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

Wednesday 25 January 2017 – Morning
Time: 1 hour 15 minutes

Paper Reference
WCH03/01

Candidates may use a 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 ▶

6/6/5/6/1/1/

Pearson

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

1 A student carried out the tests described to distinguish between the pairs of compounds named in parts (a) to (d).

State what you would **see** when the test is carried out. Identify by name or formula any **gases** evolved during the reactions in parts (b) to (d).

(a) Solid potassium chloride and solid sodium chloride.

Test: A flame test.

(2)

Observation with potassium chloride ....

Observation with sodium chloride ....

(b) Aqueous potassium sulfate and aqueous potassium carbonate.

Test: Addition of excess dilute hydrochloric acid followed by aqueous barium chloride. Identify any **gas** evolved.

(2)

Observation with potassium sulfate ....

....

....

Observation with potassium carbonate ....

....

....

(c) Solid ammonium sulfate and solid potassium sulfate.

Test: Warm the solid with aqueous sodium hydroxide and use damp red litmus paper to test any gas released.
Identify any **gas** evolved.

(3)

Observation with ammonium sulfate ....

....

....

Observation with potassium sulfate ....

....

....

(d) Solid sodium chloride and solid sodium bromide.

Test: Add concentrated sulfuric acid.
Identify all of the **gases** evolved.

(4)

Observation with sodium chloride ....

....

....

....

Observation with sodium bromide ....

....

....

....

....

(Total for Question 1 = 11 marks)

2 A halogenoalkane, **G**, has the molecular formula C_4H_9X, where X represents a halogen atom.

On heating **G** with excess dilute aqueous sodium hydroxide, compound **G** is converted into compound **J**, $C_4H_{10}O$.

Complete the tables.

(a)

Test	Observation	Inference
To the solution remaining after heating **G** with excess dilute aqueous sodium hydroxide, add .... followed by aqueous silver nitrate.	White precipitate forms.	The **atom** X is ....

(2)

(b)

Test	Observation	Inference
Add phosphorus(V) chloride to pure **J**. Test any gas evolved with	White smoke	The **formula** of the white smoke is .... Compound **J** is an alcohol.

(2)

(c)

Test	Observation	Inference
Warm **J** with acidified potassium dichromate(VI) solution.	....	Compound **J** is not oxidised. Compound **J** is a .... alcohol.

(2)

(d) On the basis of the observations and inferences made in parts (a) to (c), draw the structure of compound **J**.

(1)

(Total for Question 2 = 7 marks)

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3 A student carried out two similar, separate experiments to determine the enthalpy changes for the reactions of sodium hydrogencarbonate and sodium carbonate with excess dilute hydrochloric acid.

(a) The first experiment was to find the enthalpy change ΔH_1 for the reaction

$$NaHCO_3(s) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l) + CO_2(g)$$

Results

Measurement	Value
Mass of solid sodium hydrogencarbonate added to hydrochloric acid	4.20 g
Volume of hydrochloric acid	50.0 cm^3
Initial temperature of hydrochloric acid before addition of solid sodium hydrogencarbonate	21.0 °C
Final temperature of solution	14.0 °C
Molar mass of sodium hydrogencarbonate	84.0 g mol^{-1}
Specific heat capacity of solution	4.18 J g^{-1} $°C^{-1}$

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(i) Calculate the number of moles of sodium hydrogencarbonate used in the experiment.

(1)

moles of $NaHCO_3$ = ... mol

(ii) Calculate the heat energy absorbed in the reaction between sodium hydrogencarbonate and hydrochloric acid.

Use the expression:

Energy absorbed (J) = 50.0 × specific heat capacity of solution × temperature change

(1)

energy absorbed = ... J

(iii) Calculate the value of ΔH_1.

Your answer should be in units of $kJ\,mol^{-1}$, expressed to **three** significant figures, and include a sign.

(3)

ΔH_1 = ... $kJ\,mol^{-1}$

(b) In the second experiment, the enthalpy change for the reaction between sodium carbonate and dilute hydrochloric acid was determined.

$$Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$$

The molar enthalpy change of this reaction ΔH_2 was found to be $-36.0\ kJ\ mol^{-1}$.

(i) Describe **two** ways in which the temperature change differs when equal numbers of moles of sodium hydrogencarbonate and sodium carbonate are reacted separately with the same volume of excess dilute hydrochloric acid.

(2)

First difference ....

....

Second difference ....

....

(ii) State **one** assumption that has been made when calculating the values of ΔH_1 and ΔH_2 from the experimental results.

(1)

....

....

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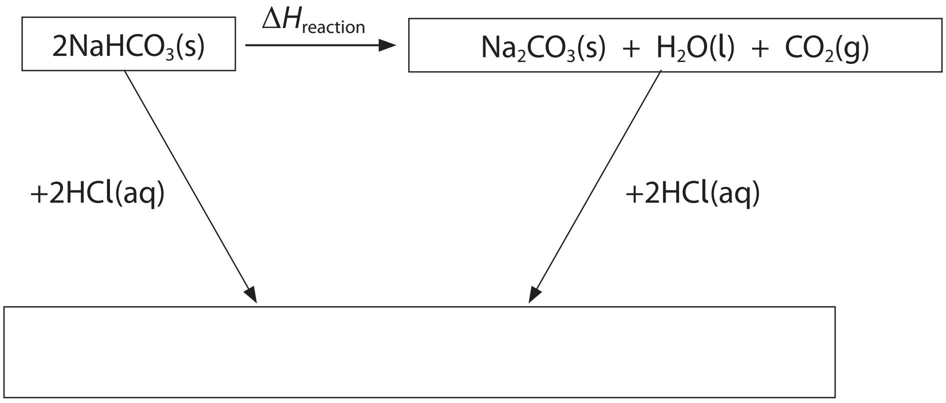
(c) The results of the experiments in parts (a) and (b) may be used to calculate the enthalpy change of reaction for the thermal decomposition of sodium hydrogencarbonate. The equation for the reaction is

$$2NaHCO_3(s) \rightarrow Na_2CO_3(s) + H_2O(l) + CO_2(g) \qquad \Delta H_{reaction}$$

(i) Complete the Hess cycle. Include state symbols with any formulae.

(2)



(ii) Using the Hess cycle, or otherwise, complete the expression for $\Delta H_{reaction}$ in terms of enthalpy changes ΔH_1 and ΔH_2.

(1)

$\Delta H_{reaction}$ =

(iii) Use your value for ΔH_1 calculated in part (a)(iii), the value of $\Delta H_2 = -36.0$ kJ mol^{-1} and your expression in (c)(ii), to calculate a value for $\Delta H_{reaction}$ in kJ mol^{-1}.

(1)

$\Delta H_{reaction}$ = ... kJ mol^{-1}

(Total for Question 3 = 12 marks)

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4 A titration is carried out to determine the concentration of a solution of sodium hydroxide, NaOH(aq), using the organic acid H_2Y.
The equation for the reaction is

$$H_2Y(aq) + 2NaOH(aq) \rightarrow Na_2Y(aq) + 2H_2O(l)$$

Sodium hydroxide solution is added from a burette to 25.0 cm^3 of a 0.0500 mol dm^{-3} solution of H_2Y, to which several drops of phenolphthalein have been added.

(a) State the colour change for the phenolphthalein indicator at the end-point of this titration.

(2)

From .... to ....

(b) A student obtained the readings shown.

Titration number	1	2	3
Burette reading (final) / cm^3	24.90	23.60	23.65
Burette reading (initial) / cm^3	1.00	0.00	0.15
Volume of NaOH used / cm^3	23.90	23.60	23.50
Used to calculate mean (✓)			

(i) Calculate the mean titre in cm^3.

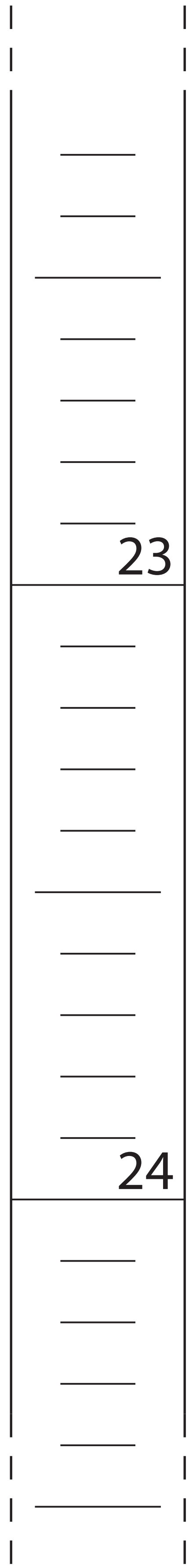
Show which titres you have used in your calculation by putting a tick (✓) in the appropriate boxes.

(2)

Mean titre = ... cm^3

(ii) On the diagram below, show how the level of the sodium hydroxide solution appears when the final burette reading of 23.65 cm^3 is recorded in titration 3.

(2)



(c) (i) Calculate the number of moles of the acid, H_2Y, in 25.0 cm^3 of a 0.0500 mol dm^{-3} solution.

(1)

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

(1)

(iii) Calculate the concentration of the sodium hydroxide solution in mol dm^{-3}.

(1)

(iv) Describe **two** things you would do when using a burette to ensure that a particular reading is as accurate as possible.

(2)

....

....

....

....

....

....

(Total for Question 4 = 11 marks)

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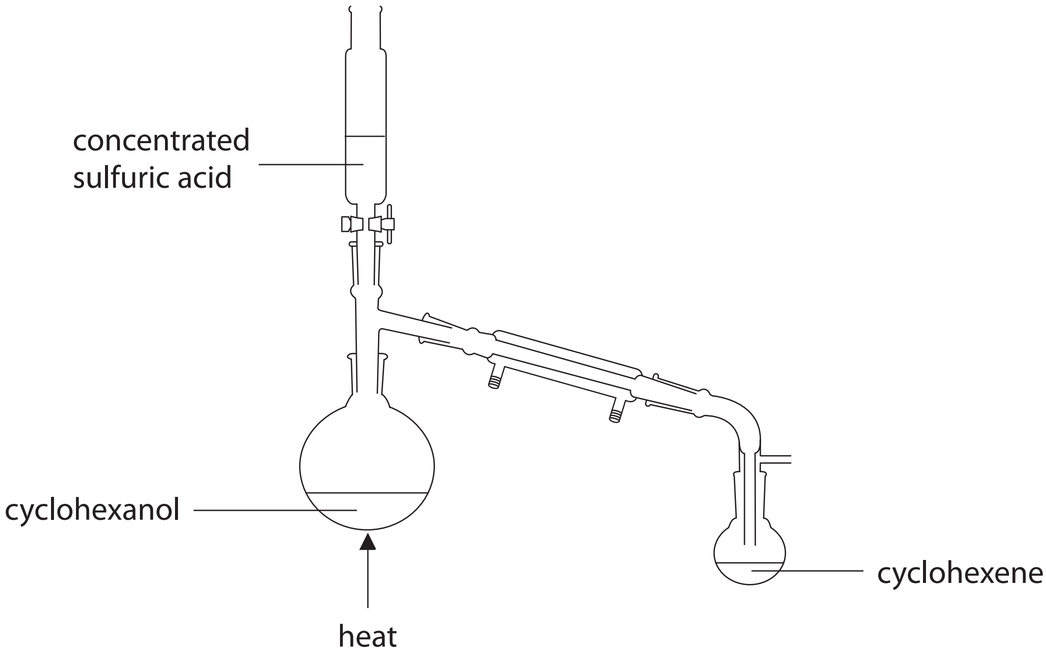
5 In an experiment to prepare cyclohexene, C_6H_{10}, concentrated sulfuric acid, H_2SO_4, was added slowly to 6.24 g of cyclohexanol, $C_6H_{11}OH$, in the apparatus shown in the diagram. The mixture was heated.



As the reaction took place, an impure liquid distilled over into the collection flask.

The equation for the preparation of cyclohexene is

$$C_6H_{11}OH \rightarrow C_6H_{10} + H_2O$$

(a) (i) Calculate the volume of cyclohexanol used in this experiment. The density of cyclohexanol is 0.962 g cm^{-3}.

(2)

(ii) Calculate the mass of cyclohexene that would be formed if **all** 6.24 g of cyclohexanol were converted into cyclohexene.

(2)

(iii) After purifying the liquid, 1.64 g of cyclohexene was collected. Calculate the percentage yield of cyclohexene in this preparation.

(1)

(b) The mixture in the collection flask contains impure cyclohexene, which is immiscible with water.

(i) Three steps, shown in the table below, are then carried out for the purposes shown.

Complete the table by identifying suitable substances for each step.

(3)

Step	Purpose of step	Suitable substance to use
1	To remove acidity	
2	To remove inorganic impurities	
3	To dry the product	

(ii) Identify the final step required in order to obtain pure cyclohexene from the dry product.

(1)

....

(Total for Question 5 = 9 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)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
							1.0 **H** hydrogen 1										4.0 **He** helium 2
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											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