

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



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. 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]

- (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.

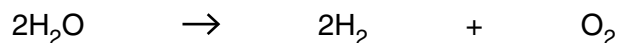
More gases are made in the reaction.

The reaction uses a catalyst.

Steam is less reactive than hydrogen.

[2]

- (ii) The new process splits water into hydrogen.



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.

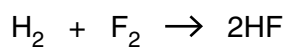
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 [2]

[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.



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	+ 432
F-F	
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)	Group 7 compound	Bond energy (kJ/mol)
F ₂	155	HF	567
Cl ₂	242	HBr	431
Br ₂	193	HCl	366
I ₂	151	HI	299

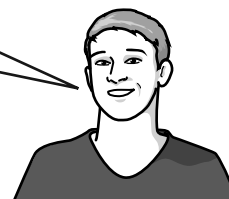
He talks about the data with Mack.



Len

I think for Group 7 all of the bonds in the elements and compounds get weaker down the group.

I don't agree. I think your idea is only true for some of the bonds.



Mack

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 tocm³

range for **acid B**: from tocm³

[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]

10
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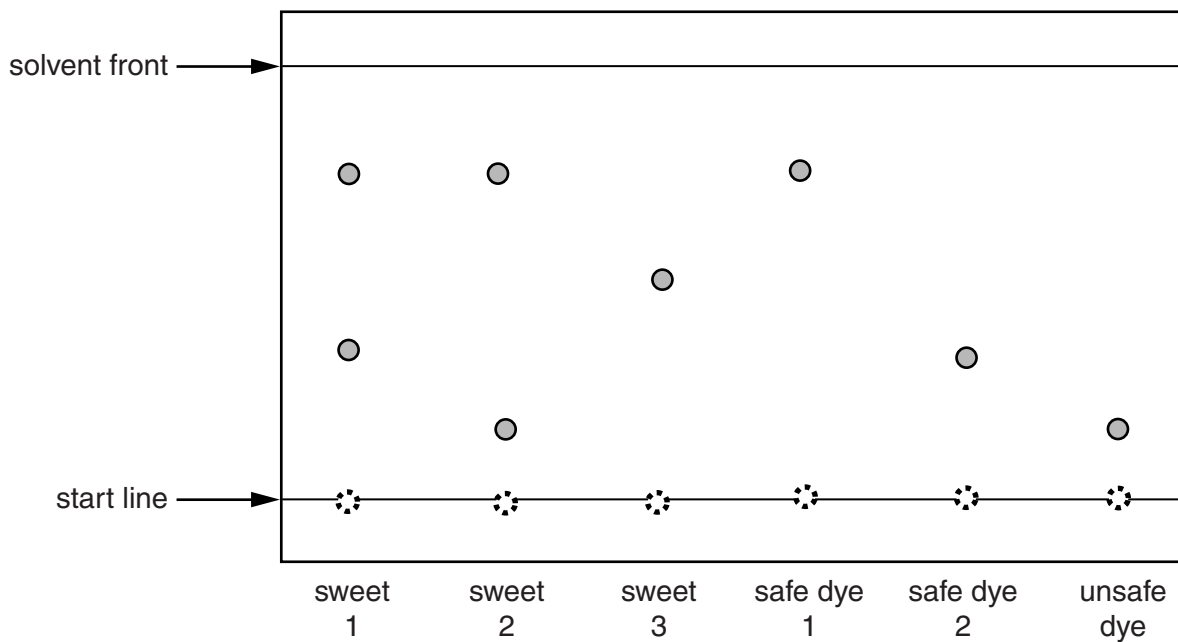
4 Alex uses chromatography to analyse the food dyes used in a packet of sweets.

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.

.....

 [2]

- (c) Alex decides to calculate the R_f 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.

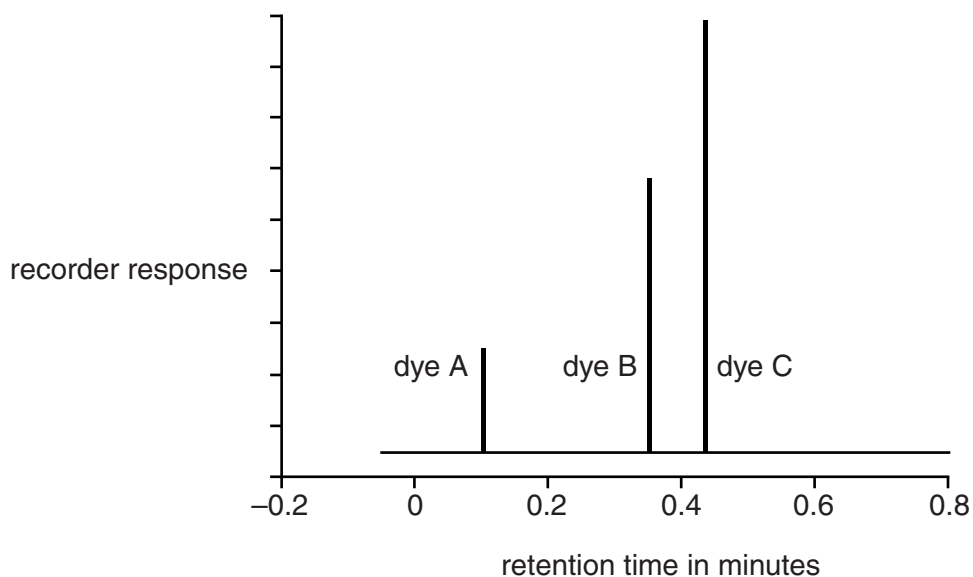
Why does Alex need to use a locating agent?

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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]

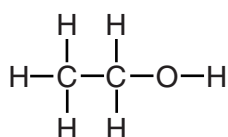
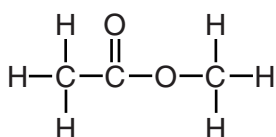
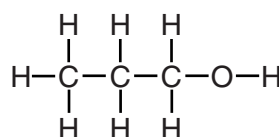
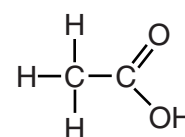
- (iii) Alex says that the chromatography printout gives both **qualitative** and **quantitative** information about the dyes used in the sweet.

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**

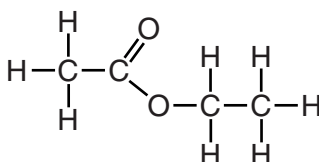
(a) Which substance is found in vinegar?

Put a (ring) around the correct answer.

A**B****C****D**

[1]

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

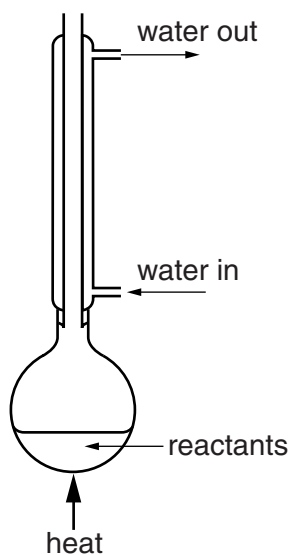


Put a (ring) around each of the **two** correct answers.

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?

.....

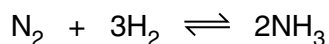
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..... [2]

[Total: 7]

6 Ammonia for making fertilisers is made in this reaction.



- (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

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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).

A large area of lined paper for writing. It consists of a vertical solid line on the left side, creating a margin. The rest of the page is filled with horizontal dotted lines, providing space for writing answers.

The Periodic Table of the Elements

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<td>Ni</td> <td>nickel</td> <td>28</td> <td>63.5</td> <td>Cu</td> <td>copper</td> <td>29</td> <td>65</td> <td>Zn</td> <td>zinc</td> <td>30</td> <td>70</td> <td>Ga</td> <td>gallium</td> <td>31</td> <td>73</td> <td>Ge</td> <td>germanium</td> <td>32</td> <td>75</td> <td>As</td> <td>arsenic</td> <td>33</td> <td>79</td> <td>Se</td> <td>selenium</td> <td>34</td> <td>84</td> <td>Kr</td> <td>krypton</td> <td>36</td> </tr> <tr> <td>85</td> <td>Rb</td> <td>rubidium</td> <td>37</td> <td>88</td> <td>Sr</td> <td>strontium</td> <td>38</td> <td>91</td> <td>Zr</td> <td>zirconium</td> <td>40</td> <td>89</td> <td>Y</td> <td>yttrium</td> <td>39</td> <td>93</td> <td>Nb</td> <td>niobium</td> <td>41</td> <td>[98]</td> <td>Tc</td> <td>technetium</td> <td>43</td> <td>101</td> <td>Ru</td> <td>ruthenium</td> <td>44</td> <td>103</td> <td>Rh</td> <td>rhodium</td> <td>45</td> <td>106</td> <td>Pd</td> <td>palladium</td> <td>46</td> <td>108</td> <td>Ag</td> <td>silver</td> <td>47</td> <td>112</td> <td>Cd</td> 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<td>209</td> <td>Bi</td> <td>bismuth</td> <td>83</td> <td>[222]</td> <td>Rn</td> <td>radon</td> <td>86</td> </tr> <tr> <td>[223]</td> <td>Fr</td> <td>francium</td> <td>87</td> <td>[226]</td> <td>Ra</td> <td>radium</td> <td>88</td> <td>[261]</td> <td>Rf</td> <td>rutherfordium</td> <td>104</td> <td>[262]</td> <td>Db</td> <td>dubnium</td> <td>105</td> <td>[266]</td> <td>Sg</td> <td>seaborgium</td> <td>106</td> <td>[264]</td> <td>Bh</td> <td>bohrium</td> <td>107</td> <td>[277]</td> <td>Hs</td> <td>hassium</td> <td>108</td> <td>[268]</td> <td>Mt</td> <td>meitnerium</td> <td>109</td> <td>[271]</td> <td>Ds</td> <td>darmstadtium</td> <td>110</td> <td>[272]</td> <td>Rg</td> <td>roentgenium</td> <td>111</td> <td colspan="3" style="text-align: center;">Elements with atomic numbers 112-116 have been reported but not fully authenticated</td> </tr> 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85	Rb	rubidium	37	88	Sr	strontium	38	91	Zr	zirconium	40	89	Y	yttrium	39	93	Nb	niobium	41	[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	127	I	iodine	53	131	Xe	xenon	54																																																																																																																																																																																																																				
133	Cs	caesium	55	137	Ba	barium	56	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	[222]	Rn	radon	86																																																																																																																																																																																																																								
[223]	Fr	francium	87	[226]	Ra	radium	88	[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.