

Thursday 20 June 2013 – Afternoon

**GCSE TWENTY FIRST CENTURY SCIENCE
CHEMISTRY 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	
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Centre number						Candidate number				
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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.

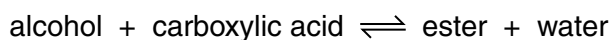
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Answer **all** the questions.

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

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



- (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, $\text{C}_4\text{H}_9\text{COOC}_3\text{H}_7$, is an ester that tastes of pineapples.

It is made by reacting propanol, $\text{C}_3\text{H}_7\text{OH}$ with pentanoic acid $\text{C}_4\text{H}_9\text{COOH}$.

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

..... \rightleftharpoons [1]

- (ii) Suggest a use for propyl pentanoate.

..... [1]

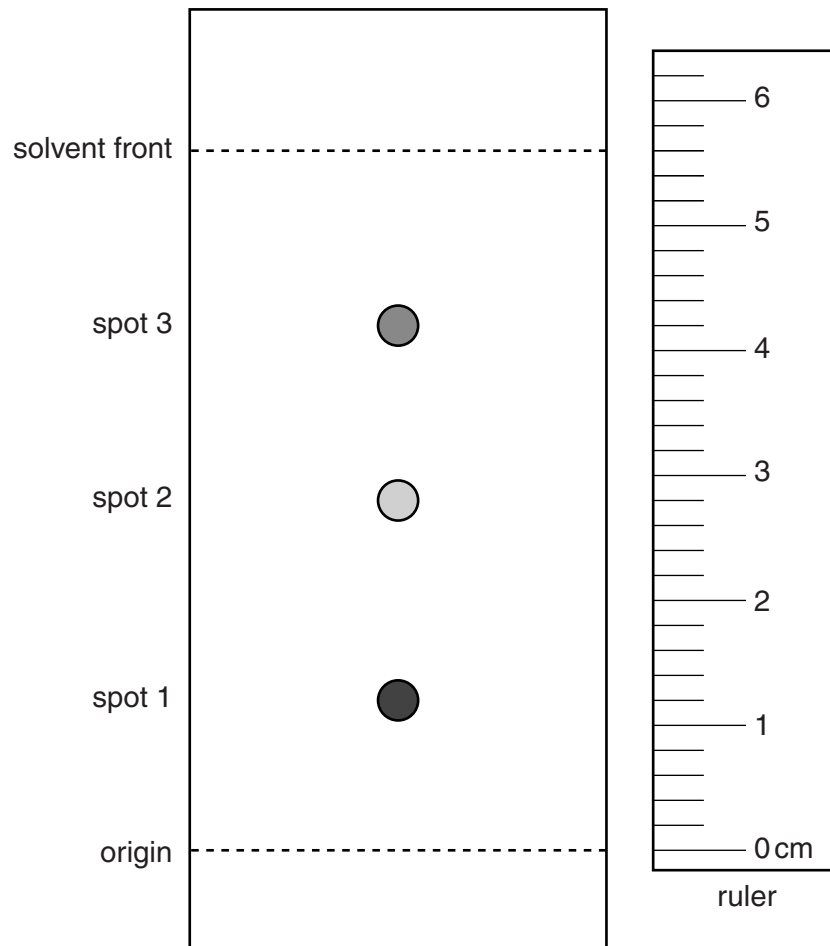
[Total: 5]

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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(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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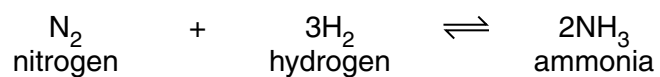
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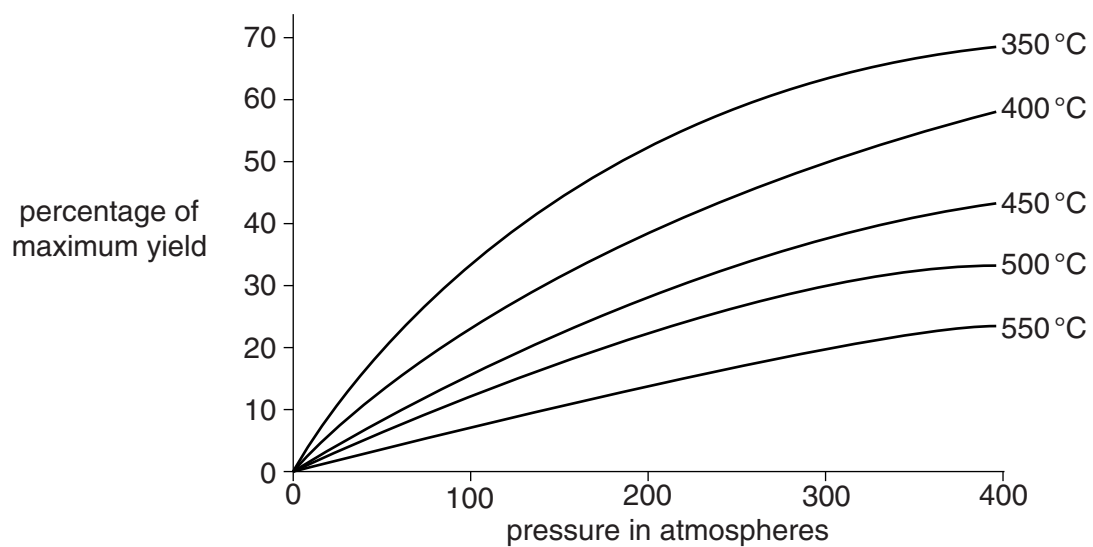
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[Total: 10]

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



(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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- (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.

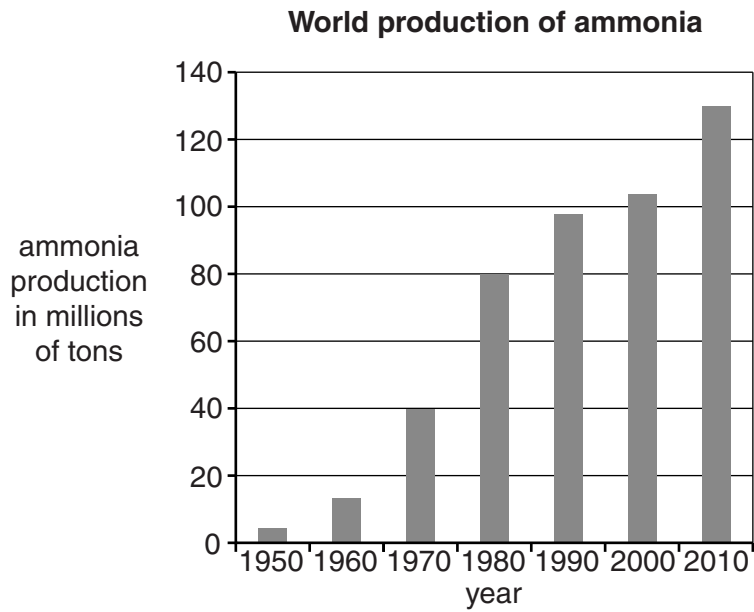
mass of ammonia = tonne [2]

- (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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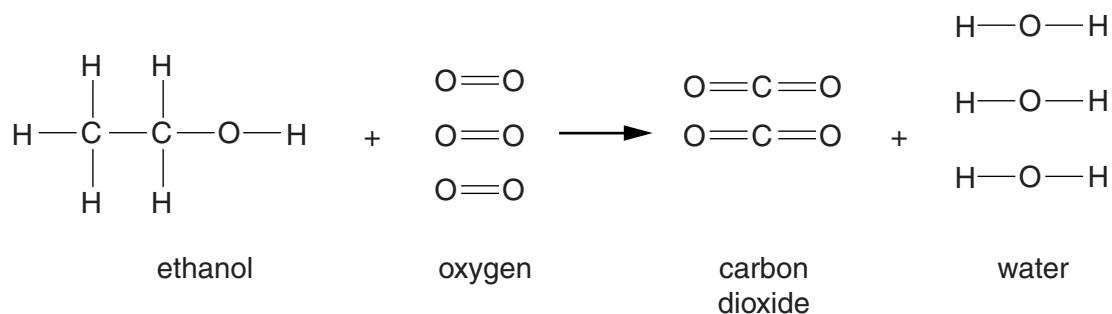
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[Total: 15]

- 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, $\text{C}_2\text{H}_5\text{OH}$.

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, $3\text{H}_2\text{O}$, 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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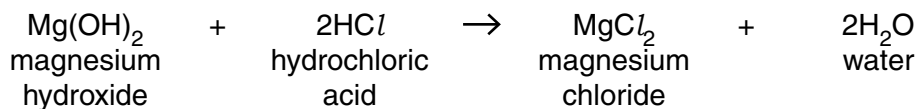
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[Total: 8]

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.



(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 cm³ 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, $\text{Mg}(\text{OH})_2$.

Show your working.

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

RFM of magnesium hydroxide = [1]

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

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

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

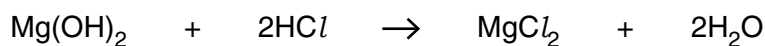
Give your answer to the nearest 0.1 g.

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.



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.

Tablet number	Mass of magnesium hydroxide in g					
	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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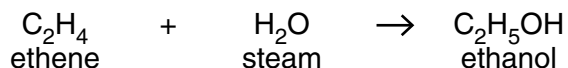
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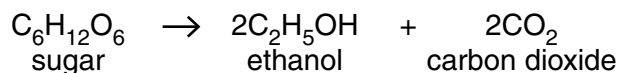
6 Ethanol can be made by the reaction of ethene with steam or by fermentation of sugar.

Method 1 – reaction of ethene with steam:



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

Method 2 – fermentation:



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																																																																																																						
	7 Li lithium 3	9 Be beryllium 4	11 Na sodium 11	12 C carbon 6	13 Al aluminium 13	14 N nitrogen 7	15 O oxygen 8	16 F fluorine 9	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	43 Tc technetium [98]	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	58 Ce cerium 58	59 Pr praseodymium 59	60 Nd neodymium 60	61 Pm promethium 61	62 Sm samarium 62	63 Eu europium 63	64 Gd gadolinium 64	65 Tb terbium 65	66 Dy dysprosium 66	67 Ho holmium 67	68 Er erbium 68	69 Tm thulium 69	70 Yb ytterbium 70	71 Lu lutetium 71	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	87 Fr francium 87	88 Ra radium 88	89 Ac* actinium 89	90 Th thorium 90	91 Pa protactinium 91	92 U uranium 92	93 Np neptunium 93	94 Pu plutonium 94	95 Am americium 95	96 Cm curium 96	97 Bk berkelium 97	98 Cf californium 98	99 Es einsteinium 99	100 Fm fermium 100	101 Mendelevium 101	102 Nobelium 102	103 Lr lawrencium 103	104 Rf rutherfordium 104	105 Db dubnium 105	106 Sg seaborgium 106	107 Bh bohrium 107	108 Hs hassium 108	109 Mt meitnerium 109	110 Ds darmstadtium 110	111 Rg roentgenium 111	112 Cn copernicium 112	113 Nh nihonium 113	114 Fl flerovium 114	115 Mc moscovium 115	116 Lv livermorium 116	117 Ts tennessine 117	118 Og oganesson 118

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

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.