OCR
Oxford Cambridge and RSA

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Wednesday 22 June 2016 – Morning

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

A173/02

5988271534

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. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- 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 **20** pages. Any blank pages are indicated.

Answer **all** the questions.

1 A company makes chemical compounds and uses them to make products such as fertilisers and drugs.

(a) The table gives information about these products.

Type of product	**Type of manufacture**	**Use**	**Other notes**
fertilisers	bulk	spread on soil to help crops grow	Company makes ammonium nitrate for fertilisers. Millions of tonnes of fertiliser compounds are needed in the UK every year.
drugs	fine	used as medicines by people and animals	Company makes a range of different compounds for use to make drugs. Purity of compounds very important.

Use the information in the table to explain why fertilisers and drugs need to be manufactured differently.

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

(b) Millions of tonnes of hydrogen are made every year. In industry, most hydrogen is made by a reaction between methane gas and steam.

methane + steam → hydrogen + carbon dioxide

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

The table shows some information about the process.

Feedstocks	methane (natural gas) and water
Number of stages in process	2
Temperature needed	700–1100 °C
Energy source	burning some of the methane gas
By-products	none
Waste product	carbon dioxide gas
Atom economy	15%

Use the information to help you to explain why this process is **not** sustainable.

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

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

(c) Scientists are working on a new process to produce hydrogen.

The new process uses a reaction that runs at a lower temperature than the reaction between methane and steam.

(i) Which two statements explain why some reactions work at a lower temperature than others?

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

The rate of reaction is lower.	☐
The reaction has a lower activation energy.	☐
More gases are made in the reaction.	☐
The reaction uses a catalyst.	☐
Steam is less reactive than hydrogen.	☐

[2]

(ii) The new process splits water into hydrogen.

$$2H_2O \rightarrow 2H_2 + O_2$$

The atom economy of the reaction can be calculated using this formula.

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

Use the formula to calculate the atom economy for the reaction.

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

(iii) The oxygen made in the new process is considered to be a by-product rather than a waste product.

Explain the difference between a by-product and a waste product.

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

[Total: 14]

2 Len investigates the bond energies of some Group 7 elements and their compounds.

(a) He calculates the energy change of the reaction when hydrogen and fluorine react together to make hydrogen fluoride.

$$H_2 + F_2 \rightarrow 2HF$$

He uses this data.

Type of bond	Bond energy (kJ/mol)
H–H	432
F–F	155
H–F	567

The boxes below show some of his working.

Energy change when bonds **break**	
H–H F–F	+ 432
Total energy change = ...kJ/mol	

Energy change when bonds **form**	
Total energy change = ...kJ/mol	

(i) Complete the boxes above to show the total energy change when bonds **break** and bonds **form** in the reaction. **[3]**

(ii) Use your answers to calculate the overall energy change for the reaction that happens when hydrogen and fluorine make hydrogen fluoride.

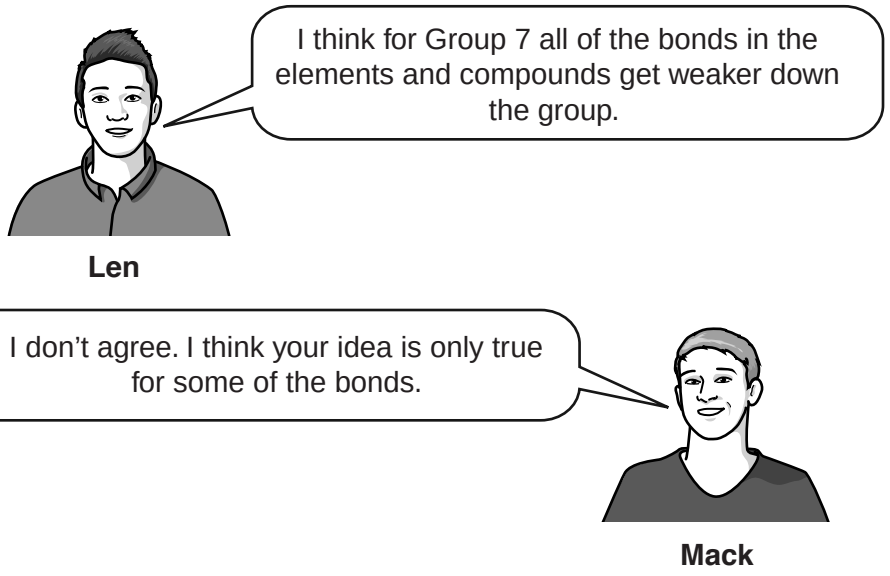
energy change = ...kJ/mol **[1]**

(b) Len finds some data about the bond energies of group 7 elements and their compounds.

Group 7 element	Bond energy (kJ/mol)
F_2	155
Cl_2	242
Br_2	193
I_2	151

Group 7 compound	Bond energy (kJ/mol)
HF	567
HBr	431
HCl	366
HI	299

He talks about the data with Mack.



7

Use examples and data from the table to explain why Len's idea is only true for some of the bonds.

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

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

[Total: 10]

3 A scientist works in a quality control laboratory for a chemical company.

The company makes acids for use in cleaning products.

(a) The scientist tests two acids, **acid A** and **acid B**.

He does a series of titrations for each acid.

He does a rough titration. He then repeats the titration three times taking more care.

These are his results.

Acid	Volume of sodium hydroxide solution used in cm^3				
	Rough	**Repeat 1**	**Repeat 2**	**Repeat 3**	
A	25.0	24.5	24.4	24.6	
B	28.0	27.7	26.1	25.0	

(i) What is the range of volumes of sodium hydroxide used for the **repeats** for each acid?

range for **acid A**: from ..... to .....cm^3

range for **acid B**: from ..... to .....cm^3

[2]

(ii) The scientist looks at the ranges to decide whether he needs to do more repeats.

Do you think he needs to do more repeats for **acid A**?

Do you think he needs to do more repeats for **acid B**?

Explain your reasons.

acid A .....

.....

acid B .....

.....

[2]

(b) The scientist tests some samples of another four dilute acids, **C**, **D**, **E** and **F**.

He uses the same volume of dilute acid each time.

He measures the pH and does titrations using sodium hydroxide solution.

He uses the same concentration of sodium hydroxide solution in each titration.

His results are shown in the table below.

Acid	pH	Mean volume of sodium hydroxide solution used in titration (cm^3)
C	5	12.0
D	1	18.5
E	4	25.0
F	1	12.0

The scientist looks at his results.

He wants to know whether each acid is a strong acid or a weak acid.

He wants to compare the concentrations of the acids.

What conclusions can you make from the results about the **strength** and **concentration** of each of the four acids, **C, D, E** and **F**?

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

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

[Total: 10]

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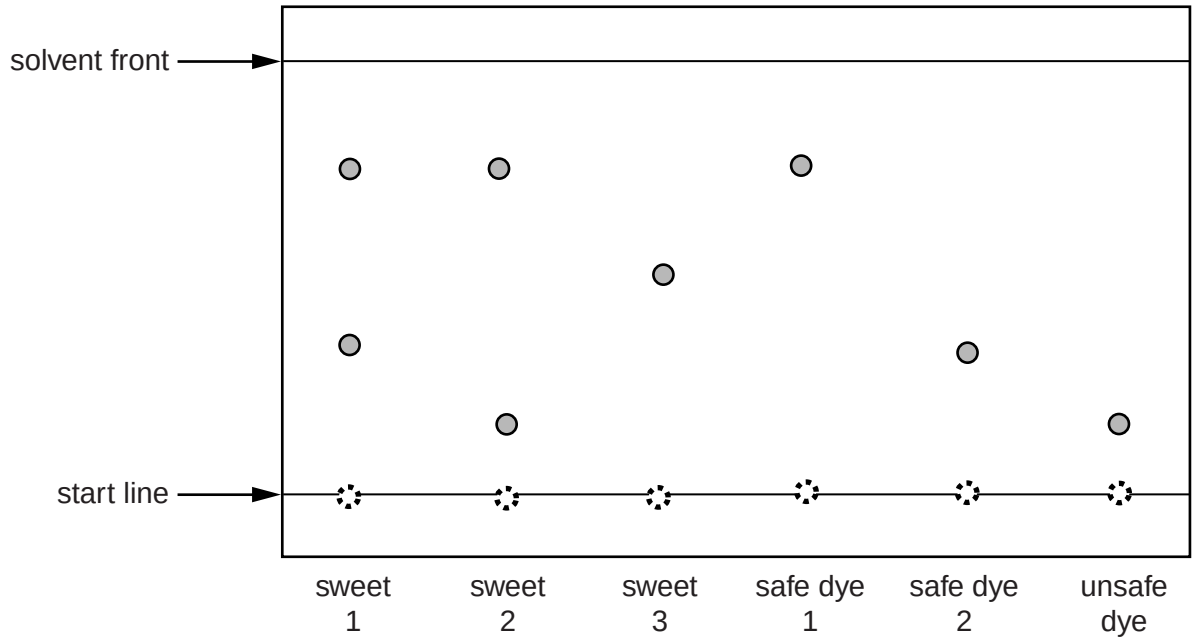
4 Alex uses chromatography to analyse the food dyes used in a packet of sweets.

The packet contains three different coloured sweets.

Alex tests one sweet of each colour.

He uses two known safe food dyes and one known unsafe dye as references.

Here is the chromatogram showing his results.



(a) How many different dyes have been used in the three sweets?

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

(b) Alex looks at the results and makes this statement:

'The results show that it is possible that two of the sweets contain an unsafe dye.'

Explain how the results of the chromatogram support Alex's conclusion.

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

(c) Alex decides to calculate the *Rf* of safe dye 1.

What measurements does he need to make from the chromatogram to use in his calculation?

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

(d) Alex also uses chromatography to identify the **flavourings** used in the sweets.

He sprays his chromatogram with a locating agent.

Why does Alex need to use a locating agent?

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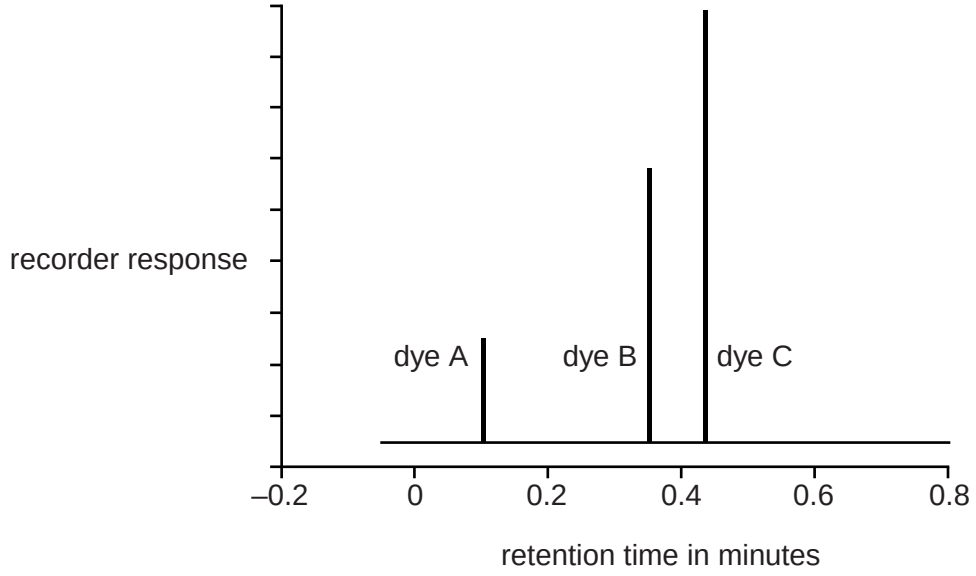
..... **[1]**

(e) Alex uses a chromatography machine to analyse the food dyes from a different type of sweet.

This is the printout he gets.



(i) The printout shows that three dyes have been used in the sweet.

Which dye has been used in the largest quantity?

Explain how you can tell.

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

(ii) Alex wants to identify dye A.

He uses data from the chromatography printout.

He also uses data from printouts for known dyes.

How does he use the data to identify dye A?

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

(iii) Alex says that the chromatography printout gives both **qualitative** and **quantitative** information about the dyes used in the sweet.

Explain why this is true.

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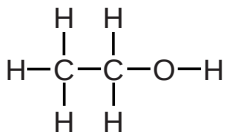
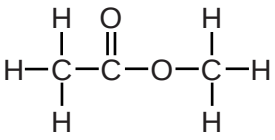
..... **[2]**

[Total: 12]

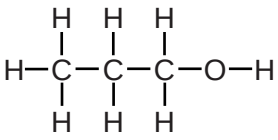
5 The diagrams show the structural formula of some substances, **A**, **B**, **C** and **D**.



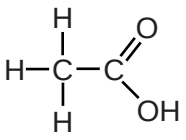
A



B



C



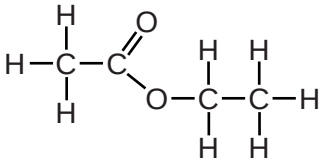
D

(a) Which substance is found in vinegar?

Put a (ring) around the correct answer.

A **B** **C** **D** **[1]**

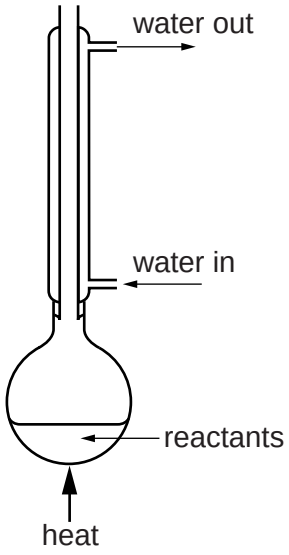
(b) Which two of the substances react together to make this ester?



Put a (ring) around each of the **two** correct answers.

A **B** **C** **D** **[1]**

(c) Sue makes an ester by heating the reactants together using this apparatus.



Why did Sue fit a vertical condenser to the flask?

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

(d) After the reaction the mixture is not pure.

Sue carries out two further stages.

- She separates the ester from the reaction mixture.
- She purifies the ester.

How does she do each stage?

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

[Total: 7]

6 Ammonia for making fertilisers is made in this reaction.

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

(a) In a closed container, this reaction does not give 100% yield, even if the reaction is left to run for a very long time.

Explain why.

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

(b) On an industrial scale, conditions for the reaction between hydrogen and nitrogen can be chosen to increase the rate of reaction and the yield.

Which conditions increase only the rate, which increase only the yield and which increase both?

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

Condition	**Increases rate only**	**Increases yield only**	**Increases both rate and yield**
High temperature			
High pressure			
Use of a catalyst			
Recycling unreacted hydrogen and nitrogen			

[3]

(c) Some living organisms use natural processes to make nitrogen compounds from nitrogen in the air.

Which **two** statements about these processes are true?

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

The reactions happen in the organisms at room temperature.	☐
Organisms use large amounts of hydrogen from the air in the reactions.	☐
The reactions take place in the organisms under high pressure.	☐
The organisms use iron metal to act as a catalyst.	☐
The reactions in living organisms rely on enzymes.	☐

[2]

[Total: 7]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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.