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Wednesday 21 June 2017 – 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

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 barcodes.

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.

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1 Indigestion is caused by excess hydrochloric acid in the stomach.

Dee looked at packets of indigestion tablets and found that they all contain sodium hydrogencarbonate, $NaHCO_3$.

(a) In the stomach, sodium hydrogencarbonate reacts with hydrochloric acid.

(i) Complete the word and symbol equation for the reaction.

sodium hydrogencarbonate + hydrochloric acid → [ ] + carbon dioxide + water

$NaHCO_3$ + [ ] → [ ] + CO_2 + H_2O

[2]

(ii) One of the side effects of taking medicines which contain sodium hydrogencarbonate is pain caused by a build-up of gas in the stomach.

Use the equation to explain how sodium hydrogencarbonate causes a build-up of gas in the stomach.

....

....

.... **[2]**

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(b) Dee makes up a standard solution of sodium hydrogencarbonate.

This is some of the equipment she uses:

- solid sodium hydrogencarbonate
- balance
- beaker and glass rod
- distilled water
- funnel
- volumetric flask
- dropping pipette.

Describe how Dee uses this equipment to make an accurate standard solution of sodium hydrogencarbonate.

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

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.... **[6]**

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(c) Dee makes some other standard solutions, **A**, **B** and **C**.

The table shows some data about the solutions she makes.

Standard solution	Mass of sodium hydrogencarbonate used in g	Volume of standard solution in cm^3	Concentration in g/dm^3
A	2.5	500.0	5.0
B	2.5	250.0	
C		100.0	2.5

(i) Calculate the concentration of solution **B**.

concentration = ... g/dm^3 **[2]**

(ii) Calculate the mass of sodium hydrogencarbonate used to make solution **C**.

mass = ... g **[2]**

[Total: 14]

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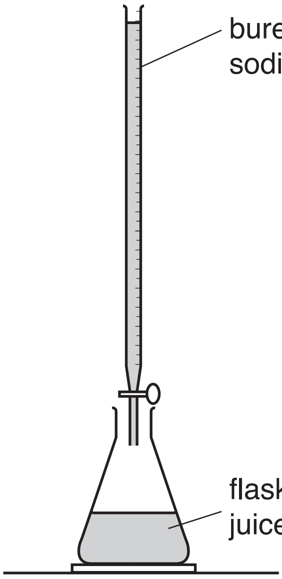
2 Lemon juice contains an acid.

Joe does some titrations to find the concentration of acid in a bottle of lemon juice from a shop.

He uses a measuring cylinder to measure 5 cm^3 samples of lemon juice.

He adds an indicator to the lemon juice, then does a titration using dilute sodium hydroxide.

The diagram shows how he sets up his titration.



For each sample of lemon juice, Joe does a rough titration and then several titration repeats.

These are Joe's results.

	Rough	**Titration repeats**			
		1	**2**	**3**	**4**
Volume dilute sodium hydroxide used (cm^3)	25.0	24.0	26.5	27.0	19.0

(a) **(i)** Joe thinks that the data from his titrations is poor quality.

Explain why he is right.

....

....

.... **[2]**

(ii) Joe thinks that the problem is caused because his measuring cylinder does not give a precise measurement of the lemon juice.

Suggest what Joe could use to measure the lemon juice more precisely.

.... **[1]**

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(b) Joe repeats his titrations.

These are his new results.

	Rough	Titration repeats			
		1	**2**	**3**	**4**
Volume dilute sodium hydroxide used (cm^3)	25.0	24.0	25.0	23.5	23.0

(i) Joe chooses titration results that are within 0.5 cm^3 of each other to calculate the best estimate of the true volume of dilute sodium hydroxide used.

Put a ring around the **three** results in the table he uses. **[1]**

(ii) Use the results to calculate a best estimate for the volume of dilute sodium hydroxide used.

.... cm^3 **[2]**

(iii) Joe uses this equation to work out the concentration of the lemon juice.

$$\text{concentration in \%} = \frac{\text{best estimate of volume of dilute sodium hydroxide in cm}^3}{5}$$

The label on the bottle of lemon juice says that it contains 5% lemon juice.

Do Joe's titration results agree with this value?
Use ideas about significant figures to justify your answer.

....

.... **[2]**

[Total: 8]

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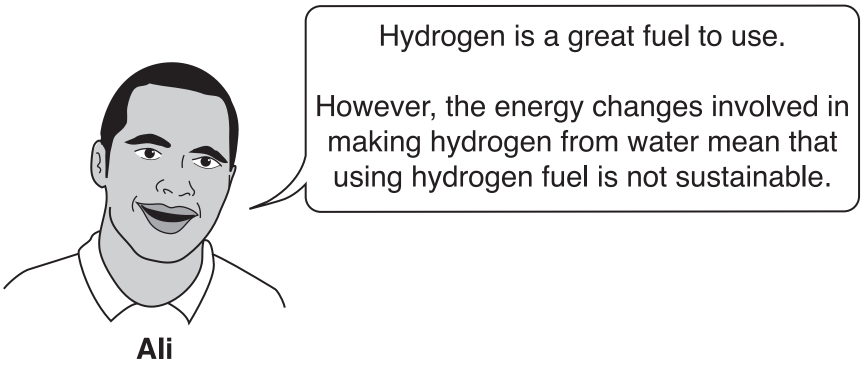
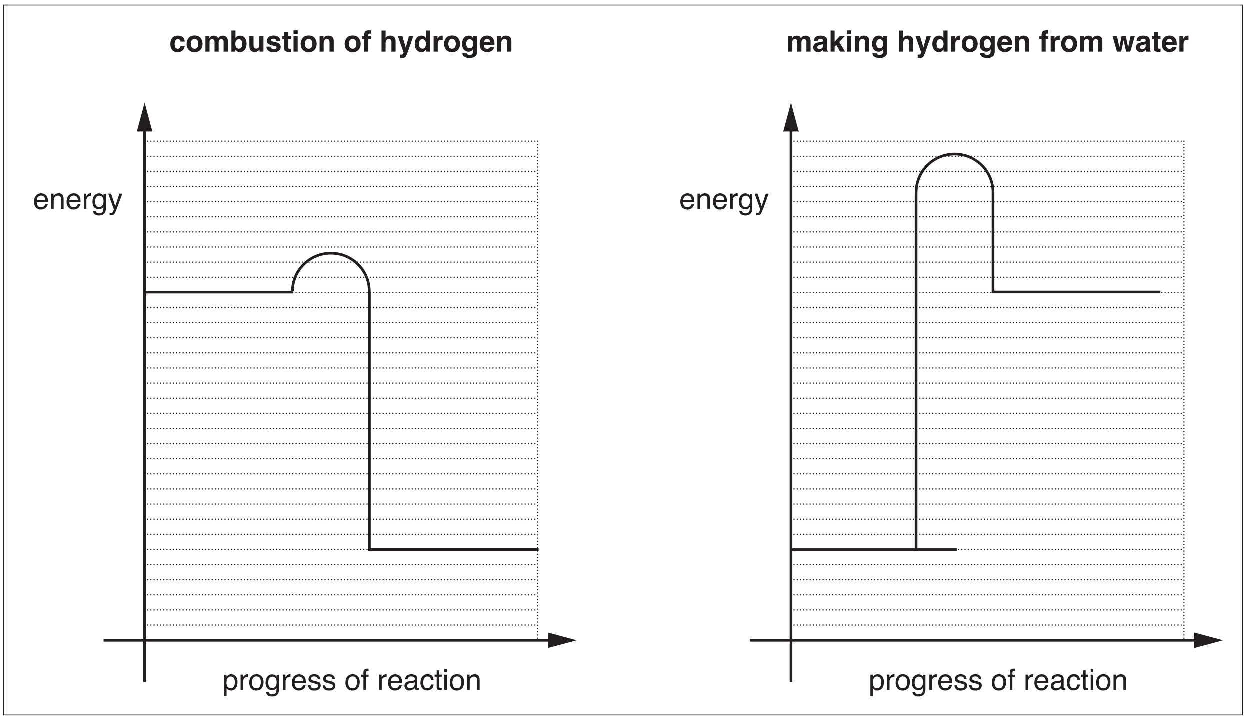
3 Ali gives a talk about making hydrogen from water to use as a fuel.



He uses a slide showing these energy level diagrams to support his points.



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Use the energy changes shown on both diagrams to justify reasons why hydrogen is a 'great fuel to use' but why using it as a fuel is not sustainable if it is made from water.

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

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.... **[6]**

[Total: 6]

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4 Octane and nonane are alkanes that are used in car fuels.

(a) Complete the balanced symbol equation for the complete combustion of nonane.

$C_9H_{20} + 14O_2 \longrightarrow$ .... + ...

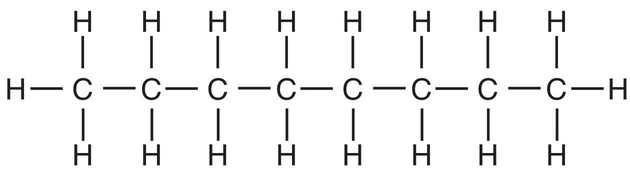
[2]

(b) Cracking is a reaction used in a petrol refinery to make smaller molecules from long-chain alkanes.

(i) The diagram shows what happens when cracking is used to make two molecules of ethene from an octane molecule.

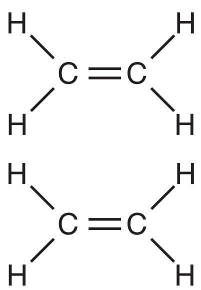
One other molecule is also made.

In the box provided **draw** the structure and give the **name** of the other molecule.



octane

↓



ethene

\+

name...

[2]

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(ii) Which statements are only **true for octane**, which are **only true for ethene**, and which are **true for both**?

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

Statement	**Only true for octane**	**Only true for ethene**	**True for both**
contains all single bonds			
molecules are unsaturated			
molecules are hydrocarbons			
unreactive with aqueous solutions			

[3]

[Total: 7]

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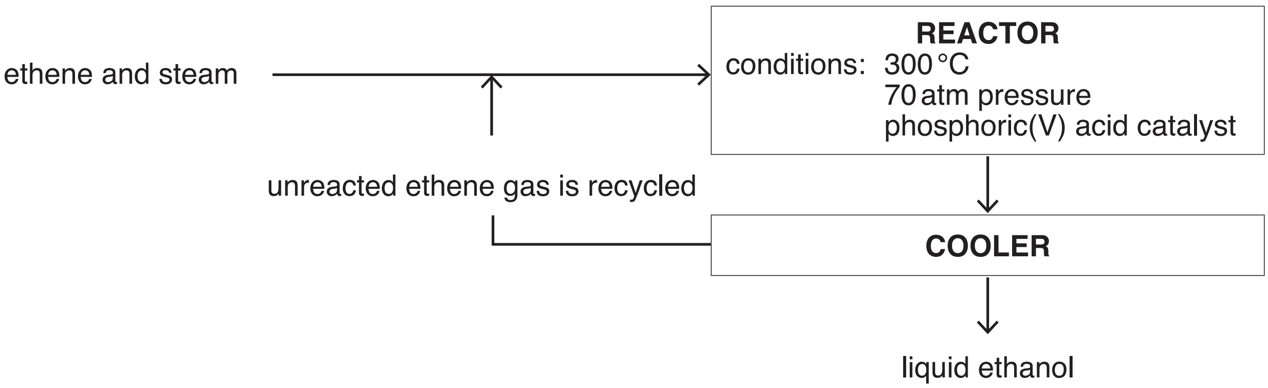
5 Ethene is used in an industrial process to make ethanol.

This is the equation for the main reaction in the process.

$$C_2H_4 + H_2O \rightleftharpoons C_2H_5OH$$

This flow diagram summarises the process.



(a) Use the equation to explain why it is necessary to recycle ethene gas in the process.

....

....

.... **[2]**

(b) The yield of ethanol is higher when the temperature of the process is lower.

Explain why the temperature chosen in the reactor is a compromise.

....

....

.... **[2]**

(c) The reactor contains phosphoric(V) acid and uses a pressure of 70 atm.

Explain how these conditions affect the reaction in the reactor.

....

....

.... **[2]**

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(d) Which compound, ethene or ethanol, has the highest boiling point?

Use information from the flow chart to explain your answer.

....

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.... **[2]**

[Total: 8]

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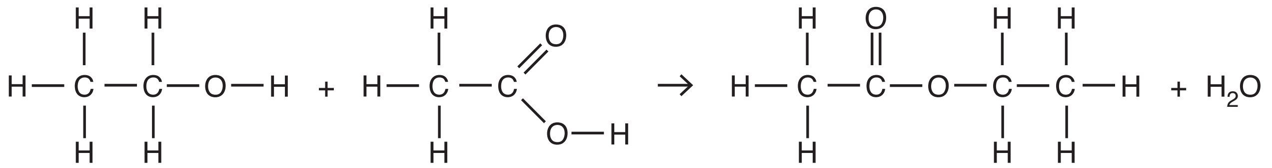
6 Ayesha investigates two reactions of ethanol, **reaction 1** and **reaction 2**.

In **reaction 1**, she reacts ethanol with ethanoic acid. In **reaction 2** she reacts ethanol with a different compound.

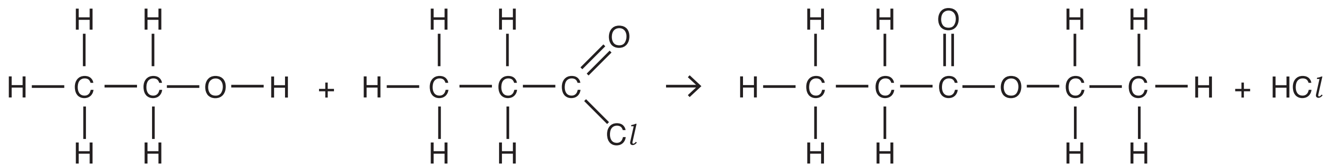
The two reactions are shown below.

Reaction 1



ethanol ethanoic acid

Reaction 2



ethanol

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Discuss the **similarities** and **differences** between the two reactions opposite and their products.

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

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.... **[6]**

[Total: 6]

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7 Over 10 million tonnes of phenol are made worldwide every year. Phenol is used to make many plastic products for buildings and packaging.

Phenol has been manufactured for over 100 years. The table gives information about an older process to make phenol and a modern process.

	Older process	**Modern process**
Raw materials	Benzene (from fossil fuels) Sulfuric acid Sodium hydroxide	Benzene Propene (both from fossil fuels)
Yield	82%	87%
Atom economy	37%	100%
Waste products	Sodium sulfite (toxic)	None, by-products are useful
Conditions	High temperature and pressure	High temperature and pressure

(a) Use the information to explain why the atom economy of the two processes are different.

....

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.... **[2]**

(b) The modern process involves more green chemistry than the older process.

Use the information to explain why.

....

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.... **[3]**

(c) A team of scientists are investigating how to make the modern process more green.

(i) One factor they are investigating is ways to increase yield.

Suggest **two** other factors they could investigate to make the process even greener.

1 ....

....

2 ....

.... **[2]**

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(ii) Scientists in the team share their data with each other.

Give **two** reasons why they do this.

1 ....

....

2 ....

.... **[2]**

(d) Some green chemical processes use enzymes as catalysts.

Enzymes have some **disadvantages** because they limit the conditions that can be used in chemical processes.

What are the **disadvantages** of using enzymes as catalysts?

Put a tick (✓) in the boxes next to **two** disadvantages of using enzymes.

Enzymes speed up chemical reactions.	☐
Enzymes have specific pH ranges.	☐
Enzymes provide alternative routes for reactions.	☐
Enzymes work best at a narrow optimum temperature range.	☐
Enzymes reduce activation energy.	☐

[2]

[Total: 11]

END OF QUESTION PAPER

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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).

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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.

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