OCR

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Thursday 19 June 2014 – Afternoon

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

A173/02 Module C7 (Higher 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 Millions of tonnes of hydrogen are made every year.

The hydrogen is usually made from methane.

The process starts with methane and steam, and makes hydrogen and carbon dioxide.

$$CH_4 + 2H_2O \rightarrow 4H_2 + CO_2$$

Formula	Relative formula mass (RFM)
CH_4	16
H_2O	18
H_2	2
CO_2	44

(a) Scientists calculate the atom economy to help decide how green the process is.

(i) Use the following formula to calculate the atom economy for the production of hydrogen in this process.

$$\text{atom economy} = \frac{\text{mass of atoms of hydrogen}}{\text{mass of atoms of all reactants}} \times 100\%$$

answer = ... % **[2]**

(ii) Why does this suggest that the process is not very green?

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

(b) A new process for making hydrogen is by heating wood from trees.
Both processes for making hydrogen make carbon dioxide.
Suggest why this new process might be greener than the old one.

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

[Total: 6]

2 Millions of tonnes of ammonia are made every year.

(a) Ammonia is made by reacting nitrogen and hydrogen.
The only product for this reaction is ammonia.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

If nitrogen and hydrogen are heated together in a flask, the reaction is slow and only a low percentage of the reactants are converted.

Suggest why so little is actually produced and how the Haber process overcomes this problem.

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

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..... **[6]**

(b) Ammonia can be used to make many different products.
One product is explosives that can be used to make weapons.
Dave says that we should not make ammonia because it is used to harm people.
Eve does not agree.
Give some arguments Eve could use to support her view.

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..... **[3]**

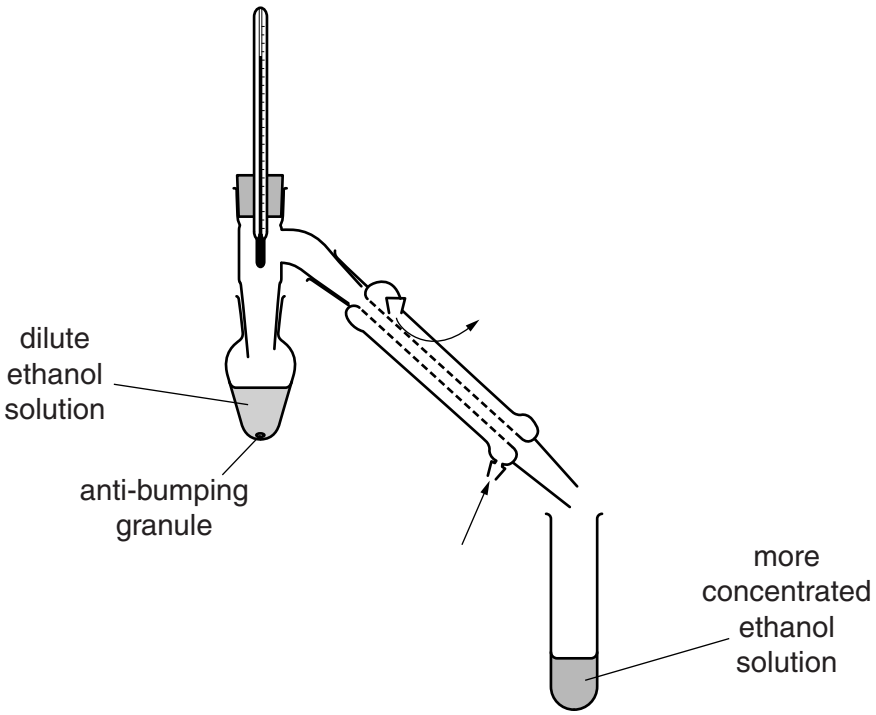
[Total: 9]

3 Kate and William decide to make some ethanol.
Ethanol is an alcohol.
They add yeast to sugar solution and leave it to ferment.
This makes a dilute solution of ethanol.

(a) Write down the formula of ethanol.

answer ..... **[1]**

(b) Kate and William decide to make their dilute ethanol solution more concentrated.
They use this apparatus.



Describe how they use this equipment to make their dilute ethanol solution more concentrated, and why it works.

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

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..... **[6]**

Question 3 continues on page 6

(c) An alcoholic drink is made by distilling a dilute alcohol solution.
The solution contains a mixture of alcohols.

	Boiling point	**Amount which will poison a person [in g]**
methanol	65 °C	120
ethanol	79 °C	560
propanol	97 °C	400
butanol	117 °C	350
pentanol	138 °C	120

William says that you should only make the drink from alcohol that distils at 79 °C.
He says that it isn't safe to drink alcohol that has been distilled at other temperatures.

Is he right? Explain your answer.

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..... **[3]**

(d) Butanol, C_4H_9OH, is another alcohol.
Butanol burns in oxygen to make carbon dioxide and water.

Write a balanced chemical equation for this reaction.

..... **[3]**

(e) Butanol reacts with sodium.
Water also reacts with sodium.
In both cases the same gas is made.

(i) Name this gas.

..... **[1]**

(ii) Give one difference between the reaction of sodium with water and of sodium with butanol.

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..... **[1]**

[Total: 15]

4 Mary and Steve make an ester by reacting a carboxylic acid with an alcohol.

(a) An acid and an alcohol react to make the ester, $CH_3COOC_2H_5$, plus one other product. What is the equation for this reaction?

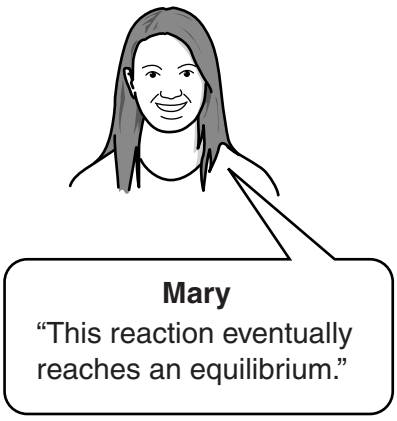
Draw a straight line to join the correct **left hand side** to the correct **right hand side**.

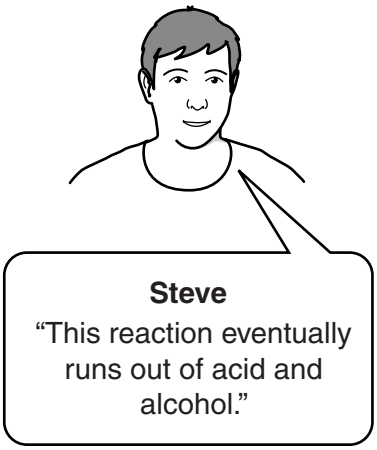
left hand side		**right hand side**
$HCOOH + C_4H_9OH$		$CH_3COOC_2H_5 + H_2$
$CH_3COOH + C_2H_5OH$		$CH_3COOC_2H_5 + O_2$
$C_2H_5COOH + C_3H_7OH$		$CH_3COOC_2H_5 + CO_2$
$C_3H_7COOH + CH_3OH$		$CH_3COOC_2H_5 + H_2O$

[2]

(b) They know that one molecule of acid reacts with one molecule of alcohol to make the ester.
They start with equal amounts of acid and alcohol.
They measure the amount of the ester which is made.
However long they leave the reaction, they never get as much ester as expected.

They try to explain this.





Explain who is right and who is wrong.

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(c) Mary and Steve add a few drops of concentrated sulfuric acid to their reaction mixture.

Explain why.

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

[Total: 7]

5 James does a titration with an acid and an alkali.

He uses dilute sulfuric acid, sodium hydroxide solution and an indicator solution.

(a) Describe and explain how James would carry out a set of titrations to get an accurate value for how much acid reacts with 25.0 cm^3 of the sodium hydroxide.

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

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(b) The sodium hydroxide solution contains 40 g/dm^3 of sodium hydroxide. How much sodium hydroxide is in 25.0 cm^3 of the solution?

answer ..... g **[2]**

(c) James gets these results.

titration number	1	2	3	4
volume of acid in cm^3	26.4	25.2	25.6	25.4

James decides that the best value for the volume of acid is 25.4 cm^3.

Show how he arrived at this value.

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

(d) The equation for this reaction is

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

(i) The relative formula mass of sodium hydroxide is 40.
Calculate the relative formula mass of sulfuric acid.
Relative atomic masses are given in the Periodic Table on the back page.

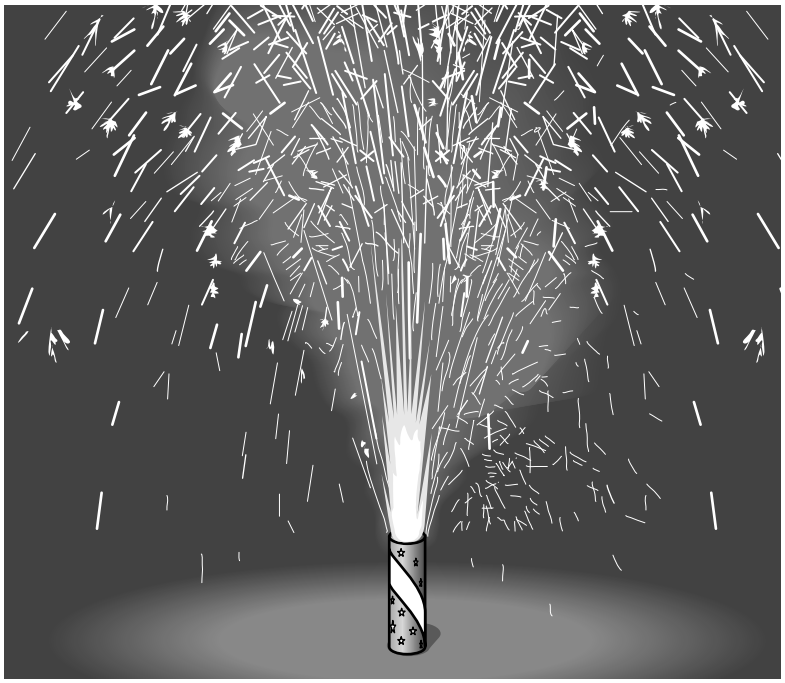
answer ..... **[1]**

(ii) What mass of sulfuric acid reacts with 40 g of sodium hydroxide?
Show your working.

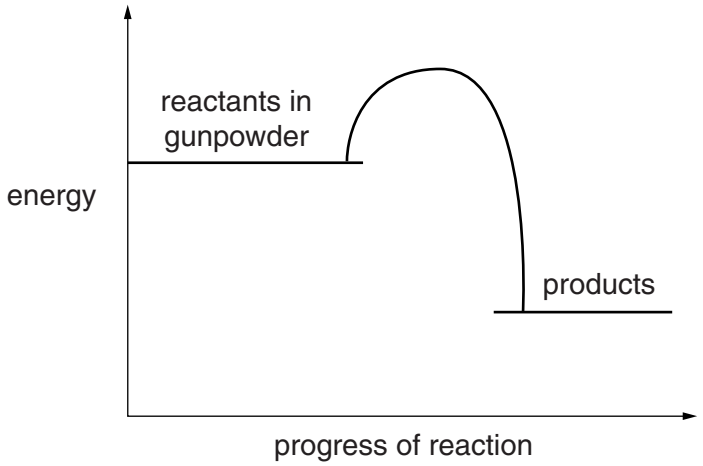
answer ..... g **[2]**

[Total: 13]

6 Fireworks contain gunpowder.
The gunpowder reacts when the firework is lit.



(a) Look at the energy level diagram for this reaction.



What does the diagram tell you about the energy changes during the reaction?

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(b) Gunpowder doesn't react until it is lit.
Use ideas about bonds to explain why.

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

(c) Some space rockets use the reaction between hydrogen and oxygen.

$$\begin{matrix} H-H \\ H-H \end{matrix} \quad + \quad O=O \quad \rightarrow \quad \begin{matrix} H-O-H \\ H-O-H \end{matrix}$$

(i) In this reaction, bonds in the hydrogen and oxygen are broken.

Fill in the blank spaces in the table.

Type of bond	Energy needed to break each bond in kJ	Number of bonds	Energy needed in kJ
H–H	436		
O=O	498	1	498
		Total energy needed	1370

[2]

(ii) New bonds are made when water is made.

The total amount of energy given out when the bonds form = 1856 kJ.

Calculate the total energy change for the whole reaction.

..... kJ **[1]**

(d) Not all rockets use the reaction between hydrogen and oxygen.
Some rockets use the reaction between hydrocarbons and oxygen.
Give one similarity and one difference between the products of these two reactions.

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[Total: 10]

END OF QUESTION PAPER

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The Periodic Table of the Elements

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						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** 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.