MODEL ANSWERS

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel International GCSE (9–1)

Centre Number | | | | | |

Candidate Number | | | | |

Monday 20 January 2020

Afternoon (Time: 1 hour 15 minutes) | Paper Reference **4CH1/2CR**

Chemistry

Unit: 4CH1

Paper: 2CR

You must have:
Calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- Show all the steps in any calculations and state the units.
- Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Information

- The total mark for this paper is 70.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Pearson

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
																	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

1 **H** hydrogen 1

**** 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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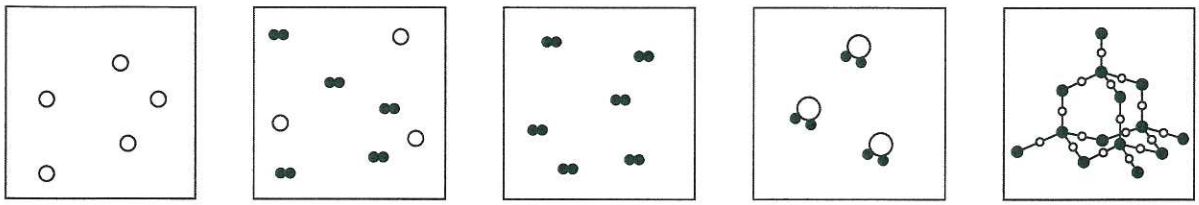
Answer ALL questions.

1 Substances can be classified as elements, mixtures or compounds.

(a) Each box represents an element, a mixture or a compound.



Box 1 Box 2 Box 3 Box 4 Box 5

(i) Which box represents a mixture?

(1)

☐ **A** 1

☒ **B** 2

☐ **C** 3

☐ **D** 4

(ii) Which two boxes represent elements?

(1)

☐ **A** 1 and 2

☐ **B** 2 and 3

☒ **C** 1 and 3

☐ **D** 3 and 4

(iii) Explain why Box 5 represents a compound.

(2)

Box 5 shows two different elements Chemically bonded together.

(b) The Periodic Table contains all the known elements.

(i) How are the elements arranged in the Periodic Table?

(1)

☐ **A** increasing mass number

☐ **B** increasing number of neutrons

☒ **C** increasing number of protons

☐ **D** increasing reactivity

(ii) Elements in the same group have the same number of

(1)

☒ **A** electrons in the outer shell

☐ **B** electron shells

☐ **C** neutrons

☐ **D** protons

(Total for Question 1 = 6 marks)

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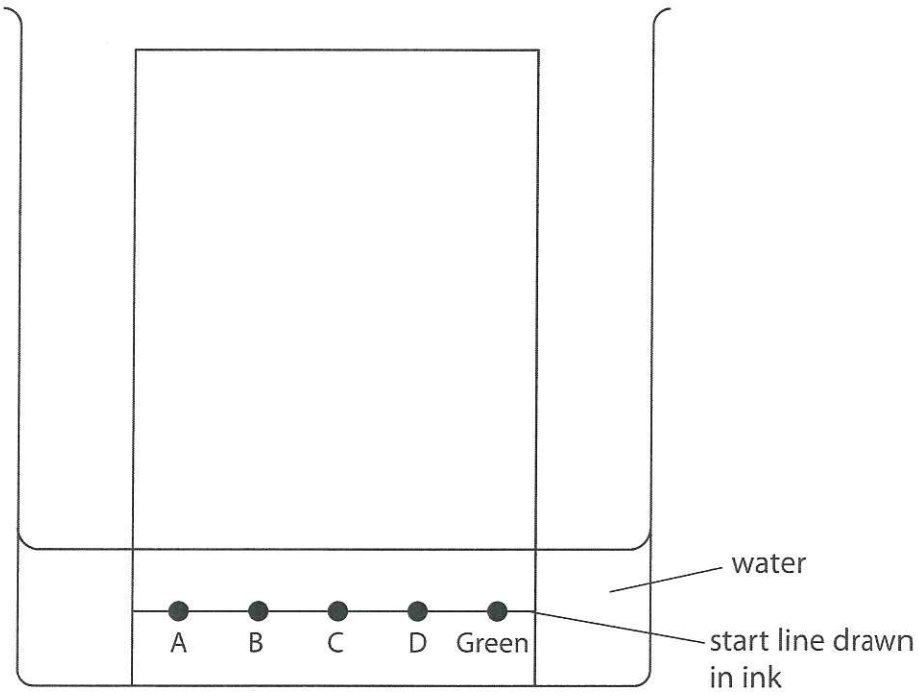
2 Chromatography is used to analyse mixtures.

A student does a chromatography experiment to analyse the composition of green food colouring in sweets.

She places four known dyes, A, B, C and D, and the green food colouring on chromatography paper.

The diagram shows the student's apparatus at the start of her experiment.



(a) The diagram shows that the student makes two mistakes when setting up her apparatus.

State the two changes that the student should make so that her experiment works.

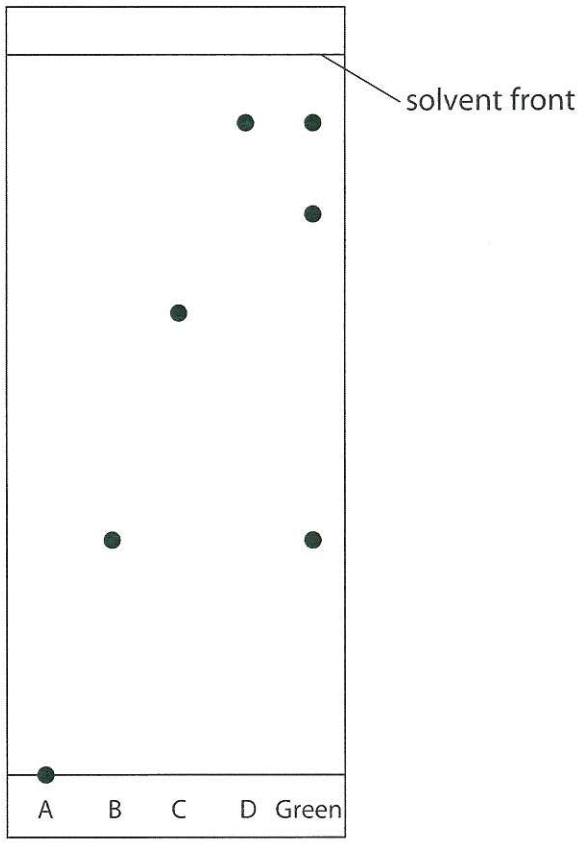
(2)

1 The level of the water must be below the start line.

2 The start line must be drawn in pencil.

(b) Another student does the chromatography experiment correctly.

The diagram shows her chromatogram at the end of the experiment.



(i) Explain what the chromatogram shows about the composition of the green food colouring.

(3)

The green food colouring contains three dyes: ~~A~~ B, D and an unknown dye. It doesn't contain A or C.

(ii) The distance between the start line and the spot for dye C is 6.2 cm.

Calculate the R_f value of dye C.

(3)

Distance moved by Solvent = 9.5 cm

R_f = distance moved by Dye C / distance travelled by Solvent

= 6.2 / 9.5 = 0.653

R_f value = 0.653 (3 s.f.)

(iii) Suggest why dye A does not move.

(1)

Dye A isn't Soluble in water.

(Total for Question 2 = 9 marks)

3 Solutions of silver nitrate and potassium chloride react together to make the insoluble salt, silver chloride.

A student uses this method to prepare a sample of silver chloride.

Step 1 add 25 cm^3 of silver nitrate solution to a conical flask

Step 2 add potassium chloride solution to the flask

Step 3 filter off the silver chloride

(a) What term is used for this reaction?

(1)

☐ **A** neutralisation

☒ **B** precipitation

☐ **C** redox

☐ **D** thermal decomposition

(b) Give two more steps that will produce a pure, dry sample of silver chloride.

(2)

Step 4 Wash the Solid with deionised water.

Step 5 Dry the Solid in a warm oven.

(c) Acidified silver nitrate solution is used to test for chloride ions.

Give a reason why hydrochloric acid is not used to acidify silver nitrate solution.

(1)

Hydrochloric acid Contains Chloride ions, producing a white precipitate with Silver nitrate.

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(d) The chemical equation for the reaction between solutions of silver nitrate and potassium chloride is

$$AgNO_3(aq) + KCl(aq) \rightarrow AgCl(s) + KNO_3(aq)$$

A student adds an excess of potassium chloride solution to 25.0 cm^3 of 0.100 mol/dm^3 silver nitrate solution.

Calculate the maximum mass of silver chloride, in grams, that can be produced.

[M_r of AgCl = 143.5]

(2)

$n(AgNO_3) = \cancel{M}\ Conc \times V = 0.1 \times 25 \times 10^{-3} = 2.5 \times 10^{-3}$ mol

$n(AgCl) = 2.5 \times 10^{-3}$ mol

$m(AgCl) = Mr \times mol = 143.5 \times 2.5 \times 10^{-3}$

$= 0.35875$

mass = 0.359 (3 sig figs) g

(Total for Question 3 = 6 marks)

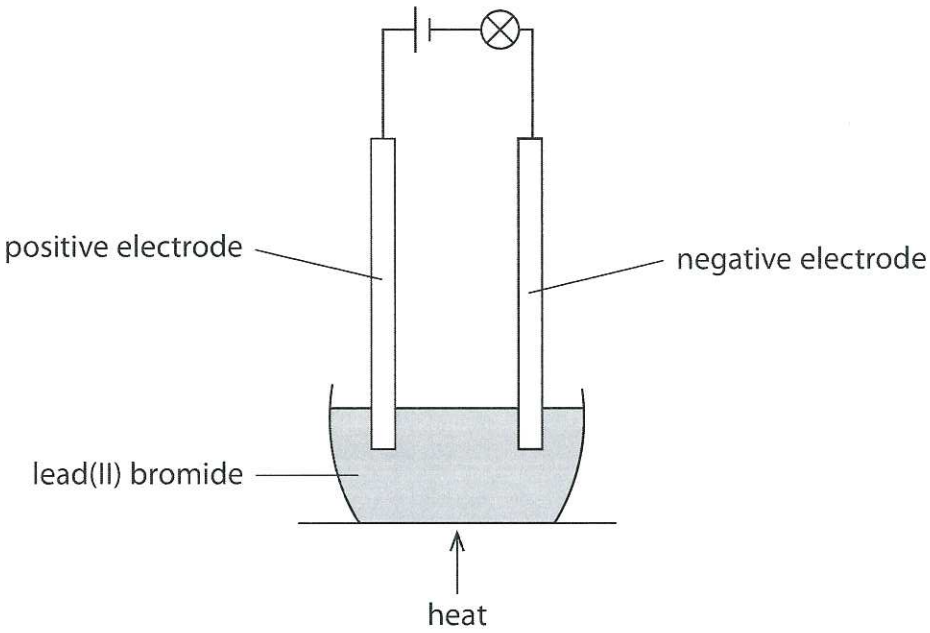
4 This question is about the metal, lead.

(a) Explain why metals, such as lead, are malleable.

(2)

Layers of ions can slide over each other.

(b) A teacher uses this apparatus in a fume cupboard to demonstrate the electrolysis of lead(II) bromide.



The lead(II) bromide is heated until it melts.

When the lead(II) bromide melts, the lamp lights.

One of the products of this electrolysis is lead.

(i) State why solid lead(II) bromide does not conduct electricity.

(1)

Ions cannot move.

(ii) Bromine is formed by the oxidation of bromide ions at the positive electrode.

Complete the ionic half-equation for the oxidation of bromide ions.

(1)

$2Br^- \rightarrow$ Br_2 + $2e^-$

(iii) Explain why lead metal forms at the negative electrode.

(2)

Lead ions are positively charged so are attracted to the negatively charged electrode where they gain electrons to form lead.

(iv) The teacher stops heating the mixture and allows it to solidify.

Suggest why the lamp stays alight.

(1)

Lead connects the electrodes, completing the circuit.

(Total for Question 4 = 7 marks)

5 This question is about Group 1 metals and their reactions.

(a) When lithium is added to water, bubbles of hydrogen gas are observed.

(i) Give two other observations that could be made.

(2)

1 Lithium moves on the surface.

Lithium gets smaller.

2 A colourless solution forms.

(ii) Give the test for hydrogen gas.

(1)

When hydrogen gas is mixed with air, a lit splint gives a squeaky pop.

(b) (i) Give one observation that would be different if potassium is used instead of lithium.

(1)

More vigorous fizzing.

Potassium would melt and turn into a ball.

Potassium would move more quickly.

Potassium would produce a flame.

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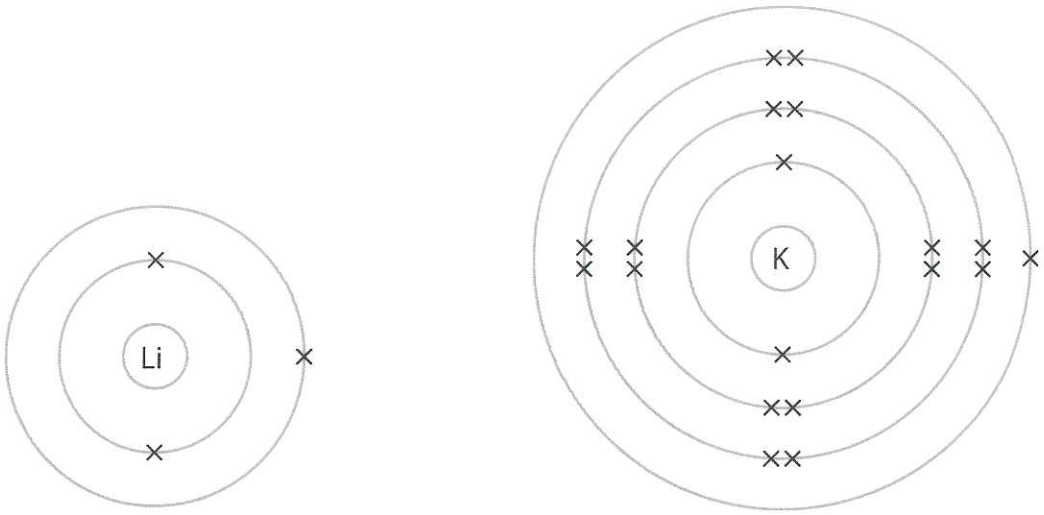
DO NOT WRITE IN THIS AREA

(ii) The diagram represents an atom of lithium and an atom of potassium.



Explain why potassium is more reactive than lithium.

(3)

Potassium has more shells of electrons than lithium. Hence, there is less attraction between the outer electron and the nucleus. Therefore, the electron in the outer shell is more easily lost.

(c) The equation for the reaction between lithium and water is

$$2Li(s) + 2H_2O(l) \rightarrow 2LiOH(aq) + H_2(g)$$

(i) A mass of 0.500 g of lithium reacts with an excess of water.

Calculate the volume, in cm^3, of hydrogen gas produced at rtp.

[molar volume of a gas at rtp = 24 000 cm^3]

Give your answer to three significant figures.

(3)

$n(Li) = \frac{mass}{Mr} = \frac{0.5}{7} = \frac{5}{70}$ mol

$n(H_2) = \frac{5}{70} / 2 = \frac{1}{28}$ mol

$V(H_2) = 24000 \times \frac{1}{28} = 857.142857 cm^3$

volume = 857 (3 SF) cm^3

(ii) In a reaction between lithium and water, 150 cm^3 of lithium hydroxide solution is formed.

The lithium hydroxide solution is then completely neutralised by 24.85 cm^3 of 0.100 mol/dm^3 sulfuric acid.

The equation for the neutralisation is

$$2LiOH(aq) + H_2SO_4(aq) \rightarrow Li_2SO_4(aq) + 2H_2O(l)$$

Calculate the concentration, in mol/dm^3, of the lithium hydroxide solution.

(3)

$n(H_2SO_4) = Conc \times V = 24.85 \times 10^{-3} \times 0.1$

$= 2.485 \times 10^{-3}$ mol

$n(Li(OH)) = 2.485 \times 10^{-3} \times 2 = 4.97 \times 10^{-3}$ mol

$[LiOH] = \frac{mol}{V} = \frac{4.97 \times 10^{-3}}{150 \times 10^{-3}} = 0.033133$ mol dm^{-3}

concentration = 0.0331 (3 SF) mol/dm^3

(Total for Question 5 = 13 marks)

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6 This question is about ethane and ethene.

(a) Ethane can be obtained from crude oil.

Describe the industrial process used to separate crude oil into fractions.

(4)

The Crude oil is vaporised and then passes into a fractionating Column. The Column is cooler at the top so fractions Condense at different heights.

(b) The equation for the reaction between ethene gas and hydrogen gas is

$$C_2H_4 + H_2 \rightarrow C_2H_6$$

The rate of this reaction can be increased by increasing the pressure.

(i) Explain why increasing the pressure increases the rate of this reaction.

(2)

There are more particles per unit volume so there are more frequent successful Collisions.

(ii) The rate of this reaction can also be increased by using a catalyst.

Explain how using a catalyst increases the rate of a reaction.

(2)

A Catalyst provides an alternative reaction pathway with a lower activation energy.

(iii) Give one other way that the rate of reaction between ethene gas and hydrogen gas can be increased.

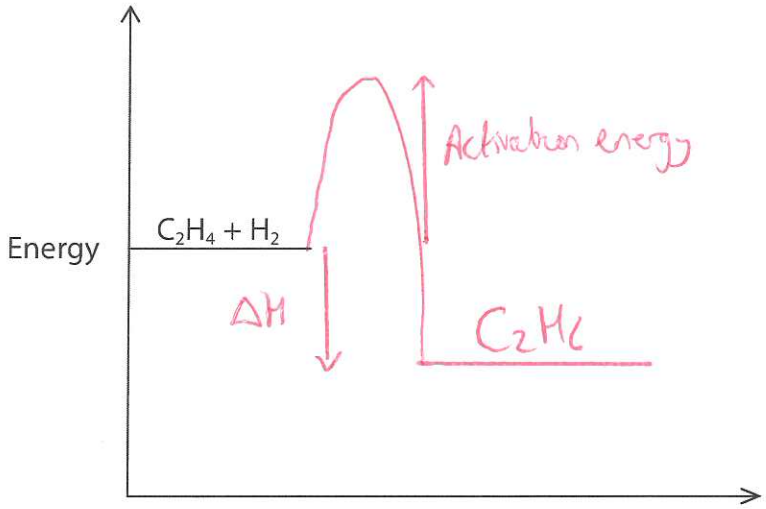
(1)

Increase the temperature.

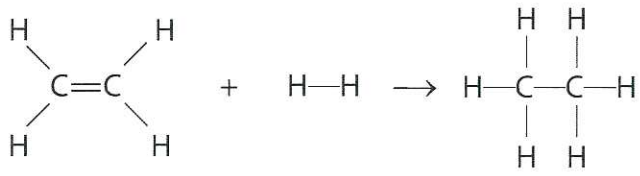
(iv) The reaction between ethene and hydrogen is exothermic.

Complete the reaction profile diagram, including labels for the activation energy and the enthalpy change, ΔH.

(3)



(c) The reaction between ethene and hydrogen can be represented using displayed formulae.



Bond	Bond energy in kJ/mol
C=C	612
C—H	412
H—H	436
C—C	348

Use the bond energies in the table to calculate the enthalpy change, ΔH, in kJ/mol for this reaction.

(3)

Breaking:

1 C=C	612
4 C-H	4(412)
1 H-H	436
	2696

Making:

1 C-C	348
6 C-H	6(412)
	2820

ΔH = Breaking - Making

= 2696 - 2820

= -124 kJ mol^{-1}

ΔH = -124 kJ/mol

(Total for Question 6 = 15 marks)

7 (a) Ethanol, C_2H_5OH, can be produced by the fermentation of glucose, $C_6H_{12}O_6$

(i) Complete the equation for the fermentation of glucose.

(1)

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2 \text{ } CO_2$$

(ii) State why it is necessary for fermentation to be done in the absence of air.

(1)

Otherwise the ethanol would be oxidised to form ethanoic acid.

(iii) Explain why the temperature should not be higher than 40 °C.

(2)

The reaction is catalysed by enzymes in yeast which denature above 40°C.

(iv) When 4 mol of glucose is fermented, a mass of 55.2 g of ethanol is produced.

Show that the percentage yield of ethanol is 15%.

[M_r of C_2H_5OH = 46]

(2)

n (Glucose) = 4 mol

n (C_2H_5OH) = 2 × 4 = 8 mol

m (C_2H_5OH) = 8 × 46 = 368 g

% yield = $\frac{55.2}{368} \times 100$

= 15%

(b) Ethanol can also be produced by the reaction between ethene and steam.

The equation for the reaction is

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

(i) This reaction is in dynamic equilibrium.

Give two features of a reaction in dynamic equilibrium.

(2)

1 Rate of forwards reaction = Rate of ~~reverse~~ backwards reaction.

2 The Concentrations of reactants and products remain Constant.

(ii) When the equilibrium mixture is heated, the yield of ethanol decreases.

Explain whether the forward reaction is exothermic or endothermic.

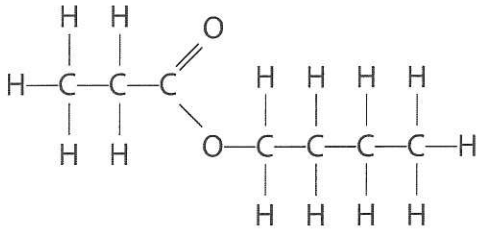
(2)

An increase in temperature shifts the position of equilibrium in the endothermic direction - here to the left.

Hence, the forwards reaction is exothermic.

(c) Carboxylic acids react with alcohols to form esters.

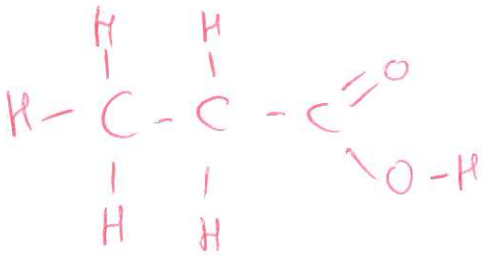
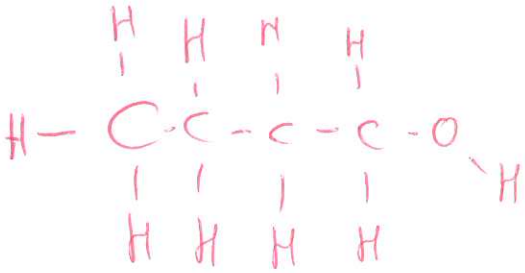
The displayed formula of an ester is



(i) Carboxylic acid A and alcohol B react to produce this ester.

Give the displayed formula of carboxylic acid A and of alcohol B.

(2)

Carboxylic acid A	Alcohol B
	

(ii) Indicators can be used to test for carboxylic acids.

Describe a different chemical test for a carboxylic acid.

(2)

Add Calcium Carbonate. Fizzing will be observed if a Carboxylic acid is present.

(Total for Question 7 = 14 marks)

TOTAL FOR PAPER = 70 MARKS

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