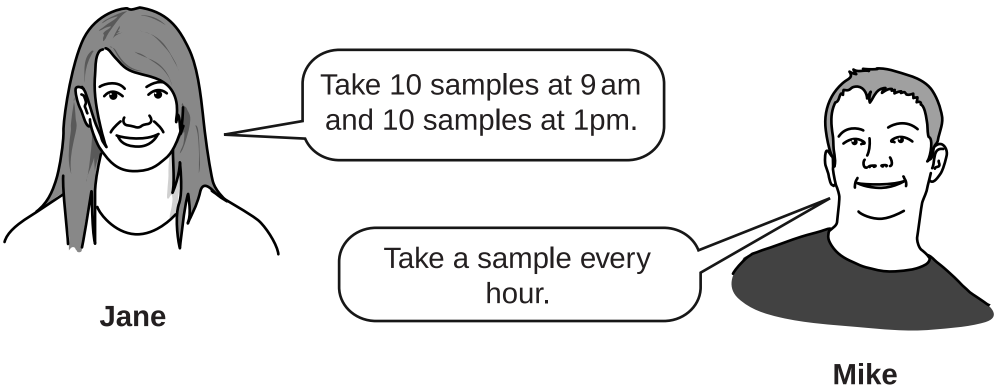
Rf for **Spot 1** = ... **[2]**

(c) Sometimes when scientists do chromatography they have to use locating agents.
Explain why.

....

.... **[2]**

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



Explain who has the best approach.

....

....

.... **[3]**

[Total: 13]

END OF QUESTION PAPER

The Periodic Table of the Elements

Key

relative atomic mass atomic symbol name atomic (proton) number

1	2											3	4	5	6	7	0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	63.5 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	[98] Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La* lanthanum 57	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] 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						

** 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.