Write your name here

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Edexcel GCE

Centre Number | Candidate Number

Chemistry

Advanced Subsidiary

Unit 3B: Chemistry Laboratory Skills I Alternative

Monday 23 May 2011 – Morning
Time: 1 hour 15 minutes

Paper Reference
6CH07/01

Candidates may use a calculator.

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.*

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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7/7/5/3/

P 3 7 6 8 2 A 0 1 1 6

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

1 A student carried out a series of tests on two solids, **X** and **Y**. In parts (a) and (b), complete the inference column in the tables using names or formulae.

(a)

(3)

	Test	Observation	Inference
(i)	Carry out a flame test on solid **X**.	Lilac flame.	Cation in **X** ....
(ii)	Dissolve solid **X** in water. Add dilute nitric acid followed by aqueous silver nitrate. Test any precipitate formed with **concentrated** ammonia solution.	Pale cream precipitate formed which dissolved in **concentrated** ammonia solution.	Anion in **X** ....
(iii)	Add a few drops of concentrated sulfuric acid to a small portion of solid **X**.	A red-brown gas **Z** was released which condensed to a red-brown liquid.	Identity of gas **Z** ....

(iv) Give the **formula** of solid **X**.

(1)

....

(b)

(3)

	Test	Observation	Inference
(i)	Warm a small quantity of solid **Y** with aqueous sodium hydroxide and test any gas evolved with damp red litmus paper.	Colourless gas evolved that turned damp red litmus paper blue.	Gas evolved .... Cation in **Y** ....
(ii)	Acidify a solution of **Y** with dilute hydrochloric acid and then add aqueous barium chloride.	White precipitate formed.	Anion in **Y** ....

(iii) Give the **formula** of solid **Y**.

(1)

....

(Total for Question 1 = 8 marks)

2 An organic liquid, **W**, has the structure

$$HOCH_2CH{=}CHCH_2OH$$

Complete the table by writing the observations you would expect to make when the following tests are carried out.

Test	Observation
Add **W**, drop by drop, to a small volume of bromine water and shake the mixture until there is no further change.	Colour change from .... to ....
Add phosphorus(V) chloride to **W**. Test any gas evolved with damp blue litmus paper.	....
Add aqueous potassium dichromate(VI), acidified with dilute sulfuric acid, to **W** and heat the mixture.	Colour change from .... to ....

(Total for Question 2 = 6 marks)

3 A titration was carried out in order to investigate the neutralization reaction shown below.

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$$

Procedure

1. Using a pipette, transfer 50.0 cm^3 of sodium hydroxide solution, concentration 1.00 mol dm^{-3}, to a polystyrene cup. Allow to stand for a few minutes.

2. Record the temperature of the solution.

3. From a burette, add 5.00 cm^3 of dilute hydrochloric acid to the solution in the cup.

4. Stir the mixture with the thermometer and record the temperature.

5. Add successive 5.00 cm^3 portions of hydrochloric acid, stirring the mixture and recording the temperature after each addition.

6. Continue adding hydrochloric acid until a total of 50.00 cm^3 of the acid has been added.

Results

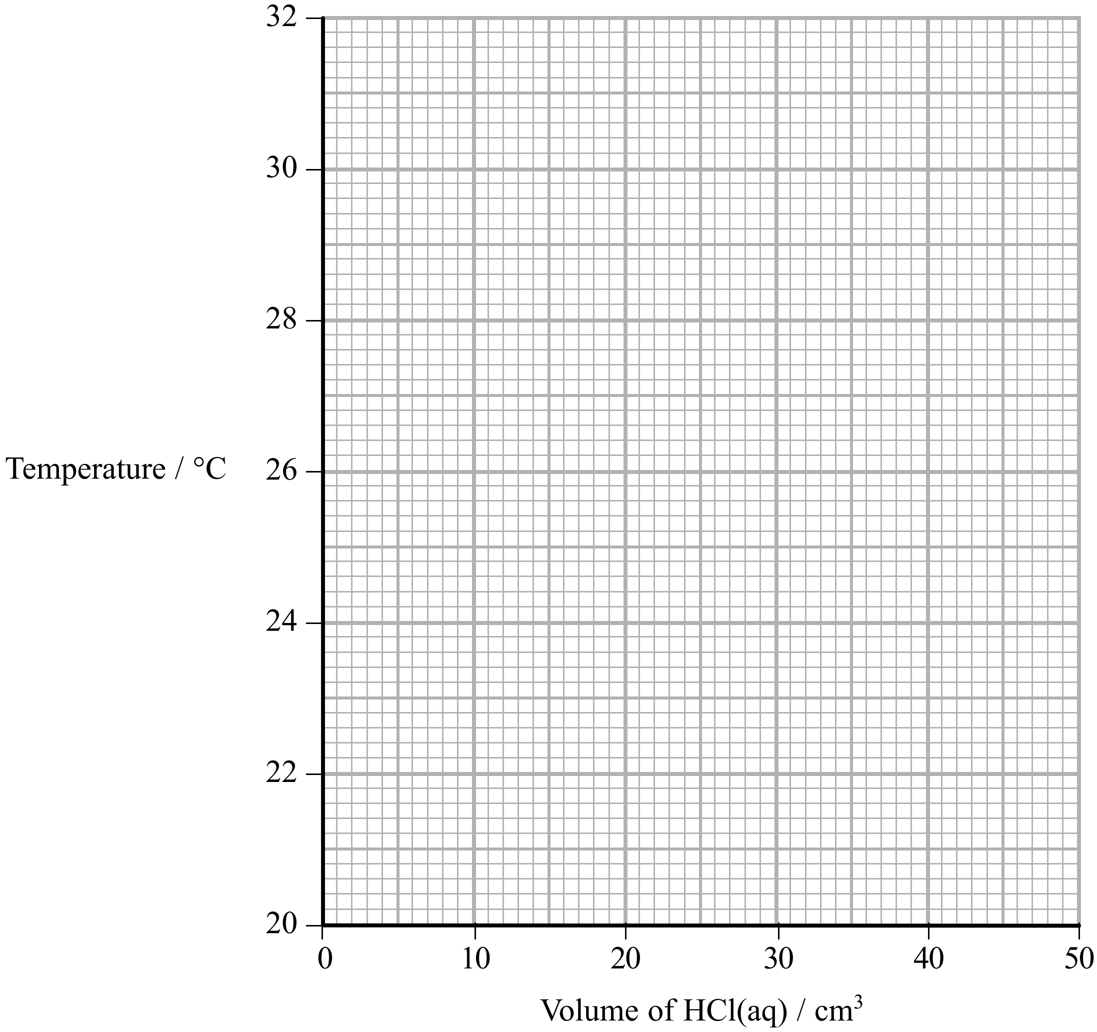
Volume of HCl(aq) added / cm^3	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
Temperature / °C	22.2	23.7	25.1	26.6	28.0	29.5	29.2	28.4	27.6	26.8	26.0

A graph of the temperature (*y*-axis) against the volume of hydrochloric acid added (*x*-axis) enables the maximum temperature rise and the volume of acid required for neutralization to be determined. From this information it is possible to calculate

- the concentration of the hydrochloric acid
- the enthalpy change for the reaction.

(a) (i) Plot a graph of temperature against volume of acid added on the axes below. Draw two straight lines on your graph and extrapolate the lines until they intersect.

(2)



(ii) Use the extrapolated lines on your graph to read off the maximum temperature reached in the neutralization reaction.

(2)

Maximum temperature .... °C

(iii) The point at which the two extrapolated lines meet corresponds to the volume of hydrochloric acid required for neutralization. Read off this volume from your graph.

(1)

Volume of hydrochloric acid .... cm^3

(iv) Calculate the number of moles of sodium hydroxide in 50.0 cm^3 of a 1.00 mol dm^{-3} solution.

(1)

(v) $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

Use this equation and your answers to (iii) and (iv) to calculate the concentration of the hydrochloric acid in mol dm^{-3}.

(2)

(b) (i) Use your graph and answer to (a)(ii) to calculate the maximum temperature **change**, ΔT, for the reaction.

(1)

ΔT = ... °C

(ii) Use your value for the temperature rise, ΔT, to calculate the heat energy produced when 50.0 cm^3 of sodium hydroxide is exactly neutralized by the volume of hydrochloric acid you obtained in (a)(iii).

Use the expression

energy produced (J) = total mass of solution × specific heat capacity of solution × temperature rise

[Assume the specific heat capacity of the solution to be 4.2 J g^{-1} $°C^{-1}$ and the density of the solution to be 1.0 g cm^{-3}]

(2)

(iii) Use your answers to (a)(iv) and (b)(ii) to calculate the enthalpy change, in kJ mol^{-1}, for this reaction.

Give your answer to **two** significant figures and include a sign.

(3)

ΔH = ... kJ mol^{-1}

(Total for Question 3 = 14 marks)

4 An experiment was carried out to determine the concentration of a solution of potassium iodate(V), KIO_3.

Procedure

1. From a large volume of a solution of potassium iodate(V), use a pipette to withdraw a 25.00 cm^3 sample and place the sample in a conical flask.

2. Add excess amounts of both potassium iodide solution and dilute sulfuric acid to the 25.00 cm^3 of potassium iodate(V) solution in the conical flask. The iodate(V) ions oxidize iodide ions to iodine, in acidic solution, as shown in Equation 1:

$$IO_3^- + 5I^- + 6H^+ \rightarrow 3I_2 + 3H_2O \qquad \textbf{(Equation 1)}$$

3. Titrate the iodine formed with a solution of sodium thiosulfate, $Na_2S_2O_3$, using starch as indicator.

$$I_2 + 2Na_2S_2O_3 \rightarrow 2NaI + Na_2S_4O_6 \qquad \textbf{(Equation 2)}$$

Results

Number of titration	1	2	3
Burette reading (final) / cm^3	25.10	26.35	24.10
Burette reading (initial) / cm^3	0.00	2.05	0.00
Volume of $Na_2S_2O_3$ used / cm^3	25.10	24.30	24.10

(a) (i) Which **two** titrations should be used to calculate the mean (average) titre? Explain your answer.

(2)

....

....

....

....

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

(1)

(iii) The sodium thiosulfate solution used in the titration has a concentration of 0.100 mol dm^{-3}. Calculate the number of moles of sodium thiosulfate in the mean titre.

(1)

(iv) Use **Equation 2** to calculate the number of moles of iodine, I_2, that reacted with the number of moles of sodium thiosulfate you have calculated in part (a)(iii).

(1)

(v) Use your answer to part (a)(iv) and **Equation 1** to calculate the number of moles of iodate(V) ions in 25.00 cm^3 of solution.

(1)

(vi) Use your answer to (a)(v) to calculate the concentration of the potassium iodate(V) solution, KIO_3, **in g dm^{-3}**.

[The molar mass of KIO_3 is 214 g mol^{-1}]

(2)

(b) (i) The error associated with reading the 25.00 cm^3 volume of the potassium iodate(V) solution in a pipette is ± 0.06 cm^3.

Calculate the percentage error associated with using a 25.00 cm^3 pipette.

(1)

(ii) Describe **two** things you could do to ensure that the burette readings are as accurate as possible. Assume that the burette has been appropriately rinsed and filled with the sodium thiosulfate solution.

(2)

1 ....

....

....

2 ....

....

....

(Total for Question 4 = 11 marks)

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5 An experiment was carried out to prepare iodoethane, CH_3CH_2I.

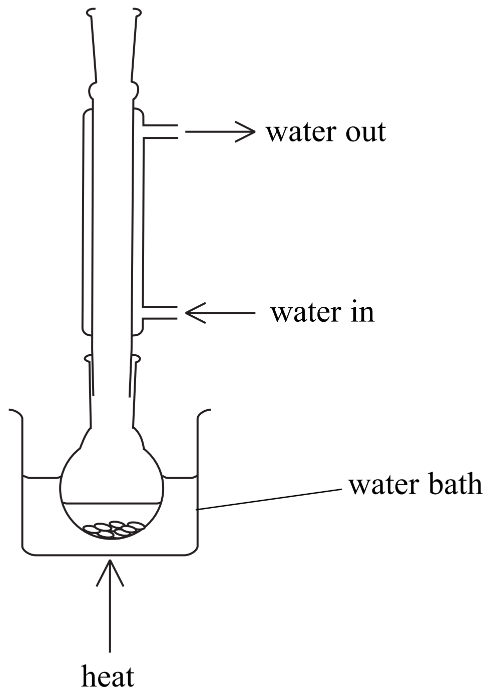
Procedure

1. Put some solid, moist red phosphorus into a flask.

2. Add ethanol to the flask.

3. Set up the apparatus as shown in diagram 1.

Diagram 1



4. Add 25.4 g of powdered iodine, in small portions, to the flask.

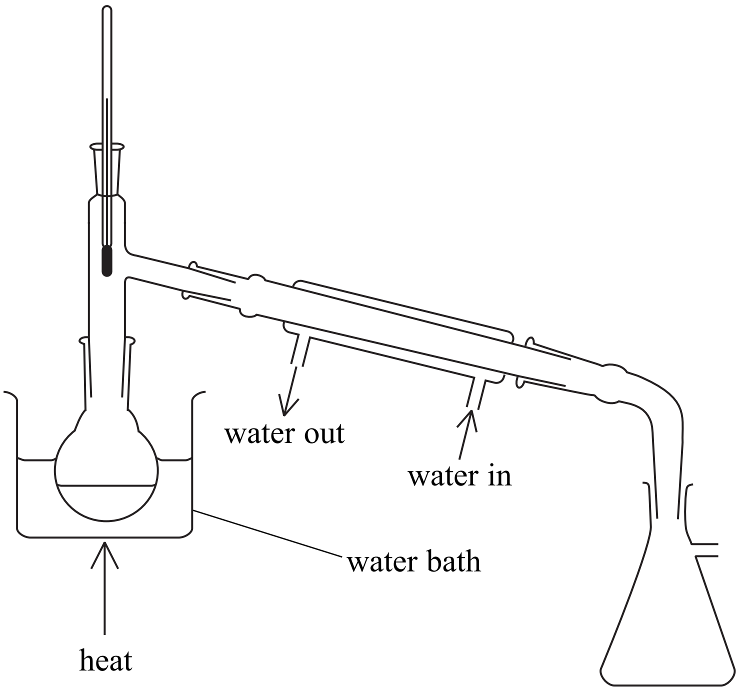
5. Before each addition, remove the condenser. Add the iodine and then immediately replace the condenser.

6. When all the iodine has been added, allow the flask to stand for 10 minutes and then heat the flask for one hour as shown in diagram 1.

7. Separate the iodoethane from the reaction mixture and dry it.

8. Finally, purify the iodoethane using the apparatus shown in diagram 2. Collect the iodoethane over a suitably narrow temperature range.

Diagram 2



Data

Name	Appearance	Flammability	Boiling temperature / °C
ethanol	colourless liquid	flammable	78
iodoethane	colourless liquid	flammable	72

Equations

$$2P + 3I_2 \rightarrow 2PI_3$$

$$3CH_3CH_2OH + PI_3 \rightarrow 3CH_3CH_2I + H_3PO_3$$

(a) (i) Identify the technique shown in each diagram.

(2)

Diagram 1 ....

Diagram 2 ....

(ii) Explain why a stopper should **not** be placed in the top of the condenser shown in diagram 1.

(1)

....

....

(b) (i) Give **one** reason why the iodine was added over a period of time and in small amounts.

(1)

....

....

(ii) Explain why water baths were used in both step 6 and step 8 rather than heating the flasks directly with a Bunsen flame.

(1)

....

....

....

(iii) Suggest the temperature range suitable for the collection of iodoethane shown in diagram 2.

(1)

From .... to .... °C

(c) (i) Calculate the number of moles of iodine, I_2, in 25.4 g of iodine.

Use the relative atomic mass of I = 127

(1)

(ii) In this reaction, 1 mol I_2 forms 2 mol CH_3CH_2I.

Calculate the maximum mass of iodoethane, in g, that could be formed from 25.4 g of iodine.

Use the following relative atomic masses: C = 12, H = 1, I = 127

(3)

(iii) In a preparation, the mass of iodoethane collected was 23.4 g.

Calculate the percentage yield in this preparation.

(1)

(Total for Question 5 = 11 marks)

TOTAL FOR PAPER = 50 MARKS

The Periodic Table of Elements

Key

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

1 (1)	2 (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	3 (13)	4 (14)	5 (15)	6 (16)	7 (17)	0 (8) (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