Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | Candidate Number

Chemistry

Advanced Subsidiary
Unit 3: Chemistry Laboratory Skills I

Tuesday 9 May 2017 – Afternoon
Time: 1 hour 15 minutes

Paper Reference
WCH03/01

Candidates must have: Scientific calculator

Total Marks

Instructions

- Use **black** ink or **black** 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.*

Information

- 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.
- A Periodic Table is printed on the back cover of this paper.

Advice

- 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.

Turn over ▶

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Pearson

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

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)

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)

Observation	Inferences
The glowing splint re-lit	The gas is .... The **formula** of **A** could be ....

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(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)

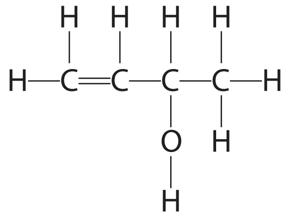
Observation	Inferences
Fizzing Limewater turned milky	The gas evolved is .... Therefore solution **B** contains ions with the **formula** ....

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

(2)

Observation	Inferences
A white precipitate formed	The precipitate is .... Solution **B** is ....

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



Complete the table by stating the observations you would expect to make when the tests described are carried out by a student.

(6)

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)

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

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

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.

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

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

(2)

Diagram 1

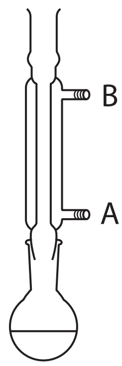


Diagram 2

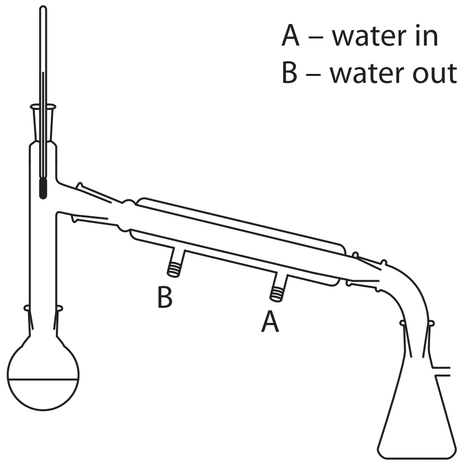


Diagram 1: ....

Diagram 2: ....

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

(1)

....

....

....

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

(1)

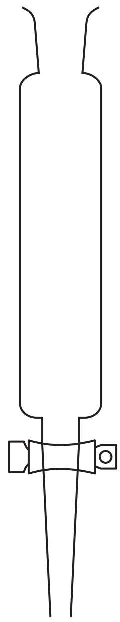
....

....

....

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

(1)



(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)

....

....

....

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

(1)

....

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

(1)

....

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P 4 8 3 8 4 A 0 8 2 0

(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.
The density of butan-1-ol is 0.810 g cm^{-3}.

(1)

(ii) Calculate the number of moles of butan-1-ol in 14.80 g.
[Molar mass of butan-1-ol = 74 g mol^{-1}]

(1)

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

(1)

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

(1)

(e) Suggest **two** reasons why the actual yield of 1-bromobutane was lower than the maximum theoretical yield.

(2)

Reason 1: ....

....

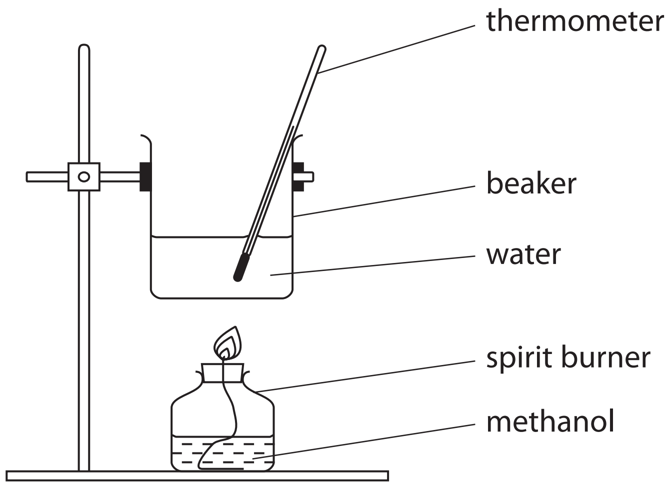
Reason 2: ....

....

(Total for Question 2 = 14 marks)

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

Diagram



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)

....

....

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

(1)

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)

(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)

(c) (i) Each reading of the thermometer used in the experiment has an uncertainty of ±0.5 °C. Calculate the overall percentage uncertainty in the value of the temperature change in this experiment.

(1)

(ii) Calculate the **maximum** temperature **change** that could have been measured during this experiment, using this thermometer, which has an uncertainty of ±0.5 °C for each temperature reading.

(1)

(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)

....

....

(ii) Suggest the identity of the black solid.

(1)

....

(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)

....

....

....

(Total for Question 3 = 11 marks)

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 (✓)			

(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)

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

(1)

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

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

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)

(iv) Calculate the concentration, in **mol dm^{-3}**, of the ethanoic acid in the sample of **undiluted** vinegar.

(1)

(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)

(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)

....

....

....

....

(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)

....

....

....

....

(Total for Question 4 = 12 marks)

TOTAL FOR PAPER = 50 MARKS

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The Periodic Table of Elements

Key

relative atomic mass **atomic symbol** name atomic (proton) number

1	2											3	4	5	6	7	0 (8)
							1.0 **H** hydrogen 1										*(18)* 4.0 **He** helium 2
(1)	*(2)*											*(13)*	*(14)*	*(15)*	*(16)*	*(17)*	
6.9 **Li** lithium 3	9.0 **Be** beryllium 4											10.8 **B** boron 5	12.0 **C** carbon 6	14.0 **N** nitrogen 7	16.0 **O** oxygen 8	19.0 **F** fluorine 9	20.2 **Ne** neon 10
23.0 **Na** sodium 11	24.3 **Mg** magnesium 12	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*	27.0 **Al** aluminium 13	28.1 **Si** silicon 14	31.0 **P** phosphorus 15	32.1 **S** sulfur 16	35.5 **Cl** chlorine 17	39.9 **Ar** argon 18
39.1 **K** potassium 19	40.1 **Ca** calcium 20	45.0 **Sc** scandium 21	47.9 **Ti** titanium 22	50.9 **V** vanadium 23	52.0 **Cr** chromium 24	54.9 **Mn** manganese 25	55.8 **Fe** iron 26	58.9 **Co** cobalt 27	58.7 **Ni** nickel 28	63.5 **Cu** copper 29	65.4 **Zn** zinc 30	69.7 **Ga** gallium 31	72.6 **Ge** germanium 32	74.9 **As** arsenic 33	79.0 **Se** selenium 34	79.9 **Br** bromine 35	83.8 **Kr** krypton 36
85.5 **Rb** rubidium 37	87.6 **Sr** strontium 38	88.9 **Y** yttrium 39	91.2 **Zr** zirconium 40	92.9 **Nb** niobium 41	95.9 **Mo** molybdenum 42	[98] **Tc** technetium 43	101.1 **Ru** ruthenium 44	102.9 **Rh** rhodium 45	106.4 **Pd** palladium 46	107.9 **Ag** silver 47	112.4 **Cd** cadmium 48	114.8 **In** indium 49	118.7 **Sn** tin 50	121.8 **Sb** antimony 51	127.6 **Te** tellurium 52	126.9 **I** iodine 53	131.3 **Xe** xenon 54
132.9 **Cs** caesium 55	137.3 **Ba** barium 56	138.9 **La*** lanthanum 57	178.5 **Hf** hafnium 72	180.9 **Ta** tantalum 73	183.8 **W** tungsten 74	186.2 **Re** rhenium 75	190.2 **Os** osmium 76	192.2 **Ir** iridium 77	195.1 **Pt** platinum 78	197.0 **Au** gold 79	200.6 **Hg** mercury 80	204.4 **Tl** thallium 81	207.2 **Pb** lead 82	209.0 **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

* Lanthanide series	140 **Ce** cerium 58	141 **Pr** praseodymium 59	144 **Nd** neodymium 60	[147] **Pm** promethium 61	150 **Sm** samarium 62	152 **Eu** europium 63	157 **Gd** gadolinium 64	159 **Tb** terbium 65	163 **Dy** dysprosium 66	165 **Ho** holmium 67	167 **Er** erbium 68	169 **Tm** thulium 69	173 **Yb** ytterbium 70	175 **Lu** lutetium 71
* Actinide series	232 **Th** thorium 90	[231] **Pa** protactinium 91	238 **U** uranium 92	[237] **Np** neptunium 93	[242] **Pu** plutonium 94	[243] **Am** americium 95	[247] **Cm** curium 96	[245] **Bk** berkelium 97	[251] **Cf** californium 98	[254] **Es** einsteinium 99	[253] **Fm** fermium 100	[256] **Md** mendelevium 101	[254] **No** nobelium 102	[257] **Lr** lawrencium 103