Paper Reference(s) **WCH03/01**

Pearson Edexcel
International Advanced Level

Chemistry
Advanced Subsidiary
Unit 3: Chemistry Laboratory Skills I

Tuesday 9 May 2017 – Afternoon

Time: 1 hour 15 minutes plus your additional time allowance

INSTRUCTIONS TO CANDIDATES
Write your centre number, candidate number, surname, other names and your signature in the boxes below. Check that you have the correct question paper.

Centre No.							
Candidate No.							
Surname							
Other names							
Signature							
Paper Reference	W	C	H	0	3	/	0	1

Pearson

- Use BLACK ink or BLACK ball-point pen.
- Answer ALL questions.
- Answer the questions in the spaces provided – there may be more space than you need.

MATERIALS REQUIRED FOR EXAMINATION

Nil

ITEMS INCLUDED WITH QUESTION PAPERS

Nil

INFORMATION FOR CANDIDATES

- The total mark for this paper is 50.
- The marks for EACH question are shown in brackets – use this as a guide as to how much time to spend on each question.
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- Candidates must have a scientific calculator.
- A Periodic Table is provided.

ADVICE TO CANDIDATES

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Answer ALL the questions. Write your answers in the spaces provided.

(Questions begin on next page)

1 (a) A student carried out tests on a solid compound, A, which contains one metal ion and one anion. These tests are described in parts (a)(i) and (a)(ii).

Complete the table in each case by stating the inference(s) that would follow each observation made by the student.

(i) A flame test was carried out on A. (1 mark)

Observation	Inference
Lilac flame	The FORMULA of the metal ion in A is _____

(ii) A sample of A was heated in a test tube and the gas given off was tested with a glowing splint. (2 marks)

Observation	Inferences
The glowing splint re-lit	The gas is _____ The FORMULA of A could be _____

(Question continues on next page)

(b) A student carried out tests on an aqueous solution, B. These tests are described in parts (b)(i) and (b)(ii).

Complete the table in each case by stating the inferences that would follow each observation made by the student.

(i) A spatula measure of sodium hydrogencarbonate was added to a sample of solution B in a test tube. Any gas evolved was passed through limewater. (2 marks)

Observation	Inferences
Fizzing	The gas evolved is _____
Limewater turned milky	Therefore solution B contains ions with the FORMULA _____

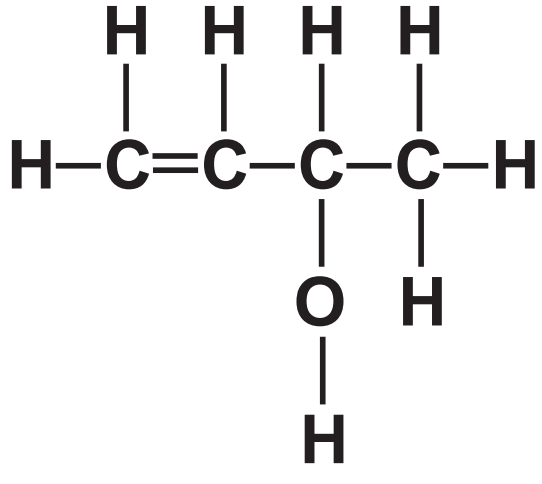
(Question continues on next page)

(ii) To another sample of solution B in a test tube, the student added dilute hydrochloric acid followed by aqueous barium chloride solution. (2 marks)

Observation	Inferences
A white precipitate formed	The precipitate is _____ Solution B is _____

(Question continues on next page)

(c) A liquid organic compound, W, has the displayed formula



Complete the table on page 8 by stating the observations you would expect to make when the tests described are carried out by a student. (6 marks)

(Question continues on next page)

Tests	Observations
In a test tube, shake a few drops of W with bromine water and record the colour change	From _____ to _____
In a test tube, add a spatula measure of phosphorus(V) chloride to W Test any gas evolved with damp blue litmus paper	_____ _____
In a test tube, add a mixture of dilute sulfuric acid and aqueous potassium dichromate(VI) to a sample of W and warm the mixture. Record the colour change	From _____ to _____

(TOTAL FOR QUESTION 1 = 13 MARKS)

(Questions continue on next page)

2 1-bromobutane may be prepared by heating a mixture of butan-1-ol, sodium bromide and 50% concentrated sulfuric acid.

$$C_4H_9OH + NaBr + H_2SO_4 \longrightarrow C_4H_9Br + NaHSO_4 + H_2O$$

The preparation is carried out in eight stages.

Stage 1 The reagents are heated in the apparatus shown in DIAGRAM 1 for 45 minutes.

Stage 2 Impure 1-bromobutane is extracted from the reaction mixture and is then transferred to the round bottom flask in the apparatus shown in DIAGRAM 2.

Stage 3 A mixture of 1-bromobutane and water is obtained when the impure 1-bromobutane is heated using the apparatus shown in DIAGRAM 2.

Stage 4 The mixture from Stage 3 is transferred to a separating funnel. This mixture consists of two layers, an aqueous layer and a layer containing impure 1-bromobutane. The two layers are separated.

Stage 5 The impure 1-bromobutane is washed with concentrated hydrochloric acid and the resulting two layers are separated.

(Question continues on next page)

Stage 6 The 1-bromobutane layer from Stage 5 is washed with sodium hydrogencarbonate solution, and any gas formed released.

Stage 7 The 1-bromobutane layer is collected in a conical flask and anhydrous solid calcium chloride is added.

Stage 8 The calcium chloride is filtered off and the filtrate is transferred to the apparatus shown in DIAGRAM 2. On heating, pure 1-bromobutane is collected. The sample is weighed and the yield of the product calculated.

Some information on 1-bromobutane, C_4H_9Br

Density = 1·3 g cm^{-3}

Immiscible with water

(Question continues on next page)

(a) Give the names of the practical techniques carried out using the apparatus shown in DIAGRAM 1 and DIAGRAM 2. (2 marks)

DIAGRAM 1

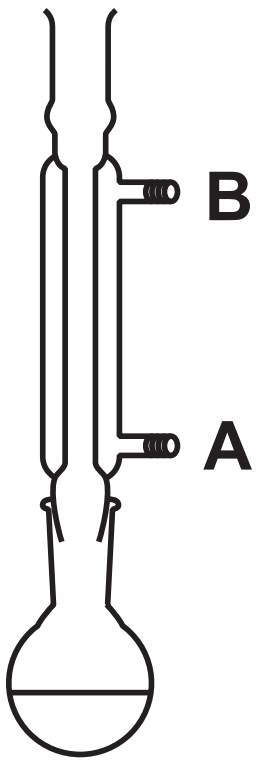


DIAGRAM 2

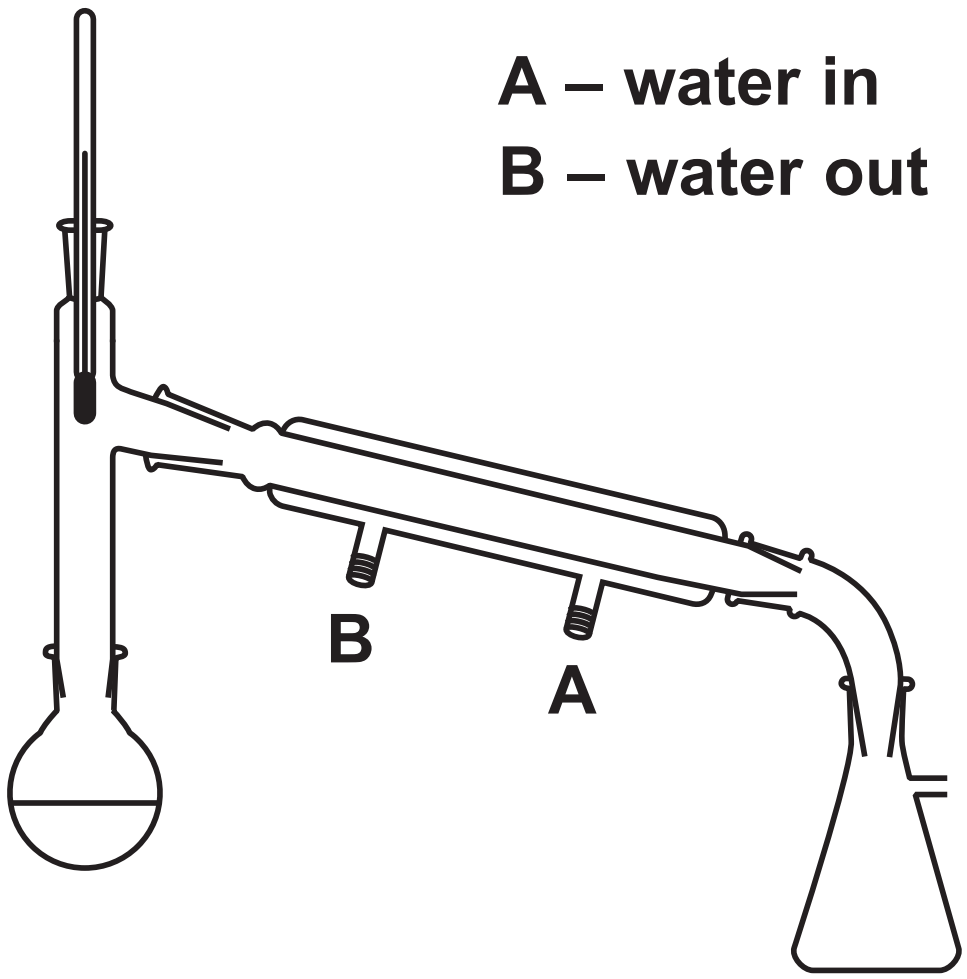


DIAGRAM 1:

DIAGRAM 2:

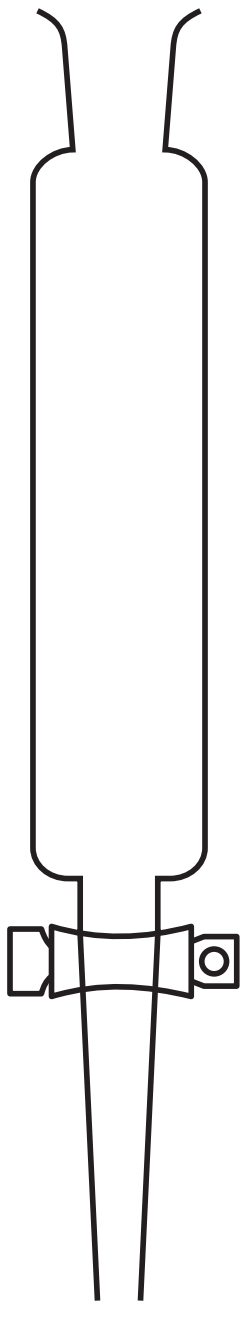
(Question continues on next page)

(b) (i) Describe, in terms of changes of state, what is happening when reagents are heated in the apparatus shown in DIAGRAM 1. (1 mark)

(ii) Explain why the reagents are heated in the apparatus shown in DIAGRAM 1 for such a long time. (1 mark)

(Question continues on next page)

(c) (i) On the diagram of the separating funnel used in Stage 4, show the 1-bromobutane and aqueous layers. Label each layer. (1 mark)



(Question continues on next page)

(ii) The product is washed with concentrated hydrochloric acid in Stage 5 to remove any unreacted butan-1-ol. The acid donates a proton to the butan-1-ol.
Suggest why this makes washing with acid more effective than washing with water.
(1 mark)

(iii) What is the purpose of adding anhydrous solid calcium chloride in Stage 7? (1 mark)

(Question continues on next page)

(iv) How can you tell when Stage 7 is complete? (1 mark)

(d) In a preparation, 14·80 g of butan-1-ol formed 17·81 g of 1-bromobutane.

(i) Calculate the volume of butan-1-ol, in cm^3, that is used in the reaction mixture. (1 mark)
The density of butan-1-ol is 0·810 g cm^{-3}.

(Question continues on next page)

(ii) Calculate the number of moles of butan-1-ol in 14·80 g. (1 mark)
[Molar mass of butan-1-ol = 74 g mol^{-1})

(iii) Calculate the mass of 1-bromobutane that would be formed if all the butan-1-ol is converted into 1-bromobutane. (1 mark)
[Molar mass of 1-bromobutane = 137 g mol^{-1})

(Question continues on next page)

(iv) Calculate the percentage yield of 1-bromobutane in this preparation. (1 mark)

(e) Suggest TWO reasons why the actual yield of 1-bromobutane was lower than the maximum theoretical yield. (2 marks)

Reason 1: _____

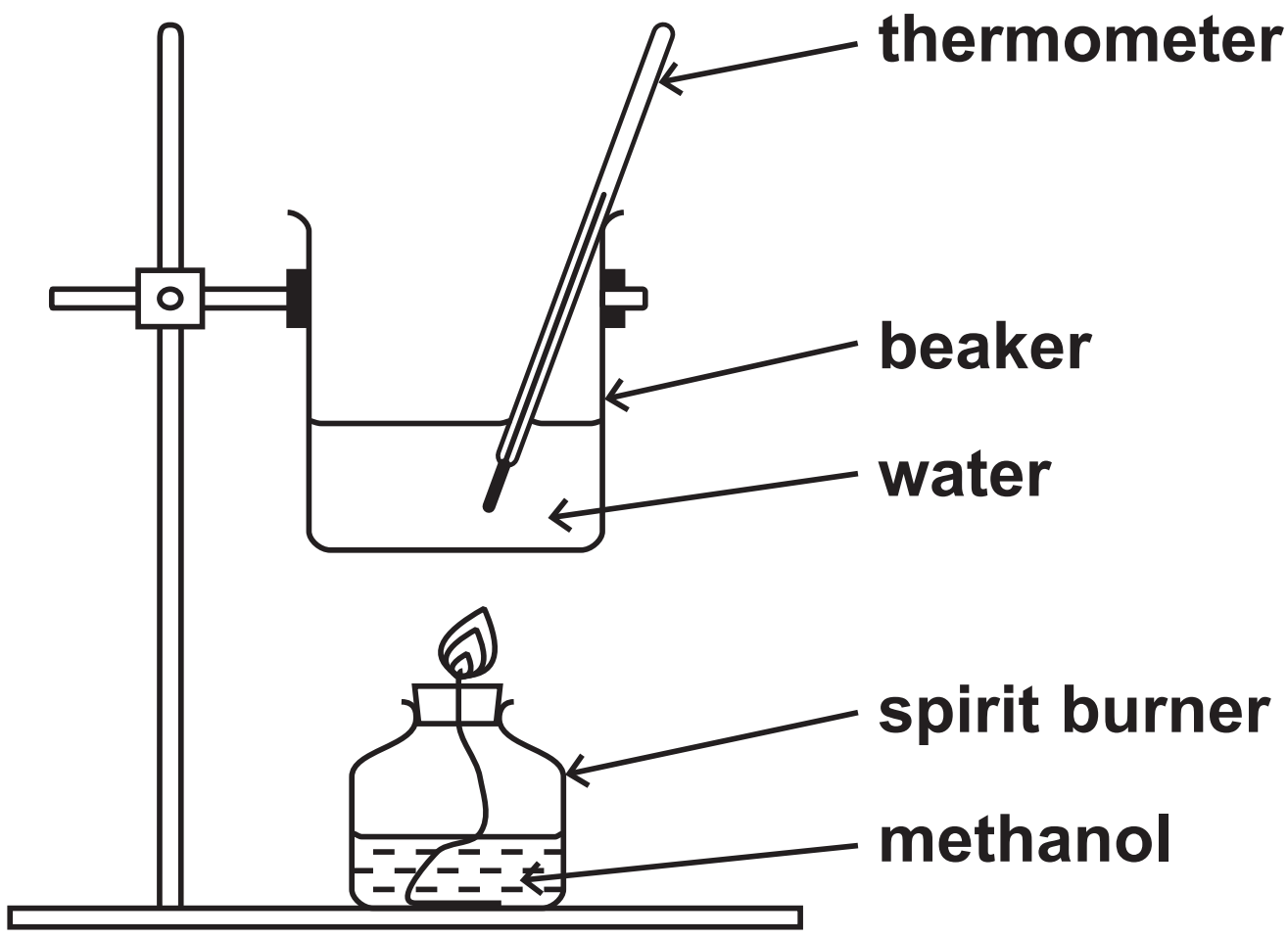
Reason 2: _____

(TOTAL FOR QUESTION 2 = 14 MARKS)

(Questions continue on next page)

3 A student carried out an experiment to determine the enthalpy change of combustion of methanol, CH_3OH.

DIAGRAM



(Question continues on next page)

RESULTS AND DATA

Name and formula of alcohol = methanol, CH_3OH

Molar mass of CH_3OH = 32·0 g mol^{-1}

Volume of water in beaker = 200 cm^3

Mass readings

Spirit burner + methanol before combustion = 173·75 g

Spirit burner + methanol after combustion = 172·66 g

Temperatures

Water before heating = 21·0 °C

Water after heating = 45·5 °C

Specific heat capacity of water = 4·18 J g^{-1} $°C^{-1}$

(a) What assumption about the water in the beaker allows the student to be able to state that the mass of water is 200 g? (1 mark)

(Question continues on next page)

(b) (i) Calculate the heat energy, in joules, gained by the water. (1 mark)

Use the expression

energy transferred (J) = mass of water × specific heat capacity of water × temperature rise

(ii) Calculate the number of moles of methanol burned in the experiment. (1 mark)

(Question continues on next page)

(iii) Hence calculate the enthalpy change of combustion of methanol.
Give your answer to a number of significant figures consistent with the data and readings in the table. Include a sign and units in your answer. (3 marks)

(Question continues on next page)

(c) (i) Each reading of the thermometer used in the experiment has an uncertainty of ±0·5 ^{o}C. Calculate the overall percentage uncertainty in the value of the temperature change in this experiment. (1 mark)

(ii) Calculate the MAXIMUM temperature CHANGE that could have been measured during this experiment, using this thermometer, which has an uncertainty of ±0·5 ^{o}C for each temperature reading. (1 mark)

(Question continues on next page)

(d) The student's evaluation of the experiment included the following points:

- My calculated value for the enthalpy change of combustion was less exothermic than the Data booklet value, mainly due to heat losses to the surroundings
- When I rechecked the mass of the spirit burner plus methanol after combustion, I noted that it had continued to lose mass, even when it was not being used
- At the end of the experiment, I noticed the formation of a black solid on the base of the beaker.

(i) Explain why the spirit burner continued to lose mass, even when not in use. (1 mark)

(ii) Suggest the identity of the black solid. (1 mark)

(Question continues on next page)

(iii) Explain how the formation of the black solid identified in (d)(ii) will lead to a less exothermic value for the enthalpy change of combustion. Do NOT refer to heat losses to the surroundings. (1 mark)

(TOTAL FOR QUESTION 3 = 11 MARKS)

(Questions continue on next page)

4 A student carried out an experiment to determine the concentration of ethanoic acid, CH_3COOH, in a sample of vinegar.

PROCEDURE

1. A 25·0 cm^3 sample of vinegar is transferred into a 250·0 cm^3 volumetric flask using a pipette fitted with a pipette filler. This solution is made up to the mark with distilled water and mixed thoroughly.
2. A pipette is used to transfer 25·0 cm^3 of the diluted solution into a conical flask.
3. A burette is filled with 0·100 mol dm^{-3} sodium hydroxide solution.
4. The diluted vinegar solution is titrated with the sodium hydroxide solution, using phenolphthalein as an indicator.

RESULTS

Number of titration	1	2	3
Burette reading (final) / cm^3	22·90	22·85	24·45
Burette reading (initial) / cm^3	0·00	0·00	1·50
Volume of NaOH used / cm^3	22·90	22·85	22·95
Used to calculate mean (✓)			

(Question continues on next page)

(a) (i) Show which titres are concordant by putting a tick (✓) in the appropriate boxes in the table of results and hence calculate the mean titre. (1 mark)

(ii) Calculate the number of moles of sodium hydroxide in the mean titre. (1 mark)

(Question continues on next page)

(iii) The equation for the reaction between ethanoic acid and sodium hydroxide is shown.

$$CH_3COOH(aq) + NaOH(aq) \longrightarrow CH_3COONa(aq) + H_2O(l)$$

Calculate the number of moles of ethanoic acid in the 25·0 cm^3 sample of UNDILUTED vinegar. Assume that no other acids are present in the vinegar. (2 marks)

(Question continues on next page)

(iv) **Calculate the concentration, in** $mol\ dm^{-3}$, **of the ethanoic acid in the sample of UNDILUTED vinegar. (1 mark)**

(v) **Calculate the concentration, in** $g\ dm^{-3}$, **of the ethanoic acid in the sample of UNDILUTED vinegar.**
Give your answer to THREE significant figures.
(3 marks)

(Question continues on next page)

(b) The pipette is rinsed out with the diluted vinegar just before use.

Explain why the pipette is rinsed.
Comment on why it is rinsed with diluted vinegar rather than distilled water. (2 marks)

(Question continues on next page)

(c) When making up the diluted solution of vinegar, another student noticed some vinegar remaining in the tip of the pipette. This student used the pipette filler to blow this vinegar into the volumetric flask before making up to the mark. State and explain the effect, if any, this would have on the mean titre in the experiment. (2 marks)

(TOTAL FOR QUESTION 4 = 12 MARKS)

TOTAL FOR PAPER = 50 MARKS

END