THIS IS A NEW SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

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Thursday 20 June 2013 – Afternoon

GCSE TWENTY FIRST CENTURY SCIENCE CHEMISTRY A

A173/02 Module C7 (Higher Tier)

A137250613

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

A173 02

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

- Your 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**.
- This document consists of **20** pages. Any blank pages are indicated.
- The Periodic Table is printed on the back page.

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Answer **all** the questions.

1 Esters are made by reacting an alcohol with a carboxylic acid.

A few drops of concentrated sulfuric acid are added to the mixture.

$$\text{alcohol} + \text{carboxylic acid} \rightleftharpoons \text{ester} + \text{water}$$

(a) What is the job of the concentrated sulfuric acid?

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

(b) The reaction mixture has to be heated for some time.

The reactants are volatile and would escape from an open flask as vapour.

(i) What piece of apparatus is fitted to the flask to prevent this loss of vapour?

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

(ii) What is the name of the technique used to prevent this loss of vapour?

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

(c) Propyl pentanoate, $C_4H_9COOC_3H_7$, is an ester that tastes of pineapples.

It is made by reacting propanol, C_3H_7OH with pentanoic acid C_4H_9COOH.

(i) Write a symbol equation for the reaction that makes propyl pentanoate.

..... $\rightleftharpoons$ .....**[1]**

(ii) Suggest a use for propyl pentanoate.

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

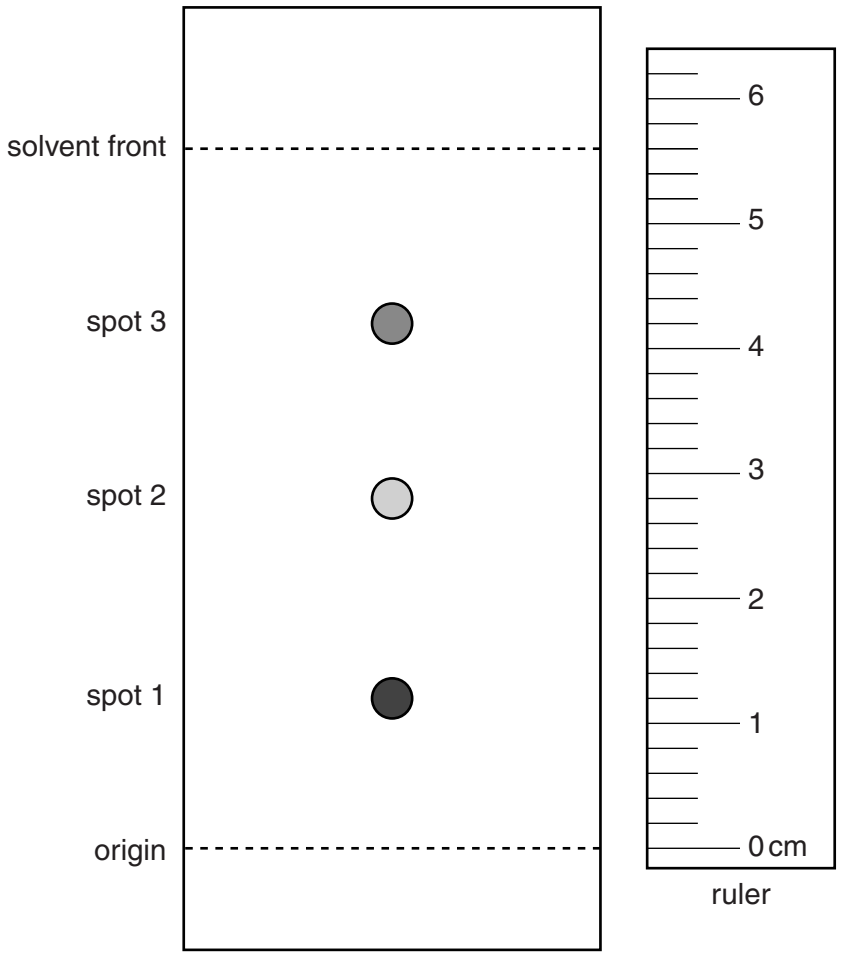
[Total: 5]

2 Peter is testing the food colourings in soft drinks made by different companies.

He wants to find out if any of these drinks contains a banned dye chemical.

Peter uses paper chromatography to separate and identify the dye chemicals in the soft drinks.

Here is Peter's chromatogram for one of the soft drinks.



(a) Explain why the three spots travel different distances up the chromatogram.

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

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

(b) Peter uses Rf values to identify the dye chemicals in a soft drink.

(i) Work out the Rf value of spot 3.

Rf value = ... **[2]**

(ii) Peter finds the Rf values for dye chemicals in several different soft drinks.

How can Peter check if any of the soft drinks contain a banned dye chemical?

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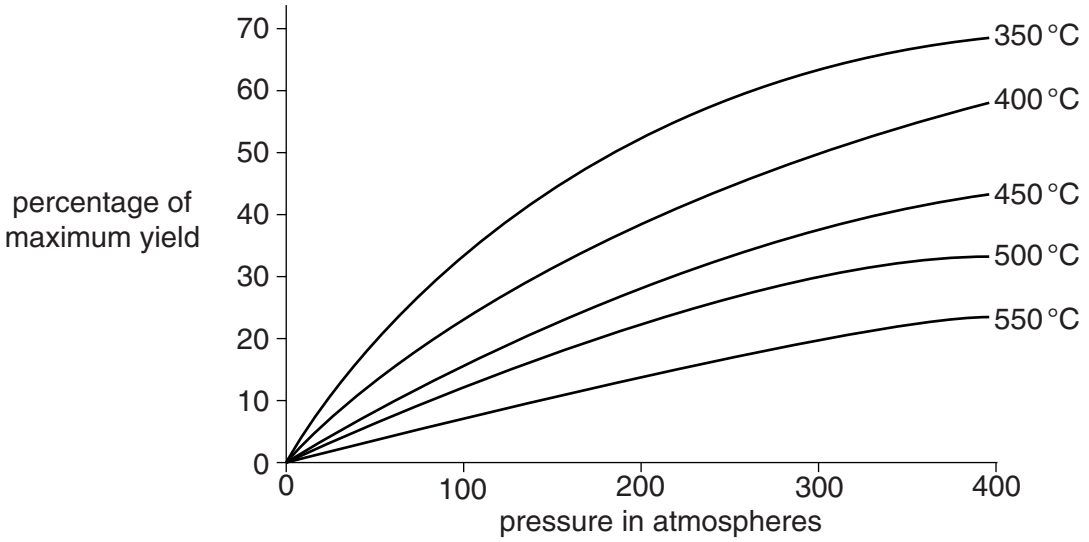
..... **[2]**

[Total: 10]

3 Ammonia, NH_3, is made from nitrogen and hydrogen by the Haber process.

$$\underset{\text{nitrogen}}{N_2} + \underset{\text{hydrogen}}{3H_2} \rightleftharpoons \underset{\text{ammonia}}{2NH_3}$$

(a) The graph shows how the yield of ammonia is related to both the temperature and the pressure used.



(i) The Haber process uses:

- a catalyst
- a temperature of 450 °C
- 250 atmospheres pressure.

These conditions do not give the highest percentage yield of ammonia.

Explain why these conditions are a compromise to make the process economically viable.

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

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

(ii) The reaction between nitrogen and hydrogen to form ammonia is reversible.

The reaction mixture can reach a dynamic equilibrium.

Which of these statements describes what is happening at equilibrium?

Put ticks (✓) in the boxes next to the **two** correct statements.

The reaction between nitrogen and hydrogen has stopped.	☐
The forward and reverse reactions happen at the same rate.	☐
All of the nitrogen and hydrogen react to make ammonia.	☐
The concentration of ammonia is increasing.	☐
The concentrations of nitrogen, hydrogen and ammonia are constant.	☐

[2]

(b) (i) Work out the relative formula mass (RFM) of ammonia, NH_3.

RFM of ammonia = ... **[1]**

(ii) What is the mass of ammonia that would be made if 1.0 tonne of nitrogen reacted completely with hydrogen?

Show your working.

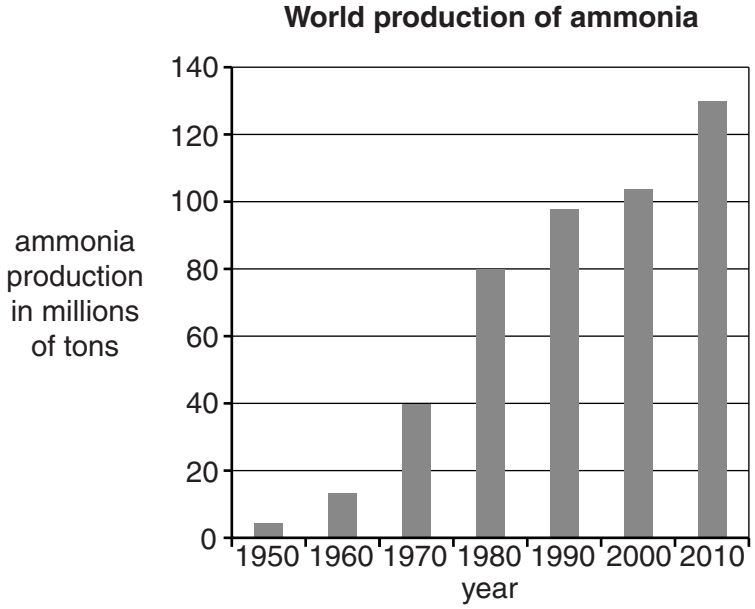
mass of ammonia = ... tonne **[2]**

(iii) A factory converts 95% of the nitrogen into ammonia.

What mass of ammonia does this factory make from each tonne of nitrogen?

mass of ammonia = ... tonne **[1]**

(c) Look at the bar chart.



The main use of ammonia is to make fertilisers.

Large scale use of fertilisers made from ammonia causes environmental problems.

Write about these problems, and explain why they have got worse over the last 60 years.

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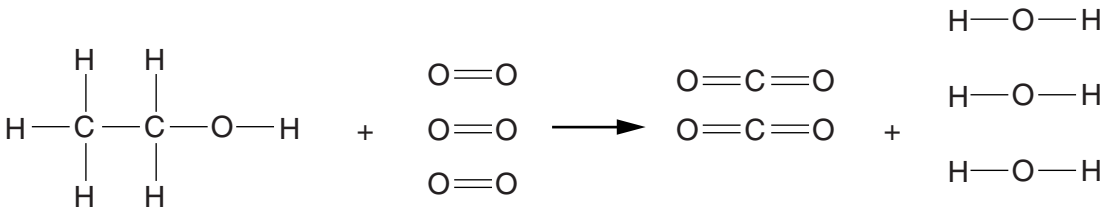
..... **[3]**

[Total: 15]

4 The table shows the energy involved in the breaking of some bonds.

Bond	Bond energy in kJ/mol
C—H	411
C—O	358
O=O	498
C=O	799
O—H	459
C—C	348

Ethanol burns to make carbon dioxide and water.



(a) The energy needed to break all of the bonds in the oxygen, $3O_2$, is 1494 kJ.

Work out the energy needed to break all of the bonds in ethanol, C_2H_5OH.

energy = ... kJ/mol **[2]**

(b) The energy given out when new bonds in $2CO_2$ are made is 3196 kJ.

Work out the energy given out when new bonds in the water, $3H_2O$, are made.

energy = ... kJ/mol **[2]**

(c) Use the information given, and your answers from **(a)** and **(b)**, to complete the table.

	Energy in kJ/mol
energy **needed** to break all the bonds in ethanol and oxygen	
energy **given out** when all the bonds in carbon dioxide and water are made	
energy change when ethanol burns	

[2]

(d) The table shows information about some bonds.

Bond	Bond energy in kJ/mol	Bond length in pm
C—C	348	154
C=C	614	134
C≡C	839	120

What conclusions can you make from this data?

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

[Total: 8]

5 Emma works for a company making indigestion tablets.

Her job is to find the mass of magnesium hydroxide in tablets from each batch.

Emma titrates the magnesium hydroxide in each tablet with hydrochloric acid.

$Mg(OH)_2$	+	$2HCl$	$\rightarrow$	$MgCl_2$	+	$2H_2O$
magnesium hydroxide		hydrochloric acid		magnesium chloride		water

(a) (i) What steps should Emma take to ensure that her titration results are as accurate as possible?

Put ticks (✓) in the boxes next to the **two** correct statements.

Add the acid as quickly as possible.	☐
Use a burette to measure the volume of acid.	☐
Add acid 1 cm^3 at a time.	☐
Add acid drop by drop near the end point.	☐
Measure the mass of the flask every 30 seconds.	☐
Allow the product to crystallise.	☐

[2]

(ii) Emma uses an indicator in her titration.

Explain why she uses an indicator.

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

(b) Emma analyses an indigestion tablet to find the mass of magnesium hydroxide.

(i) Work out the relative formula mass (RFM) of magnesium hydroxide, $Mg(OH)_2$.

Show your working.

(Relative atomic masses: H = 1; Mg = 24; O = 16)

RFM of magnesium hydroxide = ... **[1]**

(ii) Emma uses hydrochloric acid with 73.0 g of hydrogen chloride in each 1.0 dm^3 of the acid solution.

It takes 15.1 cm^3 of this hydrochloric acid to neutralise the tablet.

Work out the mass of hydrogen chloride in 15.1 cm^3 of the hydrochloric acid.

Give your answer to the nearest 0.1 g.

Show your working.

mass of hydrogen chloride = ... g **[2]**

(iii) Work out the mass of magnesium hydroxide in the tablet.

Use your answers to **(i)** and **(ii)** and this equation to help you.

$$Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$$

Show your working.

mass of magnesium hydroxide in the tablet = ... g **[2]**

(c) Emma analyses six tablets from each batch.

The table shows Emma's results for four batches of tablets.

	Mass of magnesium hydroxide in g					
Tablet number	1st	2nd	3rd	4th	5th	6th
Batch A	0.95	0.93	0.95	0.96	0.94	0.93
Batch B	0.88	0.86	0.89	0.87	0.89	0.87
Batch C	1.13	1.16	1.14	1.15	1.13	1.16
Batch D	1.03	1.13	1.05	1.04	1.15	1.03

The label on each pack of indigestion tablets says that each tablet contains 1.0 g of magnesium hydroxide.

The standard set by the company is that each tablet must be within 0.1 g of this figure.

For each batch decide whether it meets the standard and explain your answers.

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..... **[4]**

[Total: 13]

6 Ethanol can be made by the reaction of ethene with steam or by fermentation of sugar.

Method 1 – reaction of ethene with steam:

$$\underset{\text{ethene}}{C_2H_4} + \underset{\text{steam}}{H_2O} \rightarrow \underset{\text{ethanol}}{C_2H_5OH}$$

Ethene is obtained from crude oil.
The ethene is reacted with steam at about 300 °C and 60 atmospheres pressure.

Method 2 – fermentation:

$$\underset{\text{sugar}}{C_6H_{12}O_6} \rightarrow \underset{\text{ethanol}}{2C_2H_5OH} + \underset{\text{carbon dioxide}}{2CO_2}$$

The sugar is obtained from crops such as sugar beet or sugar cane.
The sugar is fermented with yeast at a temperature of about 30 °C.

(a) The sustainability of chemical processes depends on a number of factors.

One of these factors is the renewability of raw materials.

Consider this, and other factors, to compare the sustainability of making ethanol by these two methods.

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

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(b) How do the reactions of ethanol, ethane and water with sodium compare?

Put ticks (✓) in the correct boxes to show what happens in each reaction.

	Reaction of ethanol with sodium	**Reaction of ethane with sodium**	**Reaction of water with sodium**
violent reaction			
steady reaction			
no reaction			
hydrogen made			
sodium ethoxide made			
sodium hydroxide made			

[3]

[Total: 9]

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.