Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Chemistry

Advanced

Unit 6B: Chemistry Laboratory Skills II Alternative

Friday 14 May 2010 – Morning
Time: 1 hour 15 minutes

Paper Reference
6CH08/01

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

1 Compound **A** is a salt containing one cation and one anion. Complete the following table by filling in the **inferences** column.

	Test	Observations	Inferences	
(a)	Observe the appearance of **A**.	**A** is a yellow crystalline solid.		(1)
(b)	Carry out a flame test on **A**.	Persistent bright yellow flame colour.		(1)
(c)	Add 5 cm^3 of dilute sulfuric acid to 0.5 g of **A**.	**A** dissolves to form an orange solution.	Ions formed are	(1)
(d)	To the solution obtained in (c), add about 10 drops of ethanol and warm the mixture gently.	Orange solution turns green.		(2)
(e)	Divide the green solution from (d) into two equal portions. To one portion add sodium hydroxide solution a little at a time until in excess.	Green precipitate forms which dissolves in excess sodium hydroxide to form a green solution.	Green precipitate is .... Green ions formed in solution are	(2)

	Test	Observations	Inferences
(f)	To the second portion of the solution, add zinc powder.	The solution turns pale blue.	Pale blue ions formed are ..... Role of zinc ....
(g)	Filter the mixture formed in (f) to remove the excess zinc and then shake the filtrate vigorously.	The pale blue solution turns green.	Green ions formed are ..... Explanation ....

(2)

(2)

(Total for Question 1 = 11 marks)

2 **P** and **Q** are different organic compounds, each of which has **three** carbon atoms and only **one** functional group.

(a) Complete the table below by filling in the inferences column. In each case you should state what the test and observation tell you about the **original** compound **P**.

	Test	Observation	Inferences about compound **P**	
(i)	Add a small amount of dry phosphorus(V) chloride to 1 cm^3 of **P**.	Steamy fumes form which turn damp blue litmus paper red.		**(1)**
(ii)	Add about 2 cm^3 of sodium carbonate solution to 1 cm^3 of **P**.	No reaction occurs.		**(1)**
(iii)	Add about 2 cm^3 of sodium hydroxide solution to 10 drops of **P**. Then add a solution of iodine in potassium iodide, drop by drop, until the iodine is just in excess. Warm the mixture in a water bath.	A pale yellow precipitate with an antiseptic smell forms.		**(1)**

(iv) Use the information above to identify, by name or formula, the compound **P**.

(1)

(v) The mass spectrum of **P** has a peak at *m/e* = 45. Identify the species responsible for this peak and explain how this species is formed from **P**.

(2)

.....

.....

.....

.....

(b) Complete the table below by filling in the inferences column.

	Test	Observation	Inferences
(i)	Add a small amount of dry phosphorus(V) chloride to 1 cm^3 of **Q**.	Steamy fumes form which turn damp blue litmus paper red.	Steamy fumes are ....
(ii)	Add about 2 cm^3 of sodium carbonate solution to 1 cm^3 of **Q**.	Vigorous effervescence occurs and the gas evolved turns limewater milky.	Functional group in compound **Q** is ....

(1)

(1)

(iii) Use the information above to identify, by name or formula, the compound **Q**.

(1)

(Total for Question 2 = 9 marks)

3 The purity of a sample of iron from a blast furnace may be determined by titration. The iron is contaminated with carbon and calcium silicate.

A known mass of the impure iron is dissolved in dilute sulfuric acid to form a solution containing iron(II) ions. Portions of this solution are titrated with a solution of potassium manganate(VII) of known concentration.

The steps of the experimental procedure are as follows.

1. Approximately 1.5 g of a sample of the impure iron, in the form of a fine powder, was accurately weighed. The results are shown in **Table 1**.

2. The iron was transferred to a 250 cm^3 conical flask to which 50 cm^3 of dilute sulfuric acid (an excess) was added. The mixture was warmed to about 60 °C and then allowed to stand until the reaction was complete.

3. The mixture in step 2 was filtered and the residue was washed with a small volume of the dilute sulfuric acid.

4. All of the filtrate in step 3 was transferred to a 250 cm^3 volumetric flask. A further 50 cm^3 of the dilute sulfuric acid was added and then the volume was made up to the mark with distilled water. The resulting solution was mixed thoroughly.

5. 25.0 cm^3 portions of the solution in step 4 were transferred to clean conical flasks and titrated with a potassium manganate(VII) solution of concentration 0.0220 mol dm^{-3}. The results are shown in **Table 2**.

(a) Write an **ionic** equation for the reaction between iron and dilute sulfuric acid. State symbols are **not** required.

(1)

(b) How would you know when the reaction between the iron and the dilute sulfuric acid was complete?

(1)

.....

.....

(c) The results of the experiment are given in the tables below.

Table 1

Mass of weighing bottle + impure iron	11.22 g
Mass of empty weighing bottle	9.74 g
Mass of impure iron	1.48 g

Table 2

Solution in the burette: 0.0220 mol dm^{-3} potassium manganate(VII)
Solution in the flask: 25.00 cm^3 of solution containing iron(II) ions (step 5)

Titration number	Trial	1	2	3	4
Burette reading (final) / cm^3	30.00	23.10	24.80	24.45	23.20
Burette reading (initial) / cm^3	6.65	0.05	2.10	1.45	0.25
Titre / cm^3	23.35				
Titres used (✓or ×)	×				

(i) Complete **Table 2** by filling in the missing data. Then mark with a tick (✓) those titres that will be used in the calculation of the mean titre and mark with a cross (×) any titres that will be discarded.

(2)

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

(1)

(iii) The ionic half-equations for the reactions of the iron(II) ions and the manganate(VII) ions are given below.

$$Fe^{2+} \rightarrow Fe^{3+} + e^-$$

$$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$$

Calculate the mass of iron in the original sample of impure iron and hence calculate the percentage by mass of iron in the sample.

[The relative atomic mass of iron is 55.8]

(4)

(d) Name the pieces of apparatus used to measure the 25.0 cm^3 solution containing iron(II) ions in step 5 and the 50 cm^3 sulfuric acid in steps 2 and 4.

Explain why different apparatus is used in each case.

(2)

To measure 25.0 cm^3 of solution .....

To measure 50 cm^3 sulfuric acid .....

Explanation .....

.....

.....

.....

.....

(e) Suggest why it was necessary to add such a large excess of sulfuric acid.

(1)

.....

.....

.....

(f) State how you would detect the end-point of the titration.

(1)

.....

.....

(g) Explain why it is incorrect to use hydrochloric acid instead of sulfuric acid in this titration.

(2)

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.....

.....

(Total for Question 3 = 15 marks)

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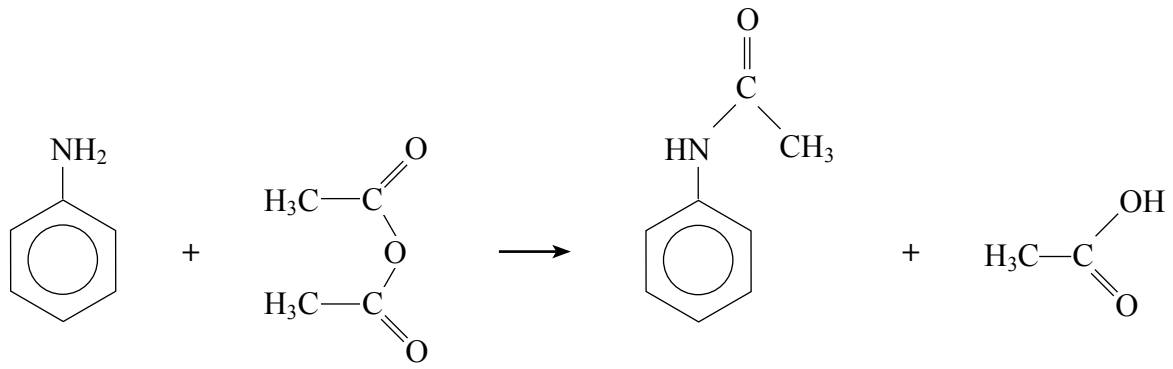
4 *N*-phenylethanamide may be prepared in the laboratory by reacting ethanoic anhydride with phenylamine; both the reactants and the products are flammable. The equation for the reaction is shown below.



***N*-phenylethanamide**

A student is asked to prepare pure *N*-phenylethanamide starting from 9.00 g of phenylamine.

(a) Calculate the minimum mass, in grams, of ethanoic anhydride required to react completely with 9.00 g of phenylamine.

[Molar masses / g mol^{-1}: $C_6H_5NH_2$ = 93.0; $CH_3COOCOCH_3$ = 102]

(2)

(b) **The steps of the experimental procedure are as follows.**

1. Mix the amount of ethanoic anhydride calculated in (a) with 10 g of glacial (pure) ethanoic acid in a round-bottom flask and add a further 1 g of the ethanoic anhydride.
2. Cool the flask from step 1 in a beaker of cold water and add 9.00 g of phenylamine, drop by drop, with gentle shaking.
3. Add anti-bumping granules and reflux the mixture from step 2 for 30 minutes.
4. Pour the liquid from the reflux flask into a beaker containing 100 cm^3 of distilled water and allow the mixture to stand until no more crystals are formed.
5. Filter the crystals under reduced pressure using a Buchner funnel and flask, washing the crystals with cold water.
6. Transfer the crystals to a boiling tube and dissolve them in the minimum volume of boiling water. Filter the hot solution using a glass filter funnel, cool the filtrate in a beaker of ice-cold water and filter the crystals formed using a Buchner funnel and flask.
7. Dry the crystals between filter papers and then by storing them in a desiccator.
8. Weigh the dry crystals and calculate the yield.

(i) Explain why, in step 1, the student is told to add a further 1 g of the ethanoic anhydride to the calculated mass so that it is in excess.

(1)

.....

.....

.....

(ii) Explain why, in step 2, the phenylamine is added drop by drop and the mixture immersed in cold water.

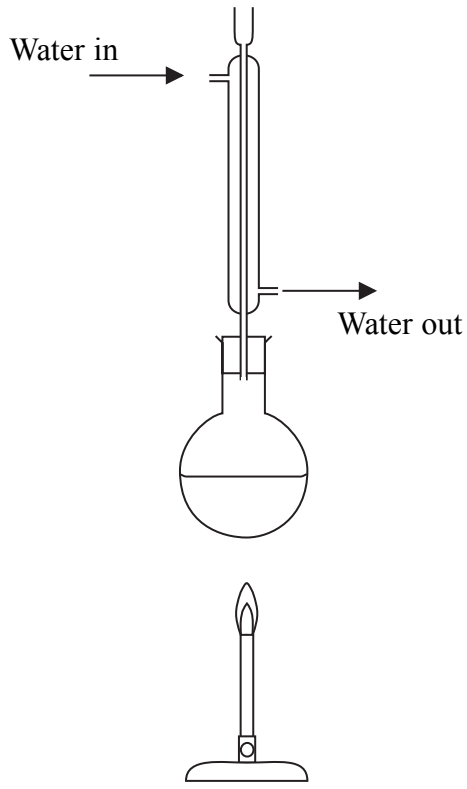
(1)

.....

.....

.....

(iii) The student set up the apparatus for the reflux (step 3) as shown in the diagram below.



The apparatus has been incorrectly set up in TWO ways. State and explain these mistakes and how they should be corrected. You may assume that the apparatus is suitably clamped and that the reaction mixture contains anti-bumping granules.

(4)

(iv) Draw a labelled diagram of a Buchner funnel and flask (step 5).

State how the reduced pressure is achieved (an explanation of this is **not** required).

(3)

Diagram

Reduced pressure is achieved by .....

.....

.....

(c) A student obtained 7.49 g of *N*-phenylethanamide from 9.00 g of phenylamine. Calculate the percentage yield.

[Molar masses / g mol^{-1}: $C_6H_5NH_2$ = 93.0; $C_6H_5NHCOCH_3$ = 135]

(2)

(d) Yields of less than 100% are often explained as being due to '**transfer losses**'.

Explain this term by referring to the recrystallization of *N*-phenylethanamide in steps 6 and 7.

(1)

(e) Another student reported a yield of greater than 100%. Assuming that the student used the correct amounts of reagents and carried out the calculation correctly, suggest a reason for this result.

(1)

(Total for Question 4 = 15 marks)

TOTAL FOR PAPER = 50 MARKS

The Periodic Table of Elements

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							

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

Elements with atomic numbers 112-116 have been reported but not fully authenticated

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
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

* Lanthanide series

* Actinide series

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Mark Scheme (Results)
June 2010

GCE

GCE Chemistry (6CH07/01)

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Summer 2010

Publications Code US023643

Question Number	Acceptable Answers	Reject	Mark
1 (a)(i)	Nichrome wire / platinum wire / ceramic / silica rod **(1)** Accept recognisable spelling eg platinium, nickrome (Concentrated /dilute) hydrochloric acid/HCl/HCl(aq)/ solution **(1)** Salt (mixed with wire and acid, and) placed in a hot/blue/roaring/non-luminous/Bunsen/Bunsen burner **flame (1)**	Titanium, aluminium, nickel, chromium, copper, silicon Salt placed in Bunsen burner OR flame alone OR burn it	**3**

Question Number	Acceptable Answers	Reject	Mark
1 (a)(ii)	Li^+ Accept li^+/ Li^+ ions/ A is Li^+ Ignore (aq), (s), (l), (g)	Li, Li^{2+},Ca, Sr, Rb Ca^{2+}, Sr^{2+}, Rb^+ Lithium/ lithium ions	**1**

Question Number	Acceptable Answers	Reject	Mark
1 (b)(i)	Calcium hydroxide/$Ca(OH)_2$ / slaked lime Accept calcium oxide/CaO / quicklime Ignore (aq) / solution / (s) / solid	Calcium/Ca CO_2/$CaCO_3$	**1**

Question Number	Acceptable Answers	Reject	Mark
1 (b)(ii)	CO_3^{2-} / HCO_3^- **(1)** Ignore separated additional cation **Carbon dioxide** gas given off (when this carbonate /hydrogencarbonate is heated/decomposed) **(1)** Second mark depends on a recognisable carbonate/hydrogencarbonate ie CO_3, CO_3^-, carbonate, hydrogencarbonate Li_2CO_3, $LiHCO_3$, $CaCO_3$ etc	CO_3, CO_3^-, carbonate, hydrogencarbonate Li_2CO_3, $LiHCO_3$, $CaCO_3$ etc	**2**

Question Number	Acceptable Answers	Reject	Mark
1 (c)(i)	Oxide / O^{2-}	Oxygen, O_2, O, O^- calcium oxide / CaO	**1**

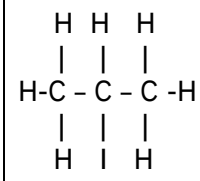
Question Number	Acceptable Answers	Reject	Mark
1 (c)(ii)	Hydroxide / OH^-/$(OH^-)_2$	$(OH)_2^-$	**1**

Question Number	Acceptable Answers	Reject	Mark
1 (c)(iii)	Mark with reference to (ii) For correct answer to (ii) Universal indicator (paper) **(1)** Turns blue/purple/pH12-14 **(1)** Accept other appropriate indicators eg (red) litmus (paper) turns blue OR Add a suitable metal ion solution **(1)** to give a correct colour of precipitate **(1)** [see User Guide 2 page 17 for some details] OR **Warm / heat** with ammonium ions **(1)** Alkaline gas given off/damp red litmus turns blue/ammonia gas given off **(1)** OR Other reasonable tests with results eg Titrate with hydrochloric acid and suitable indicator with correct final colour If incorrect answer to (ii) but answer as above (1) max If incorrect answer to (ii) with correct test and correct result for that ion (1) max		**2**

Question Number	Acceptable Answers	Reject	Mark
1 (d)	Li_2CO_3 Accept $Li_2(CO_3)$ OR $LiHCO_3$ Accept correct formula of any red flame coloured s block metal carbonate/hydrogencarbonate eg Rb_2CO_3, $CaCO_3$, $SrCO_3$	$LiCO_3$	**1**

Question Number	Acceptable Answers	Reject	Mark
2 (a)(i)	Silver((I))iodide (solid / precipitate) / AgI / Ag^+I^- /AgI(s) OR Silver((I))iodide (solid / precipitate) and AgI / Ag^+I^- /AgI(s)	Iodide (alone) Iodine Silver ((I)) iodine AgBr and AgI $Cl^-/Br^-/I^-$ If both name and formula are given and either is wrong eg Silver((I)) Iodine and AgI	**1**

Question Number	Acceptable Answers	Reject	Mark
2 (a)(ii)	**C_3H_7I** (in any order) Accept additional information like additional formulae	Any answer which does not have **C_3H_7I** somewhere	**1**

Question Number	Acceptable Answers	Reject	Mark
2 (a)(iii)	 Accept structural formula CH_3CHICH_3	Displayed or structural formula for 1-iodopropane	**1**

Question Number	Acceptable Answers	Reject	Mark
2 (a)(iv)	At first ignore answer to (iii) Propan-2-ol / 2-propanol / $CH_3CH(OH)CH_3$ Accept displayed formula (allow slightly displaced bonds C) | HO Accept skeletal formula Allow TE from (a)(iii) eg 1-iodopropane forms propan-1-ol	 Propanol prop-1-ol C_3H_7OH	**1**

Question Number	Acceptable Answers	Reject	Mark
2 (b)(i)	Mark colours independently From orange **(1)** To green/blue **(1)** Accept shades of green eg dark green, muddy green, green-brown	 yellow	**2**

Question Number	Acceptable Answers	Reject	Mark
2 (b)(ii)	Propanone Accept propan-2-one Allow propanal/propanoic acid if TE from **(a)(iv)**	prop((-2-))one	**1**

Question Number	Acceptable Answers	Reject	Mark
2 (b)(iii)	Oxidation / redox / oxidation and reduction / oxidation of … (eg alcohol)	Reduction Condensation/ substitution/ Addition	**1**

Question Number	Acceptable Answers	Reject	Mark
3 (a)(i)	(Glass/graduated/volumetric/bulb)pipette (and pipette filler) Accept any recognisable spelling of pipette eg pipet, pipette etc	Burette/ pipette and burette/ measuring cylinder/ teat pipette/ dropping pipette Pipate/pipotte	**1**

Question Number	Acceptable Answers	Reject	Mark
3 (a)(ii)	Starch (solution) **(1)** Accept startch Blue-black/blue/black to colourless **(1)** Accept purple/blue-black to colourless **Second mark depends on first**	Other indicators eg Methyl orange /phenolph-thalein Colourless to blue-black/blue/ black	**2**

Question Number	Acceptable Answers	Reject	Mark
3 (b)(i)	14.5(0), 13.7(0), 13.75 All three needed for the mark		**1**

Question Number	Acceptable Answers	Reject	Mark
3 (b)(ii)	The first result is discarded/ ignored/ not included/a range finder OR Only use last two values OR The second and third are concordant / first value not within 0.2 cm^3 Accept: This is the average of the second and third runs OR Actual correct average calculation to give 13.73/13.725		**1**

Question Number	Acceptable Answers	Reject	Mark
3 (b)(iii)	$\frac{13.73 \times 0.0200}{1000} = 2.746 \times 10^{-4}$ /0.0002746(mol) Accept $2.7/2.75 \times 10^{-4}$ Note that 13.725 gives 2.745×10^{-4} Allow TE from different calculated average titre	1 sf	**1**

Question Number	Acceptable Answers	Reject	Mark
3 (c)	1.373×10^{-4} /0.0001373(mol) Also $1.35/1.37/1.375/1.4 \times 10^{-4}$ Accept answer to $\frac{\text{(b)(iii)}}{2}$	1 sf (unless already penalised anywhere in this question)	**1**

Question Number	Acceptable Answers	Reject	Mark
3 (d)	4.58×10^{-5} /0.0000458(mol) 4.57667/4.577 x 10^{-5} etc Also 4.583/4.57/4.6(0) x 10^{-5} Accept answer to $\frac{(c)}{3}$	1 sf (unless already penalised anywhere in this question)	**1**

Question Number	Acceptable Answers	Reject	Mark
3 (e)(i)	Volumetric/graduated (flask)	($100\ cm^3$) round bottomed flask/ conical flask/ measuring cylinder	**1**

Question Number	Acceptable Answers	Reject	Mark
3 (e)(ii)	These marks are independent of flask used in (i) Transfer solution and rinsings/washings **(1)** Make up to the mark **(1)** Mixing / inverting / shaking (this must be at the end) **(1)**	Make sure it is all transferred	**3**

Question Number	Acceptable Answers	Reject	Mark
3 (e)(iii)	4.58×10^{-4} /0.000458 (mol) Also 4.57/4.6 x 10^{-4} Accept Answer to (d) x 10	1 sf (unless already penalised anywhere in this question)	**1**

Question Number	Acceptable Answers	Reject	Mark
3 (e)(iv)	$4.58 \times 10^{-4} \times 214$ = 0.098 /0.98012 g Also 0.097941/0.0979 etc Accept answer to (e)(iii) x 214 Ignore SF	1 sf (unless already penalised anywhere in this question)	**1**

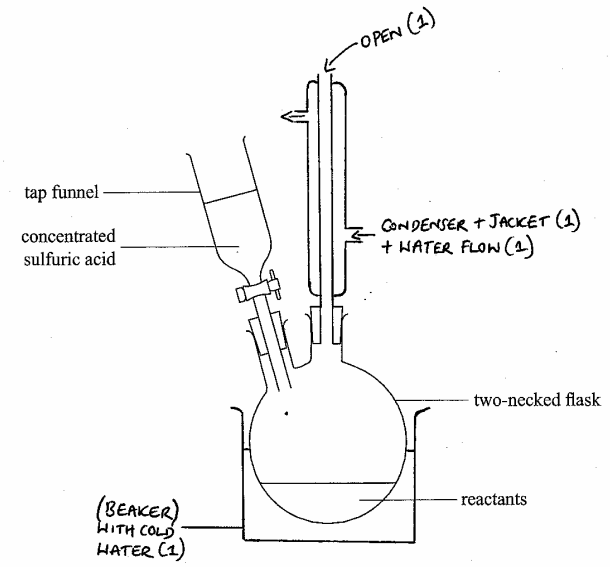
Question Number	Acceptable Answers	Reject	Mark
3 (e)(v)	$\frac{0.098}{0.10} \times 100$ = 98 /98.0/98.01/98.012 % Also 97.941/97.94/97.9 % Accept answer to $\frac{\text{(e)(iii)}}{0.10} \times 100$ correct answer with no working scores **(1)** Ignore SF	1 sf (unless already penalised anywhere in this question)	**1**

Question Number	Acceptable Answers	Reject	Mark
3 (f)	Sulfuric acid is corrosive/irritant/irritable/burns (skin)	Sulfuric acid is harmful/ hazardous/ toxic	**1**

Question Number	Acceptable Answers	Reject	Mark
4 (a)(i)	From the equation 1 mol butan-1-ol gives 1 mol of 1-bromobutane / ratio 1:1 OWTTE **(1)** As 80% yield, 0.125 mol of butan-1-ol gives 0.125 x 0.8 mol = 0.1 mol of 1-brombutane **(1)** Accept any clear indication that they appreciate the proportion calculation and the mole ratio Examples: Number of moles of butan-1-ol = $0.1 \times \frac{100}{80} / \frac{0.1}{0.8}$ (= 0.125) OR Number of moles of 1-bromobutane = $\frac{80}{100} \times 0.125$ (= 0.1) In both these examples 'butan-1-ol'/ '1-bromobutane' as appropriate, must be present to gain **(2)** The numerical expression alone would gain **(1)** OR As above examples but additionally using molar masses to calculate masses		**2**

Question Number	Acceptable Answers	Reject	Mark
4 (a)(ii)	74 x 0.125 **(1)** = 9.25 (g) $\frac{9.25}{0.81}$ = 11.4 /11.42/11.420/11.419753 cm^3 **(1)** ie ignore sf unless only one Accept 11.4 /11.42/11.420/11.419753 cm^3 **(2)** (with no working)	1sf	**2**

Question Number	Acceptable Answers	Reject	Mark
4 (a)(iii)	0.125 x 119 = 14.875 /14.87/14.88/14.9/15 (g)	1 sf	**1**

Question Number	Acceptable Answers	Reject	Mark
4 (b)	Flask **in** beaker of labelled cold water **(1)** Water need not be drawn in but… Condenser with jacket **(1)** Need not be labelled, can be at any angle so long as it goes upwards Condenser inlet and outlet with correct water direction **(1)** This mark can be given if no jacket is present open at top **and** no leaks**(1)** This mark is conditional on a condenser **Do not penalise** accidental closures in drawing or attempts to draw out perimeter of apparatus making the condenser appear closed If distillation set up is drawn the beaker of cold water mark can be awarded  	heated beaker (of cold water) stopper in the top/tap funnel in the top of the condenser unless clearly open	**4**

Question Number	Acceptable Answers	Reject	Mark
4 (c)(i)	Lower layer as more dense Lower layer is 1-bromobutane because it is dense**r** Lower layer as denser than water / butan-1-ol		**1**

Question Number	Acceptable Answers	Reject	Mark
4 (c)(ii)	To remove / neutralize / react with remaining hydrochloric acid/HCl/acid/sulfuric acid/H_2SO_4 **(1)** by reacting to form **carbon dioxide** (gas) **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
4 (d)(i)	Distillation /fractional distillation /redistil /distil /distillate Accept any recognisable spelling Ignore further description Allow a description which includes the words heating / boiling followed by condensing	Dry/filter/or anything else	**1**

Question Number	Acceptable Answers	Reject	Mark
4 (d)(ii)	Measure boiling temperature of liquid {and compare with Data Book value (101.7 ^oC) (Pure if it agrees)} OR Boils at boiling temperature of liquid/ 101.7 ^oC / boils over a very small temperature range/ boils at one particular temperature OR Collect the product at 101.7 ^oC/ between 100 and 103 ^oC		**1**

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Edexcel GCE

Centre Number	Candidate Number

Chemistry

Advanced
Unit 6B: Chemistry Laboratory Skills II
Alternative

Tuesday 7 June 2011 – Morning
Time: 1 hour 15 minutes

Paper Reference
6CH08/01

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 ▶

P38481A

7/7/5/2/

P 3 8 4 8 1 A 0 1 1 2

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

1 Solid **W** is a blue salt containing a transition metal complex cation and one anion.

(a) Give the formulae of **two** different transition metal ions which can form blue complex cations.

(2)

.....

(b) Complete the following table.

	Test	Observation	Inference(s)	
(i)	Heat compound **W**.	.....	Water	**(1)**
(ii)	Test any gas evolved with moist red litmus paper.	Red litmus paper turns blue	.....	**(1)**

(iii) Suggest **two** sources of the water which was given off when a pure dry sample of **W** was heated.

(2)

.....

.....

(c) The following tests are carried out on **separate** portions of an aqueous solution of **W**.

Complete the table.

Note: in the third column, the **formula** of the ion, molecule or compound giving rise to the observation is required.

	Test	Observation	**Formula**	
(i)	Add concentrated hydrochloric acid slowly,	..... -coloured precipitate	$Cu(OH)_2$	**(1)**
	until in excess.	green-yellow solution	.....	**(1)**
(ii)	Acidify with dilute hydrochloric acid and then add barium chloride solution.	white precipitate	.....	**(1)**
(iii)	Add dilute sulfuric acid until the solution is pale blue; then add potassium iodide solution.	white precipitate	.....	**(1)**
		in a brown solution	.....	**(1)**

(d) Suggest the **formula** of the complex cation in an aqueous solution of compound **W**.

(1)

.....

(Total for Question 1 = 12 marks)

2 The tertiary halogenoalkane 2-chloro-2-methylpropane reacts with hydroxide ions in solution as follows:

$$(CH_3)_3CCl + OH^- \rightarrow (CH_3)_3COH + Cl^-$$

The progress of the reaction can be followed by titrating the reaction mixture with a solution of hydrochloric acid of known concentration.

In an experiment designed to determine the order of the reaction, the following procedure was used.

1. 250 cm^3 of an ethanolic solution of 2-chloro-2-methylpropane, of concentration 0.100 mol dm^{-3}, was placed in a flask in a water bath at 25 °C. 250 cm^3 of aqueous sodium hydroxide solution, also of concentration 0.100 mol dm^{-3}, was placed in a similar flask in the same water bath. The temperature of the solutions was allowed to reach 25 °C.
2. A series of conical flasks were prepared, each containing about 40 cm^3 of propanone.
3. The reaction was started by mixing the halogenoalkane solution and the sodium hydroxide solution in a large flask in the water bath. A clock was started as the solutions were mixed.
4. At intervals, a 25 cm^3 pipette was used to withdraw samples of the reaction mixture. Each sample was added to a flask containing propanone and the time was noted. The propanone slows but does not completely stop the reaction.
5. Each sample was titrated immediately with a solution of hydrochloric acid of concentration 0.0500 mol dm^{-3}, using methyl orange as the indicator.

(a) (i) What colour change would you see at the end point of the titration?

(1)

.....

(ii) Explain why it is necessary to titrate the samples **immediately** after they have been withdrawn from the reaction mixture. State the effect, if any, on the titre if this were not done.

(2)

.....

.....

.....

(b) Suggest why it is necessary to use a solvent of aqueous ethanol rather than water alone for this reaction.

(1)

.....

.....

.....

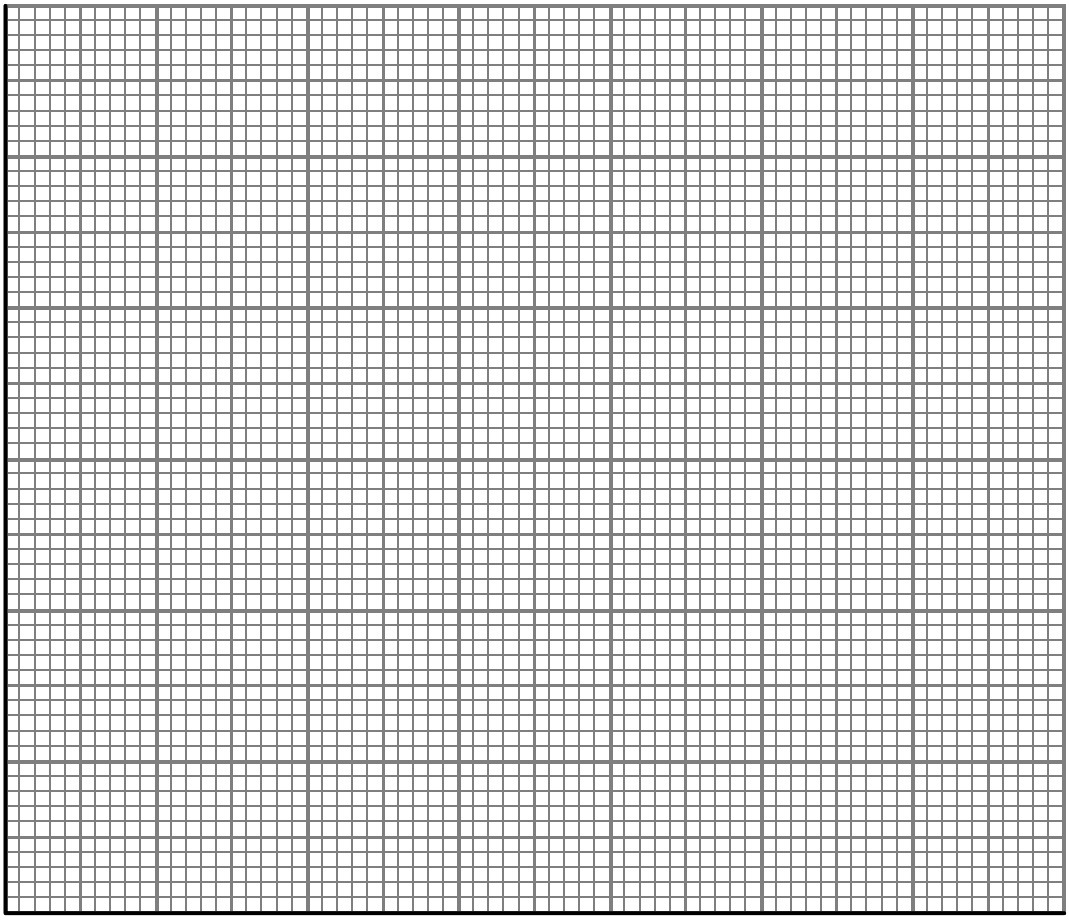
(c) In an experiment which was carried out as described above, the following data were obtained.

Time/min	1	5	12	20	32	49	65
Volume of HCl/cm^3	25.5	22.5	18.5	15.5	11.5	8.0	5.5

(i) Using the axes below, plot a suitable graph of these data.

(2)

Volume of HCl/cm^3



Time/min

(ii) Show **two** successive half-life measurements on your graph and write their values below.

(2)

First half-life .....

Second half-life .....

(iii) Explain how your answers to (ii) show that this reaction is first order.

(1)

.....

.....

(iv) Give the units of the rate constant for this reaction.

(1)

.....

(v) Because the initial concentrations of the reactants are the same, it is not possible to tell whether the rate equation is of the form

$$\text{rate} = k[(CH_3)_3CCl]$$

or of the form $\text{rate} = k[OH^-]$

Suggest a further experiment which could be carried out to show that it is in fact first order with respect to the halogenoalkane.

(2)

.....

.....

.....

(d) In a further experiment to investigate the hydrolysis, a solution of 2-chloro-2-methylpropane in aqueous ethanol was prepared at room temperature. The pH of this solution was measured at intervals using narrow-range pH paper. The reaction occurring is

$$(CH_3)_3CCl + H_2O \rightarrow (CH_3)_3COH + H^+ + Cl^-$$

(i) Suggest what the initial pH of the mixture would be. Justify your answer.

(1)

.....

.....

(ii) The pH rapidly falls to 2 or lower. Explain why this confirms that the rate of the hydrolysis of 2-chloro-2-methylpropane is independent of the hydroxide ion concentration in the reaction

$$(CH_3)_3CCl + OH^- \rightarrow (CH_3)_3COH + Cl^-$$

(2)

.....

.....

.....

.....

.....

(iii) Assuming that the reaction rate follows the rate equation

$$\text{rate} = k[(CH_3)_3CCl]$$

write the equation for the rate-determining step.

(2)

(Total for Question 2 = 17 marks)

3 Propyl ethanoate is an ester which has a smell similar to that of bananas or pears. It can be made in the laboratory from propan-1-ol and ethanoic acid. The equation for the reaction is

$$CH_3COOH + CH_3CH_2CH_2OH \rightleftharpoons CH_3COOCH_2CH_2CH_3 + H_2O$$

Procedure

1. Propan-1-ol (50 cm^3) and ethanoic acid (50 cm^3) are mixed thoroughly in a 250 cm^3 round-bottomed flask.
2. Concentrated sulfuric acid (10 cm^3) is added drop by drop to the mixture, keeping the contents of the flask well-shaken and cooled in an ice-water bath.
3. When the acid has all been added, a reflux condenser is fitted to the flask and the mixture gently boiled over an electric heating mantle for about 30 minutes.
4. The mixture is cooled, and the apparatus rearranged for distillation. The crude ester (about 60 cm^3) is distilled off.
5. The distillate is placed in a separating funnel and shaken with about half its volume of 30% sodium carbonate solution, with the pressure being released at intervals. The lower aqueous layer is then discarded.
6. The crude ester is shaken in a separating funnel with about half its volume of 50% calcium chloride solution, which removes unreacted alcohol. The lower layer is discarded.
7. The ester is run into a clean, dry flask containing some anhydrous calcium chloride and swirled.
8. The ester is filtered into a clean, dry flask, with a few anti-bumping granules, and distilled. The fraction boiling between 100 °C and 103 °C is collected.

(a) (i) Explain why the concentrated sulfuric acid is added slowly with **cooling**.

(1)

.....

.....

.....

(ii) Explain why the mixture is heated **under reflux** for **about 30 minutes**.

(2)

Under reflux.....

.....

For about 30 minutes.....

.....

(iii) What is the **main** function of the sulfuric acid in this reaction?

(1)

(iv) Suggest the identity of **two** impurities that might be present in the crude distillate from step 4.

(2)

(v) What data would you need about propyl ethanoate to be sure that the instruction in step 5 to discard the lower layer is correct?

(1)

(vi) Step 5 requires that you release the pressure at intervals. Explain why the pressure in the funnel increases.

(2)

(vii) Explain why anhydrous calcium chloride is added in step 8 and state how the appearance of the liquid changes when this stage is complete.

(2)

(viii) What is the reason for adding anti-bumping granules in step 8?

(1)

(b) (i) Use the data in the table below to show, by calculating the numbers of moles, which reactant is in excess.

(2)

Substance	Density / g cm^{-3}	Molar mass / g mol^{-1}
Ethanoic acid	1.05	60.1
Propan-1-ol	0.804	60.1

(ii) The mass of the ester collected was 35.0 g. Calculate the percentage yield of the ester propyl ethanoate.

Assume the molar mass of propyl ethanoate is 102 g mol^{-1}.

(2)

(c) A student who carried out this experiment, according to the instructions, obtained a product that boiled at 95 °C. The student suspected that the alcohol originally provided was not propan-1-ol, but was 2-methylpropan-2-ol, since that would have given an ester with this boiling temperature.

(i) Draw the structural formula for the ester that is formed from the reaction of ethanoic acid with 2-methylpropan-2-ol.

(1)

(ii) Suggest a simple test-tube experiment that the student could carry out on the original alcohol to see if the suspicion could be correct. Give the reagents used and the expected result for both propan-1-ol and 2-methylpropan-2-ol. Explain why the results are different.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 3 = 21 marks)

TOTAL FOR PAPER = 50 MARKS

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
																	(18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)		Key									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass atomic symbol name atomic (proton) number									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

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
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

* Lanthanide series

* Actinide series

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Mark Scheme (Results)

June 2011

GCE Chemistry (6CH07) Paper 01
Chemistry Laboratory Skills (WA)

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June 2011
Publications Code US027573

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. Questions labelled with an **asterix (*)** are ones where the quality of your written communication will be assessed.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

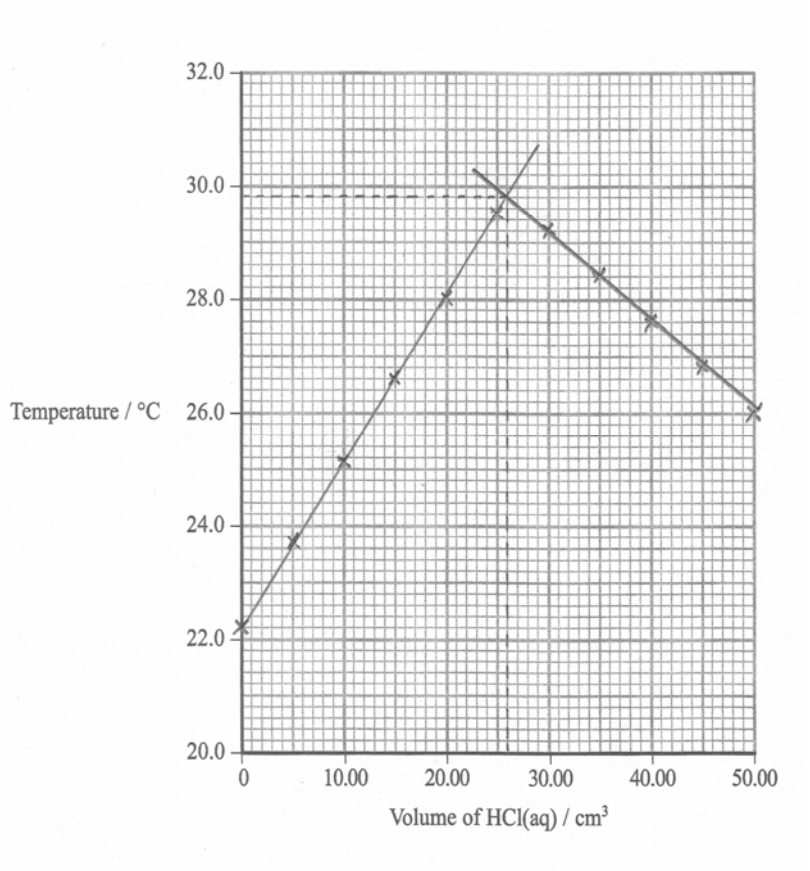
Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Question Number	Acceptable Answers	Reject	Mark
1 (a)	**(i) Cation in X** is potassium / K^+ **(1)** **(ii) Anion in X** is bromide / Br^- **(1)** **(iii) Gas Z** is bromine / Br_2 **(1)** **(iv) X is** KBr **(1)** Mark cq on (i) and (ii)	"K" Br_2 or "bromine" "bromide" or Br^- or Br Just "potassium bromide" CQ formula from incorrectly charged ions	**4**

Question Number	Acceptable Answers	Reject	Mark
1 (b)	**(i) Gas evolved:** ammon**ia** / NH_3 **(1)** **Cation in Y:** ammon**ium**/ NH_4^+ **(1)** *If formula given, it must be correct* **(ii) Anion in Y:** sulfate / SO_4^{2-} **(1)** **(iii) Y is** $(NH_4)_2SO_4$ **(1)** Mark cq on (i) and (ii)	"ammonium" "ammonia" Just "ammonium sulfate" CQ formula from incorrectly charged ions	**4**

Question Number	Acceptable Answers	Reject	Mark
2	**Bromine water** **From:** red / brown / orange / yellow (or combinations of these colours) **(1)** **To:** colourless/decolourised **(1)** *NOTE:* If colours are both correct but are given the wrong way round, award **(1)** **Phosphorus(V) chloride** Steamy fumes/misty fumes/white fumes/steamy vapour/steamy gas/white dense fumes **(1)** Ignore fizzing/gets hot/ etc. (damp blue litmus paper) red **(1)** **Acidified potassium dichromate(VI)** **From:** orange **(1)** **To:** green or blue **(1)** (or combinations of blue and green) *NOTE:* If colours are both correct but are given the wrong way round, award **(1)**	Just "clear" (White) **smoke**/**solid** **Just** 'fumes' yellow yellow	**6**

Question Number	Acceptable Answers	
3 (a) (i)	Points correctly plotted **(1)** [allow one slip] Two best fit straight lines **(1)**  	**2**

Question Number	Acceptable Answers	Reject	Mark
3 (a) (ii)	Extrapolation **(1)** **Maximum temperature** Read off candidate's graph Expect value between 29.6 – 30.0(°C) **(1)** *ALLOW* a stated value within ±0.1 (°C) of graph's max temp	If the two straight lines do not meet **above** 29.5 °C	**2**

Question Number	Acceptable Answers	Reject	Mark
3 (a) (iii)	**Volume of HCl(aq):** Read off candidate's graph Expect value between 25.5 – 26.5 (cm^3) *ALLOW:* a stated volume within ±0.5 cm^3 of graph's volume of HCl(aq) *ALLOW:* whole numbers (e.g. "27" if intersection is at 27.0)		**1**

Question Number	Acceptable Answers	Reject	Mark
3 (a) (iv)	0.05(00)		**1**

Question Number	Acceptable Answers	Reject	Mark
3 (a) (v)	**Mark consequentially on (a)(iii) and (iv):** Working e.g. 0.05(00) ÷ candidate's volume of HCl(aq) in dm^3 **(1)** Answer **(1)** e.g. for a volume of HCl(aq) = 26.0 cm^3 [NOTE: *ALLOW* "26" for 26.0] 0.05(00) ÷ candidate's volume of HCl(aq) in dm^3 $= \frac{0.05(00)}{0.026}$ **=** 1.92 (mol dm^{-3}) Correct answer only using suitable volume of HCl(aq) scores both marks *IGNORE* s.f. including 1 s.f. (e.g. "2 (mol dm^{-3})")		**2**

Question Number	Acceptable Answers	Reject	Mark
3 (b) (i)	**Read off candidate's graph:** Expect ΔT = (29.8 — 22.2) = 7.6 (^{o}C) *IGNORE* s.f. *IGNORE* any signs *NOTE:* Initial temp is that from the graph		**1**

Question Number	Acceptable Answers	Reject	Mark
3 (b) (ii)	**Mark consequentially on (a)(iii):** Working **(1)** Answer **(1)** (e.g. [**volume of HCl(aq) + 50(.00)** x 4.2 x ΔT] = 76 x 4.2 x 7.6 = 2426 (J)) Assume 2.426 (or similar) is the answer in **kJ** *NOTE:* 2nd mark can be awarded cq on a wrong mass and/or a wrong ΔT (e.g. use of 50(.00) x 4.2 x 7.6 = 1596 (J) scores **(1)**) *IGNORE* sig figs (except one sig fig) *IGNORE* any signs *ALLOW* use of 4.18 instead of 4.2	Incorrect rounding of figures	**2**

Question Number	Acceptable Answers	Reject	Mark
3 (b) (iii)	**Working** Dividing as follows:- (—) $\frac{\text{answer to (b)(ii) in kJ or J}}{\text{answer to (a)(iv)}}$ **(1)** **Negative sign** **(1)** **Answer to 2 s.f.** **(1)** ***NOTE:* The 2 s.f. mark is CQ on dividing kJ or J by mol** e.g. — $\frac{2.426}{0.05(00)}$ = — 49 (kJ mol^{-1}) ***NOTE:* must be to 2 s.f.** Correct answer to correct s.f. gets 3 marks even with no working Correct answer to 2 s.f. with negative sign in **J mol^{-1}** (e.g. — 49000) scores max **(2)**		**3**

Question Number	Acceptable Answers	Reject	Mark
4 (a) (i)	Titres 2 and 3 **(1)** Concordant / agree within (±)0.2 (cm^3) / in close agreement/ titration 1 is a trial or rangefinder or a rough titration, etc. **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
4 (a) (ii)	24.20 / 24.2 (cm^3) **Mark cq** on **any** titres chosen		**1**

Question Number	Acceptable Answers	Reject	Mark
4 (a) (iii)	**Mark CQ on (a)(ii)** $\frac{0.100 \times 24.20}{1000}$ = 0.00242 / 0.0024 / 2.42×10^{-3} / 2.4×10^{-3} (mol)		**1**

Question Number	Acceptable Answers	Reject	Mark
4 (a) (iv)	Answer to (a)(iii) **÷ 2** = 0.00121 / 0.0012 / 1.21×10^{-3} / 1.2×10^{-3} (mol)		**1**

Question Number	Acceptable Answers	Reject	Mark
4 (a) (v)	Answer to (a)(iv) **÷ 3** = 0.000403 / 0.0004(0) / 4.03×10^{-4} / $4(.0) \times 10^{-4}$		**1**

Question Number	Acceptable Answers	Reject	Mark
4 (a) (vi)	EITHER Answer to (a)(v) ÷ 0.025(0) = 0.0161 / 0.016(0) / 1.61×10^{-2} / $1.6(0) \times 10^{-2}$ (mol dm^{-3}) **(1)** so concentration of KIO_3 in g dm^{-3} is 214 (g mol^{-1}) x 0.0161 (mol dm^{-3}) = 3.45 (g dm^{-3}) OR 214 (g mol^{-1}) x 0.016(0) (mol dm^{-3}) = 3.42 (g dm^{-3}) **(1)** OR Calculate mass KIO_3 using 0.000403 x 214 = 0.086242 (g) **(1)** *IGNORE* units even if incorrect (then) $\frac{0.086242 \text{ (g)}}{0.025 \text{ (dm}^3\text{)}}$ = 3.45 (g dm^{-3}) **(1)** *ALLOW* 2 s.f. but reject 1 s.f. *NOTE:* Check all calculations as final answer is dependent on accuracy in interim steps		**2**

Question Number	Acceptable Answers	Reject	Mark
4 (b) (i)	$\frac{0.06}{25.00}$ x 100% = (±) 0.24 / 0.2% *NOTE:* **±** not required for the mark		**1**

Question Number	Acceptable Answers	Reject	Mark
4 (b) (ii)	Any **TWO** from:- • use white tile or paper as background to burette readings • have eyes level with meniscus (to avoid parallax error) • measure level at bottom of the meniscus • ensure that the burette is upright *ALLOW* • ensure that there are no air bubbles • ensure that the jet is full • remove the funnel from the top of the burette • use a white tile beneath flask • swirl the (conical) flask • run solution from burette **slowly** (into conical flask) • ensure no solution from the burette is left on the sides/walls of the (conical) flask • add solution from burette drop-wise close to the end-point **(2)**	Do more repeats / take more means Temperature of lab must be kept constant, etc	**2**

Question Number	Acceptable Answers	Reject	Mark
5 (a) (i)	**Diagram 1:** (heating under) reflux **(1)** **Diagram 2:** distillation **(1)** ***IGNORE*** "simple" before "distillation"	**fractional** distillation /condensation	**2**

Question Number	Acceptable Answers	Reject	Mark
5 (a) (ii)	(Expansion of vapour will) build up pressure / prevent explosion	**Just** "dangerous" OR "to prevent vapour escaping" OR "so that heat is not able to escape"	**1**

Question Number	Acceptable Answers	Reject	Mark
5 (b) (i)	The reaction is vigorous OR the reaction is exothermic OR the reaction is (very) fast or violent *ALLOW* To stop a reactant or product escaping *ALLOW* To prevent too much heat being produced *IGNORE* any reference to accidents	So that all the iodine reacts/so that iodine is not in excess OR "It is very reactive" OR "Increase the time for which the solids are in contact" OR "To compensate for heat loss" OR Iodine/I_2 is toxic	**1**

Question Number	Acceptable Answers	Reject	Mark
5 (b) (ii)	(One or both of) the **liquids** flammable / the mixture is flammable/ the organic compounds are flammable OR ethanol and iodoethane are flammable OR ethanol is flammable OR iodoethane is flammable OR to keep the temperature below 100°C OR to control the temperature throughout the heating OR for uniform heating OR to prevent uneven heating	Any mention that iodine/I_2 is flammable OR **Just** "gentle heating" OR To prevent the reaction going (any) faster	**1**

Question Number	Acceptable Answers	Reject	Mark
5 (b) (iii)	Any lower temperature: 69 to 71 (^{o}C) Any upper temperature: 73 to 75 (^{o}C) *NOTE:* Award the mark if the correct numbers are written the other way round (e.g. **from** 74 (^{o}C) **to** 70 (^{o}C))		**1**

Question Number	Acceptable Answers	Reject	Mark
5 (c) (i)	0.1(00) (mol)	0.2(00) (mol)	**1**

Question Number	Acceptable Answers	Reject	Mark
5 (c) (ii)	***1st mark*** M_r (CH_3CH_2I) = 156 **(1)** 0.2(00) mol of iodoethane **(1)** ***2nd mark*** *CQ* on (c)(i) 0.2(00) x 156 = 31.2 g **(1)** ***3rd mark*** is cq on moles of iodoethane ***NOTE*** If 0.2(00) mol of iodine given in Q5 (c)(i), by CQ marking can score all 3 marks here with: M_r (CH_3CH_2I) = 156 **(1)** 0.4(00) mol of iodoethane **(1)** 0.4(00) x 156 = 62.4 g **(1)**		**3**

Question Number	Acceptable Answers	Reject	Mark
5 (c) (iii)	$\frac{23.4}{\text{ans to (c)(ii)}}$ x 100 % = 75% *IGNORE* s.f. except 1 s.f. ***NOTE*** If 0.2(00) mol of iodine given in 5 (c)(i), by CQ marking can score the mark here with: $\frac{23.4}{62.4}$ x 100 % = 37.5%	$\frac{23.4}{25.4}$ x 100 % = 92.1%	**1**

TOTAL FOR PAPER = 50 MARKS

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Edexcel GCE

Centre Number	Candidate Number

Chemistry

Advanced

Unit 6B: Chemistry Laboratory Skills II Alternative

Tuesday 22 May 2012 – Morning
Time: 1 hour 15 minutes

Paper Reference
6CH08/01

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 ▶

P39311A

7/7/5/5/

P 3 9 3 1 1 A 0 1 1 6

PEARSON

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

1 (a) The colours of aqueous solutions containing chromium(III) chloride and nickel(II) chloride are similar.

What colour are these solutions?

(1)

.....

(b) Tests were carried out on a dilute aqueous solution of chromium(III) chloride. Complete the table below.

You may use **either** names **or** formulae unless only **one** of these is specified.

	Test	Observations	Inferences	
(i)	Add a few drops of dilute sodium hydroxide solution to the chromium(III) chloride solution.	A precipitate forms.	The precipitate is	**(1)**
(ii)	Add dilute sodium hydroxide to the mixture made in (i), until the sodium hydroxide is present in excess.	....	The complex ion $[Cr(OH)_6]^{3-}$ forms.	**(1)**
(iii)	Add a few drops of dilute ammonia to another sample of the chromium(III) chloride solution.	....	The substance containing chromium which is observed on adding the ammonia is	**(2)**

	Test	Observations	Inferences	
(iv)	Continue to add dilute ammonia to the mixture in (iii) until the ammonia is present in excess.	A solution forms.	The **formula** of the chromium containing ion in the solution is	(1)
(v)	Warm another sample of the chromium(III) chloride solution with alkaline hydrogen peroxide solution, which acts as an oxidizing agent. Add sulfuric acid to the resulting mixture.	A yellow solution forms. The solution goes orange when sulfuric acid is added.	The **formula** of the ion causing the yellow colour is ..... The ion causing the orange colour is dichromate(VI), $Cr_2O_7^{2-}$.	(1)

(c) Tests (i) and (ii) above were repeated on an aqueous solution of nickel(II) chloride.

In what way, other than any difference in colour, does the reaction of dilute sodium hydroxide solution with nickel(II) chloride differ from its reactions with chromium(III) chloride?

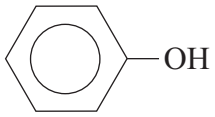
(1)

.....

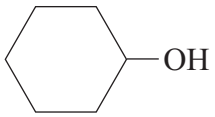
.....

(Total for Question 1 = 8 marks)

2 This question is about some reactions of phenol and cyclohexanol.



phenol



cyclohexanol

(a) Give **two** observations you would make when bromine water is added, drop by drop, to an aqueous solution of phenol.

(2)

.....

.....

(b) (i) What is observed when cyclohexanol is warmed with a mixture of aqueous potassium dichromate(VI) and sulfuric acid?

(1)

.....

(ii) Give the skeletal formula of the organic product of the reaction in (b)(i).

(1)

(iii) What change, if any, is observed when the organic product of the reaction in (b)(i) is mixed with the following reagents?

(2)

2,4-dinitrophenylhydrazine solution

.....

Tollens' reagent

.....

(c) Both phenol and cyclohexanol react with ethanoyl chloride to produce steamy fumes and an ester. Phenol behaves like an alcohol in this reaction.

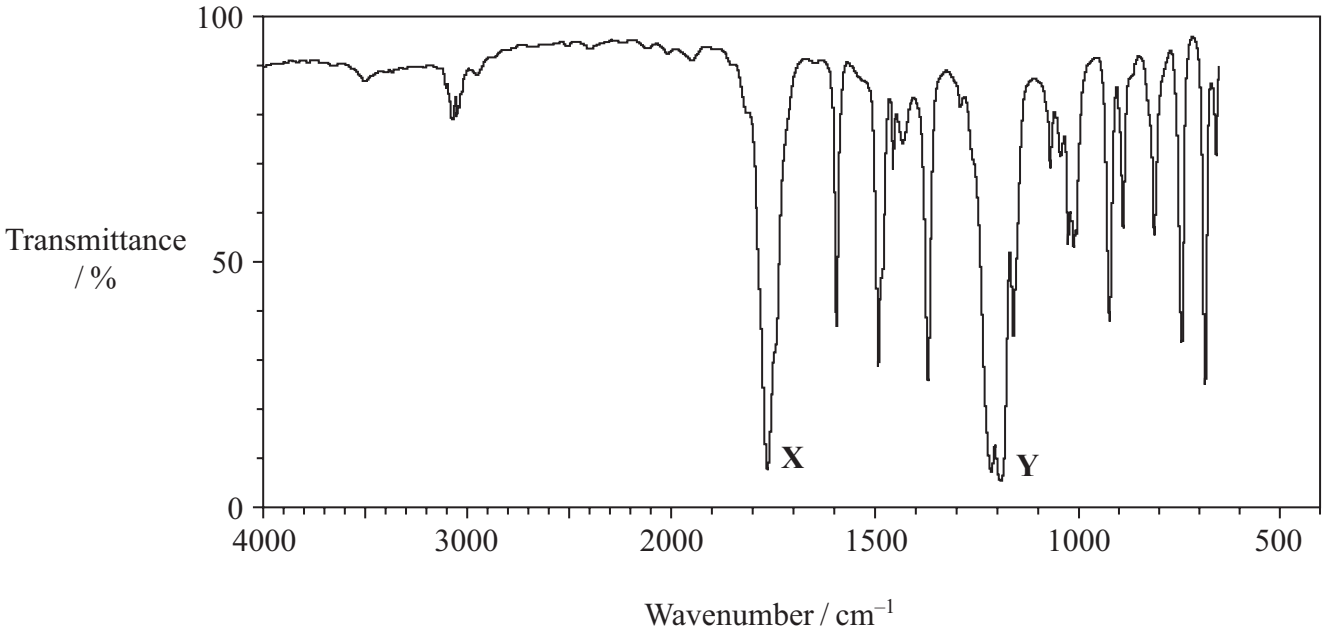
(i) How could you show that the steamy fumes were due to the presence of a hydrogen halide, which in this case is hydrogen chloride?

(2)

.....

.....

(ii) The infrared spectrum below is for the ester produced in the reaction of ethanoyl chloride with phenol.



Bond	Group	Wavenumber range / cm^{-1}
C—H	alkanes	2962 – 2853
	arenes	3030
O—H	alcohols and phenols	3750 – 3200
C—O	ethanoates	1250 – 1190
	benzoates	1310 – 1250 and 1150 – 1100
C═C	arenes	1600, 1580, 1500, 1450
C═O	ketones	1700 – 1680
	esters	1770 – 1715

Identify the bond and group which cause each of the absorptions **X** and **Y**.

(2)

X .....

Y .....

(iii) Draw the structural formula of the ester produced in the reaction of ethanoyl chloride with phenol.

(1)

(Total for Question 2 = 11 marks)

3 Some old coins with a high copper content were analysed as follows.

Procedure

1. The coins were weighed and dissolved in concentrated nitric acid, producing a solution which contained copper(II) nitrate.

2. The solution containing copper(II) nitrate was neutralized by adding sodium carbonate solution until a precipitate of copper(II) carbonate just appeared. Dilute ethanoic acid was then added, drop by drop, until the copper(II) carbonate precipitate just dissolved.

3. The solution containing copper(II) nitrate was transferred to a volumetric flask and made up to 250 cm^3 with distilled water.

4. 25 cm^3 portions of this solution were transferred to separate conical flasks. Then 10 cm^3 of 1.0 mol dm^{-3} potassium iodide (an excess) was added to each flask.

5. The liberated iodine was titrated with 0.125 mol dm^{-3} sodium thiosulfate solution.

(a) One reason why the solution for titration must be neutralized is because sodium thiosulfate reacts with acid as shown below.

$$S_2O_3^{2-} + 2H^+ \rightarrow S + SO_2 + H_2O$$

State **one** observation you would make when an acid reacts with sodium thiosulfate solution.

(1)

.....

.....

(b) (i) What colour is the diluted solution containing copper(II) nitrate?

(1)

.....

(ii) What would you observe in Step 2, before the formation of the copper(II) carbonate precipitate, when the sodium carbonate was added?

(1)

.....

.....

(c) The equation for the reaction producing iodine in Step 4 is shown below.

$$2Cu^{2+}(aq) + 4I^{-}(aq) \rightarrow 2CuI(s) + I_2(aq)$$

(i) Give the name of the precipitate formed in this reaction.

(1)

.....

(ii) Suggest, by considering the electronic configuration of the relevant ion, why the precipitate is white.

(1)

.....

.....

.....

(d) The equation for the reaction of thiosulfate ions in the titration is

$$2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^{-}(aq)$$

Results:

Mass of coins	2.10 g
Mean (average) volume of 0.125 mol dm^{-3} sodium thiosulfate used in titration	24.40 cm^3

(i) Calculate the number of moles of sodium thiosulfate used in the titration.

(1)

(ii) Calculate the number of moles of Cu^{2+} in the 25 cm^3 samples used for the titration.

(2)

(iii) Hence calculate the mass of copper present in the original mass of coins.

(2)

(iv) What is the percentage of copper in the coins?

(1)

(e) (i) The balance used to weigh the coins produced a **total** error in the weighing of ± 0.01 g. Calculate the percentage error in the weighing.

(1)

(ii) The error in the mean titre of 24.40 cm^3 was ± 0.10 cm^3. Show, by calculation, that the percentage error in the titration reading is less than the percentage error in the balance reading.

(1)

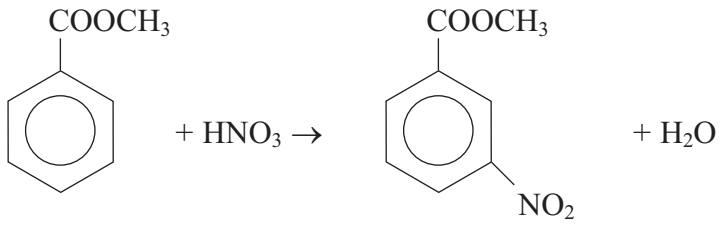
(f) Starch solution can be used to show the end point for this titration, or the titration can be self-indicating.

What colour change would be observed at the end point if starch was **not** used?

(1)

(Total for Question 3 = 14 marks)

4 A student attempted to make a sample of methyl 3-nitrobenzoate using the following reaction.



methyl benzoate methyl 3-nitrobenzoate

Procedure

1. Transfer 9 cm^3 of concentrated sulfuric acid into a 100 cm^3 conical flask and cool it to below 10 °C in an ice bath. Add 5.0 g of methyl benzoate, swirling the flask. Mix 3 cm^3 of concentrated nitric acid with 3 cm^3 of concentrated sulfuric acid in another small flask and cool it in ice.

2. Add the mixture of nitric and sulfuric acids, drop by drop, to the methyl benzoate solution, making sure that the temperature stays below 15 °C.

3. Take the mixture out of the ice bath and leave it to stand for 10 minutes at room temperature. Pour the mixture over 40 g of crushed ice and collect the solid product by filtering the mixture under suction. Wash the precipitate, first with cold water, then with ice-cold ethanol. Keep the washings obtained with the ethanol for a further experiment.

4. Purify the impure methyl 3-nitrobenzoate by recrystallization, using ethanol as the solvent, cooling the solution in an ice bath to assist recrystallization.

5. Dry the recrystallized product and determine the yield.

(a) The student wore goggles and a laboratory coat. For each of the processes below, state the hazard and give one further safety precaution which should be taken.

(i) Working with concentrated nitric and sulfuric acids.

(1)

.....

.....

(ii) Carrying out the recrystallization using ethanol.

(1)

.....

.....

(b) What is the purpose of adding sulfuric acid to the nitric acid in this reaction?

(1)

.....

.....

(c) (i) Calculate the number of moles in 5.0 g of methyl benzoate.

Assume the molar mass of methyl benzoate is 136 g mol^{-1}.

(1)

(ii) Methyl benzoate is a liquid at room temperature. What is the volume of 5.0 g of methyl benzoate?

The density of methyl benzoate is 1.09 g cm^{-3}.

(1)

(iii) After recrystallization and drying, 3.4 g of methyl 3-nitrobenzoate was obtained.

Calculate the percentage yield of methyl 3-nitrobenzoate, assuming that an excess of nitric and sulfuric acids was present.

(3)

(d) One reason for the low yield in this experiment is that methyl 2-nitrobenzoate is also formed. This compound dissolves in ethanol and would be present in the ethanol washings from **step 3**. Methyl 2-nitrobenzoate and methyl 3-nitrobenzoate are both pale yellow.

(i) Describe how to make a chromatogram with the ethanol washings from **step 3** in order to separate methyl 2-nitrobenzoate and methyl 3-nitrobenzoate. The chromatogram can be made on a plate covered with a layer of silica, and you may assume that a suitable solvent is available.

(4)

(ii) How would you improve the chromatogram to confirm that both methyl 2-nitrobenzoate and methyl 3-nitrobenzoate are present in the washings? You may show this on a diagram if you prefer.

(1)

(e) The table below gives data about the solubility of methyl 3-nitrobenzoate in two solvents. This data may be used to select the best solvent for recrystallization.

	Solubility of methyl 3-nitrobenzoate / g per 100 g solvent	
Temperature / °C	Solvent 1	Solvent 2
10	6.0	2.0
70	11.0	9.5

(i) Explain why using Solvent 1, rather than Solvent 2, would lead to a lower yield of recrystallized methyl 3-nitrobenzoate.

(1)

.....

.....

.....

.....

(ii) 50 g of Solvent 2 was saturated with methyl 3-nitrobenzoate at 70 °C, and the solution was then cooled to 10 °C. Calculate the mass of methyl 3-nitrobenzoate crystals which would be obtained.

(1)

(f) What method, other than spectroscopy or chromatography, could be used to assess the purity of the methyl 3-nitrobenzoate? How would the result of the experiment indicate if it was pure?

(2)

.....

.....

.....

(Total for Question 4 = 17 marks)

TOTAL FOR PAPER = 50 MARKS

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The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8) (18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)		Key: relative atomic mass / atomic symbol / name / atomic (proton) number									(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

* Actinide 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
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

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Mark Scheme (Results)

Summer 2012

GCE Chemistry (6CH07) Paper 01
Chemistry Laboratory Skills (WA)

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Summer 2012
Publications Code US031870

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. Questions labelled with an **asterix (*)** are ones where the quality of your written communication will be assessed.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Reject</th><th>Mark</th></tr>
<tr><td>1(a)</td><td>
<table>
<tr><th>Name of solution</th><th>Letter</th></tr>
<tr><td>Sodium chloride solution</td><td>C</td></tr>
<tr><td>Potassium iodide solution</td><td>B</td></tr>
<tr><td>Dilute hydrochloric acid</td><td>D</td></tr>
<tr><td>Dilute nitric acid</td><td>A</td></tr>
</table>
All four letters correct = 3
Two / three letters correct = 2
One letter correct = 1
</td><td></td><td>3</td></tr>
</table>

Question Number	Correct Answer	Reject	Mark
1(b)	Hydrochloric acid gives effervescence/fizzing/gas /CO_2 OR sodium chloride gives no effervescence/fizzing/gas /CO_2/no reaction	Incorrect gas Incorrect gas	**1**

Question Number	Correct Answer	Reject	Mark
1(c)	$Ag^+(aq) + I^-(aq) \rightarrow AgI(s)$ species **(1)** ALLOW Ag^+I^- state symbols **(1)** This mark is only available if the equation is correct OR is correctly balanced with only the ion charge(s) incorrect. ALLOW Non-ionic equation with correct state symbols **(1)** Equations including spectator ions with correct state symbols **(1)** $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ **(1)**		**2**

Question Number	Correct Answer	Reject	Mark
1(d)	(The white precipitate) dissolves/ disappears OR a colourless solution is formed	**Just** "clear" instead of "colourless"	**1**

Question Number	Correct Answer	Reject	Mark
2(a)	(**The metal ion is**) barium/Ba^{2+} **(1)** **(The precipitate is)** barium sulfate/ $BaSO_4$ **(1)** ALLOW barium sulphate **(The gas is)** nitrogen dioxide/NO_2 **(1)** ALLOW dinitrogen tetroxide/N_2O_4 **(The gas which relights the glowing splint is)** Oxygen/O_2 **(1)** **Note:** If both name and formulae are given both must be correct Mark the four parts independently	**Just** "Ba" Ba^+	**4**

Question Number	Correct Answer	Reject	Mark
2(b)	$Ba(NO_3)_2$ ALLOW $Ba(NO_3)_2.xH_2O$ where x is a number between 1 and 10 e.g. $Ba(NO_3)_2.2H_2O$		**1**

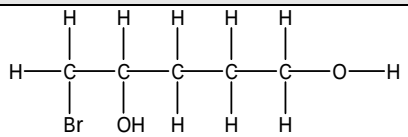
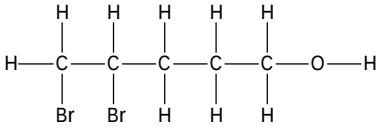
Question Number	Correct Answer	Reject	Mark
2(c)	$2Ba(NO_3)_2 \rightarrow 2BaO + 4NO_2 + O_2$ Fully correct equation **(2)** Formulae of all three products correct **(1)** ALLOW multiples ALLOW $4BaNO_3 \rightarrow 2Ba_2O + 4NO_2 + O_2$ **(1)**		**2**

Question Number	Correct Answer	Reject	Mark
3(a)(i)	**(From)** orange **(1)** **(To)** green/blue/brown **(1)**	Two colours e.g. "blue/green" "blue-green"	**2**

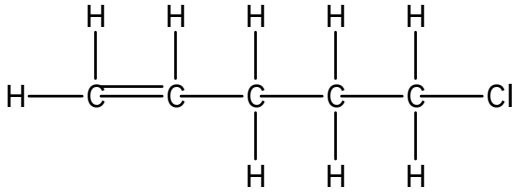
Question Number	Correct Answer	Reject	Mark
3(a)(ii)	$CH_3CH_2CH_2CH_2OH$ **(1)** $CH_3CH(CH_3)CH_2OH$/ $(CH_3)_2CHCH_2OH$ **(1)** In either order Formulae may also be displayed or skeletal	C_4H_9OH Displayed formula with C-H-O OR C-HO	**2**

Question Number	Correct Answer	Reject	Mark
3(b)	$(CH_3)_3COH$ ALLOW $CH_3COH(CH_3)CH_3$ Formula may also be displayed or skeletal ALLOW $CH_3CH_2CH_2OCH_3$ $CH_3CH(CH_3)OCH_3$ $CH_3CH_2OCH_2CH_3$	Displayed formula with C-H-O OR C-HO	**1**

Question Number	Correct Answer	Reject	Mark
3(c)(i)	**(From)** red-brown/ orange/yellow/brown **(1)** ALLOW Any combination of these colours **(To)** colourless **(1)**	**Just** "clear"	**2**

Question Number	Correct Answer	Reject	Mark
3(c)(ii)	 ALLOW Addition of –Br and –OH across the double bond, in either order OR  ALLOW Correct structural or skeletal formula		**1**

Question Number	Correct Answer	Reject	Mark
3(c)(iii)	steamy fumes/misty fumes/white fumes/cloudy fumes IGNORE dense	Any mention of "smoke", "solid" or "precipitate"	**1**

Question Number	Correct Answer	Reject	Mark
3(c)(iv)	 IGNORE addition of HCl across the C=C double bond ALLOW Correct structural or skeletal formula		**1**

Question Number	Correct Answer	Reject	Mark
3(c)(v)	Alkene **(1)** ALLOW carbon-carbon double bond Alcohol/primary alcohol/hydroxy/hydroxyl/alkanol **(1)** In either order	Ethene, alkyl hydroxide	**2**

Question Number	Correct Answer	Reject	Mark
4(a)(i)	(25.0 x 4.18 x 10.0 =) 1045/1050/1000 (J) ALLOW 1.045/1.05/1.0 **kJ** IGNORE signs IGNORE sf except 1		**1**

Question Number	Correct Answer	Reject	Mark
4(a)(ii)	$\left(\frac{3.48}{100}\right)$ = 0.0348/0.035 (mol) IGNORE sf except 1		**1**

Question Number	Correct Answer	Reject	Mark
4(a)(iii)	$\left(\frac{\text{Answer to (a)(i) in kJ}}{\text{Answer to (a)(ii)}}\right) = \frac{1.045}{0.0348}$ = **+**30.03/30.0/30 (kJ mol^{-1}) ALLOW any answer which rounds to 30 to 2 sf. Mark CQ on (a)(i) and (ii) which should be checked. Value must round to the correct answer to 2 sf. Sign **(1)** value **(1)** Mark independently	1.0/0.035=29	**2**

Question Number	Correct Answer	Reject	Mark
4(b)(i)	Decrease (in temperature) for $KHCO_3$ **and** an increase (in temperature) for K_2CO_3 **(1)** OR Endothermic for $KHCO_3$ **and** exothermic for K_2CO_3 **(1)**	**Just** Temperature change different	**1**

Question Number	Correct Answer	Reject	Mark
4(b)(ii)	No heat lost/no heat gained/ reaction is complete/ specific heat capacity of the solution is the same as water/molar mass of $KHCO_3$ is 100 (not 100.1)/density of solution is 1.00 gcm^{-3}	Thermometer is accurate	**1**

Question Number	Correct Answer	Reject	Mark
4(c)(i)	(ΔH_r =) 2 x ΔH_1 — ΔH_2		**1**

Question Number	Correct Answer	Reject	Mark
4(c)(ii)	(ΔH_r = (2 x +30) — (—34) =) + 94 (kJ mol^{-1}) value **(1)** sign **(1)** The sign mark is only available if the value is correct or almost correct. ALLOW (ΔH_r = (+30) — (—34) =) = +64 (kJ mol^{-1}) **(1)** IGNORE sf except 1		**2**

Question Number	Correct Answer	Reject	Mark
5(a)(i)	(Mass of contents after heating / g) **2.49**		**1**

Question Number	Correct Answer	Reject	Mark
5(a)(ii)	(Mass of water removed / g) **0.98**		**1**

Question Number	Correct Answer	Reject	Mark
5(b)(i)	$\left(\frac{0.98}{18.0}\right)$ = 0.0544 / 0.054/ 5.44×10^{-2}/ 5.4×10^{-2} (mol) IGNORE sig figs except ONE sf CQ on mass of water removed		**1**

Question Number	Correct Answer	Reject	Mark
5(b)(ii)	$\left(\frac{2.49}{102.9}\right)$ = 0.0242 / 0.024/ 2.42×10^{-2}/2.4×10^{-2} (mol) NaBr molar mass = 102.9/ 23.0+79.9 (g mol^{-1}) ALLOW 103 instead of 102.9 **(1)** answer **(1)** CQ on molar mass IGNORE sig figs except ONE sf CQ on mass of contents after heating		**2**

Question Number	Correct Answer	Reject	Mark
5(b)(iii)	(x = 0.0544/0.0242 = 2.2499) **x** = 2.2 to 2 sf ALLOW 2.3 answer **(1)** two sig figs **(1)** ALLOW 2.1,2.4,2.5 **(1)** ALLOW Either numerator 0.054 or denominator 0.024 and answer correct to 2 sf **(1)**		**2**

Question Number	Correct Answer	Reject	Mark
5(c)	$\left(\frac{2 \times \pm 0.005}{3.47} \times 100\%\right) =$ 0.3% / 0.29% / 0.288% Ignore sf doubling the maximum error **(1)** answer **(1)** NOTE $\left(\frac{\pm 0.005}{3.47} \times 100\%\right) =$ 0.1% / 0.14% / 0.144% scores one only		**2**

Question Number	Correct Answer	Reject	Mark
5(d)(i)	**(Apparent mass of water removed)** decreases/less **(1)** **(Value of x)** decreases/less (than 2) **(1)** Mark independently		**2**

Question Number	Correct Answer	Reject	Mark
5(d)(ii)	**(Apparent mass of water removed)** increases/more **(1)** **(Value of x)** increases/ more (than 2) **(1)** Mark independently		**2**

Question Number	Correct Answer	Reject	Mark
5(e)	**Any two improvements from** • use a lid on the crucible • heat to constant mass • heat with a gentle/blue flame • use a larger mass of crystals • cool in a dry atmosphere • repeat experiment • electrical heating IGNORE "use a more accurate balance"	Heat loss	**2**

TOTAL FOR PAPER: 50 MARKS

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. Questions labelled with an **asterix (*)** are ones where the quality of your written communication will be assessed.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Question Number	Correct Answer	Reject	Mark
1(a)	Green ACCEPT any green eg blue-green		**1**

Question Number	Correct Answer	Reject	Mark
1 (b)(i)	Chromium((III)) hydroxide/ $Cr(OH)_3$ /([])$Cr(OH)_3(H_2O)_3$([])/([])$Cr(H_2O)_3(OH)_3$ ([]) If oxidation number is given must be correct	Correct name with incorrect formula and vice versa	**1**

Question Number	Correct Answer	Reject	Mark
1 (b)(ii)	The precipitate dissolves ALLOW the precipitate redissolves/ disappears OR A solution (forms) IGNORE colours of solutions		**1**

Question Number	Correct Answer	Reject	Mark
1(b)(iii)	(green) precipitate forms Allow same precipitate forms **(1)** IGNORE other colours Chromium((III)) hydroxide/$Cr(OH)_3$/ ([])$Cr(OH)_3(H_2O)_3$([]),/([])$Cr(H_2O)_3(OH)_3$] **(1)**		**2**

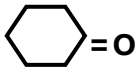
Question Number	Correct Answer	Reject	Mark
1(b)(iv)	([])$Cr(NH_3)_6^{3+}$([]) Allow other numbers of NH_3 with H_2O provided correct charge and 6 ligands	Mixture of NH_3 and OH^- in ligands	**1**

Question Number	Correct Answer	Reject	Mark
1(b)(v)	CrO_4^{2-}	Chromate ((VI))	**1**

Question Number	Correct Answer	Reject	Mark
1(c)	Nickel hydroxide/precipitate doesn't dissolve in excess (sodium hydroxide) ALLOW "Ppt with nickel chloride is insoluble in excess NaOH" "Nickel chloride will not form a solution in excess NaOH" "The precipitate does not redissolve"	Nickel/nickel ion doesn't dissolve in excess "Nickel chloride is insoluble in excess NaOH"	**1**

Question Number	Correct Answer	Reject	Mark
2(a)	**First mark:** Goes (from brown/red-brown/ orange/orange-brown/yellow to) colourless OR (the bromine) is decolorised **(1)** **Second mark:** (White) precipitate forms OR misty/steamy fumes form **(1)** IGNORE Medicinal/antiseptic smell Names of products even if incorrect	Clear for colourless Effervescence White smoke Layers formed	**2**

Question Number	Correct Answer	Reject	Mark
2(b)(i)	(orange to) green/blue/brown IGNORE Initial colour even if incorrect		**1**

Question Number	Correct Answer	Reject	Mark
2(b)(ii)	 Accept displayed / structural formula	$C_6H_{10}O$	**1**

Question Number	Correct Answer	Reject	Mark
2(b)(iii)	(2,4-dinitrophenylhydrazine:) yellow/ orange/red precipitate or yellow/orange/red solid **(1)** both colour and state needed ALLOW Combinations of above colours "Crystals" for solid (Tollens':) no change/no reaction Allow "nothing" (1) If aldehyde in b(ii) –allow TE for 2,4-dnp mark as above and silver mirror with Tollens If carboxylic acid in b(ii) – allow TE for no reaction in either case	Brown	**2**

Question Number	Correct Answer	Reject	Mark
2(c)(i)	React with ammonia (fumes) **(1)** White smoke /white solid **(1)** OR React with silver nitrate (solution) **(1)** (White/cream /yellow) precipitate forms **(1)** IGNORE use of acid-base indicators (litmus, universal indicator)	React with a solution of ammonia White fumes/ white gas Just "silver chloride test"	**2**

Question Number	Correct Answer	Reject	Mark
2(c)(ii)	(X) C=O ester **(1)** (Y) C–O ethanoate **(1)** Two correct bonds with incorrect/no groups **(1)** Two correct groups with incorrect/no bonds **(1)**	 C-O benzoate	**2**

Question Number	Correct Answer	Reject	Mark
2(c)(iii)	CH_3-C=O | O-C_6H_5 ALLOW skeletal, displayed, $CH_3COOC_6H_5$ and $C_6H_5OCOCH_3$ ALLOW C_6H_5 as benzene ring	$C_6H_5COOCH_3$ $C_6H_5OOCCH_3$ Hexagon with no circle for benzene ring	**1**

Question Number	Correct Answer	Reject	Mark
3(a)	(white/yellow) precipitate (of sulfur) /goes cloudy/solid forms ALLOW choking/pungent smell (of sulfur dioxide) IGNORE effervescence/bubbles/gas forms/Gas turns blue litmus red /Heat evolved	Yellow solution Colours other than white or yellow e.g. black solid Smell of bad eggs/ bad smell	**1**

Question Number	Correct Answer	Reject	Mark
3(b)(i)	Blue ACCEPT any blue eg blue-green		**1**

Question Number	Correct Answer	Reject	Mark
3(b)(ii)	Effervescence /fizzing /bubbling IGNORE identity of gas	Just "Gas given off" Effervescence with brown fumes	**1**

Question Number	Correct Answer	Reject	Mark
3(c)(i)	Copper**(I)** iodide Oxidation number is essential	Just "Copper iodide" Oxidation number **after** iodide	**1**

Question Number	Correct Answer	Reject	Mark
3(c)(ii)	(In CuI) the copper (ion) has a full d (sub) shell/does not have an incomplete d (sub) shell/has configuration (3)d^{10} ALLOW Cu^+ has full d orbital(s)	Configuration of element Just "d-d transitions cannot occur" Just "all the shells are full"	**1**

Question Number	Correct Answer	Reject	Mark
3(d)(i)	((24.40 x 0.125) / 1000) = 3.05 x 10^{-3} / 0.00305 (mol) ALLOW 3.1 x 10^{-3} (mol)	 3.00 x 10^{-3} 3.10 x 10^{-3}	**1**

Question Number	Correct Answer	Reject	Mark
3(d)(ii)	Mol I_2 = half answer to (i) **(1)** =1.525 x 10^{-3} Mol Cu^{2+} = 2 x mol I_2 **(1)** =3.05 x 10^{-3} IGNORE sf unless 1 sf Correct final answer without working **(2)**		**2**

Question Number	Correct Answer	Reject	Mark
3(d)(iii)	mass Cu in 25 cm^3 = (63.5 x 3.05 x 10^{-3} = 1.93675 x 10^{-1}) = 1.94 x 10^{-1} / 0.194 (g) **(1)** Mass in original = (1.93675) = 1.94 (g) **(1)** TE for 10x mass in 25 cm^3 Ignore sf except 1 sf ALLOW use of Cu = 64 which gives 1.95 (g) Correct final answer without working **(2)**		**2**

Question Number	Correct Answer	Reject	Mark
3(d)(iv)	% Cu = (1.93675 x 100 / 2.10 = 92.2261) = 92.2 % OR (1.94 x 100) / 2.10 = 92.38095) =92.4% ALLOW TE from use of Cu = 64 which gives 92.9% ALLOW TE from mass of Cu provided less than 100% IGNORE sf except 1 sf		**1**

Question Number	Correct Answer	Reject	Mark
3(e)(i)	(0.01 / 2.10 x 100 = ± 0.4761904) = (±) 0.48 (%) / (±)0.5 (%) IGNORE sf		**1**

Question Number	Correct Answer	Reject	Mark
3(e)(ii)	(0.10 / 24.40 x 100 = 0.4098) = (±) 0.41 (%) / (± 0).4 (%) IGNORE sf If errors in (i) and (ii) are both doubled allow 1 mark in e(ii)	0.40/ 0.409	**1**

Question Number	Correct Answer	Reject	Mark
3(f)	Brown /straw-coloured/yellow to colourless solution/white solid Both colours in change needed	Blue to colourless Red-brown to colourless Clear for colourless	**1**

Question Number	Correct Answer	Reject	Mark
4(a)(i)	Corrosive so wear gloves ALLOW burns skin/damages skin ALLOW exothermic reaction so keep cool/add acids drop by drop	Toxic Irritant/irritates skin	**1**

Question Number	Correct Answer	Reject	Mark
4(a)(ii)	(In)flammable so use water bath/ electric hotplate/keep away from naked flames	Keep away from heat Use fume cupboard	**1**

Question Number	Correct Answer	Reject	Mark
4(b)	(Reacts with nitric acid) to make NO_2^+ /to make nitronium ion/to make an electrophile	To make a nitrating agent/ NO_2/ nitrate/ nitro group/nitrite ion Just "as a catalyst/to speed up reaction" Just "Drying agent" Oxidizing agent Reducing agent Just a correct equation	**1**

Question Number	Correct Answer	Reject	Mark
4(c)(i)	(5.0/ 136 = 0.0367647) =0.0368/ 0.037 (mol) IGNORE sf except 1 sf		**1**

Question Number	Correct Answer	Reject	Mark
4(c)(ii)	(5.0 / 1.09 = 4.587156) = 4.59/ 4.6 (cm^3) IGNORE sf except 1 sf		**1**

Question Number	Correct Answer	Reject	Mark
4(c)(iii)	M_r for product = 181 (1) Max yield = (181 x 0.0367647 = 6.6544118) = 6.65/ 6.7g **(1)** % yield = (3.4/6.6544118 x 100 = 51.09392) = 51.1/ 51 **(1)** OR M_r for product = 181 (1) Moles product = (3.40/181 = 0.0187845) = 0.0188/ 0.019 **(1)** % yield = (0.01878/ 0.036747 x 100 = 51.111854) = 51.1/ 51 **(1)** IGNORE sf except 1 sf ALLOW final answers rounding to 51 which will depend how number of moles is rounded. Working need not be shown, but if incorrect molar mass used max **(2)** TE from (c)(i) and in intermediate stages		**3**

Question Number	Correct Answer	Reject	Mark
4(d)(i)	**First mark:** Use a spot/small drop (of the ethanol washings) **(1)** Then any 3 points from the following: put spot near the bottom of the plate/on a marked line/on a datum line **(1)** Put plate in a sealed container **(1)** with the (suitable) solvent below the spot **(1)** Leave until the solvent has moved to near the top of the plate/till solvent has risen up/until separated **(1)** ALLOW any of these points shown on a diagram. ALLOW use of paper instead of plate IGNORE references to spraying with a reagent to make spots visible	Put the solvent on the plate Put the sample under the solvent level Use of electric current	**4**

Question Number	Correct Answer	Reject	Mark
4(d)(ii)	Add pure samples (of methyl 2-nitrobenzoate and methyl 3-nitobenzoate) to chromatogram and get two spots at different levels corresponding to pure samples This may be shown on a diagram GIVE THE MARK FOR THIS QUESTION IF THIS PROCEDURE IS DESCRIBED IN 4(d)(i) OR measure R_f values on chromatogram of washings and compare with R_f of pure samples	Use of electrophoresis Spectroscopy	**1**

Question Number	Correct Answer	Reject	Mark
4(e)(i)	Higher proportion of product would remain in solution/ more product would stay dissolved/ less product would crystallize out/ product is more soluble in solvent 1 **at room temp**	Solvent is more soluble Just "It dissolves more in solvent 1"	**1**

Question Number	Correct Answer	Reject	Mark
4(e)(ii)	$\frac{(9.5 - 2)}{2}$ =3.75 (g) IGNORE sf except 1 sf		1

Question Number	Correct Answer	Reject	Mark
4(f)	Measure the melting temperature ALLOW measure the boiling temperature / measure the melting and boiling temperature (1) Should be sharp ALLOW Should match data book value (1)	Recrystallization Just "compare with data book"	2

TOTAL FOR PAPER = 50 MARKS

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Unit 6B: Chemistry Laboratory Skills II Alternative

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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 ▶

P41653A

10/5/6/7/7/

P 4 1 6 5 3 A 0 1 1 6

PEARSON

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

1 (a) Compound **Z** is a crystalline solid that contains a nickel cation and one type of anion. Complete the table below.

	Test	Observation	Inference
(i)	Add dilute sulfuric acid to compound **Z**	Bubbles of a colourless gas are released. The gas turns limewater milky and a ..... coloured solution is formed **(1)**	Name of gas released is ..... Formula of anion in **Z** is ..... Formula of the complex ion formed is $[Ni(H_2O)_6]^{2+}(aq)$ **(2)**
(ii)	Add concentrated hydrochloric acid to the solution containing $[Ni(H_2O)_6]^{2+}$ ions	Yellow-brown solution forms	Formula of the complex ion formed is ..... **(1)**
(iii)	Add a few drops of dilute aqueous ammonia to the solution containing $[Ni(H_2O)_6]^{2+}$ ions	Green precipitate forms	Formula of the precipitate formed is ..... **(1)**
(iv)	Add excess dilute aqueous ammonia to the solution containing $[Ni(H_2O)_6]^{2+}$ ions until no further change is observed	.... **(1)**	Formula of the complex ion formed is $[Ni(NH_3)_6]^{2+}$

(b) A 10.0 cm^3 sample of a solution containing $[Ni(H_2O)_6]^{2+}$ ions was titrated with a solution of concentration 0.010 mol dm^{-3} with respect to the ligand $EDTA^{4-}$ ions. The equation for the reaction is

$$[Ni(H_2O)_6]^{2+} + EDTA^{4-} \rightarrow [Ni(EDTA)]^{2-} + 6H_2O$$

(i) The mean titre of the solution containing $EDTA^{4-}$ ions was 24.20 cm^3. Use this information, and the equation above, to calculate the concentration in mol dm^{-3} of the solution containing $[Ni(H_2O)_6]^{2+}$ ions.

(2)

(ii) Assuming the total error in the measurement of the mean titre is ±0.10 cm^3, calculate the percentage error in this titre.

(1)

(iii) A similar solution, containing the same concentration of $[Ni(H_2O)_6]^{2+}$ ions, also contained a small amount of an impurity, copper(II) sulfate.

Suggest what effect this impurity would have on the titre. Justify your answer.

(2)

.....

.....

.....

.....

(Total for Question 1 = 11 marks)

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2 A colourless liquid, compound **X**, was extracted from raspberries. **X** has the molecular formula $C_{10}H_{12}O_2$ and contains a benzene ring.

(a) What would you expect to see if a sample of compound **X** was burned in air?

(1)

.....

.....

(b) A series of tests was carried out on compound **X**. In each test, state what you can deduce about the structure of compound **X** from the results described.

(i) **X** forms a white precipitate with aqueous bromine solution.

(1)

.....

.....

(ii) **X** forms an orange precipitate with 2,4-dinitrophenylhydrazine.

(1)

.....

.....

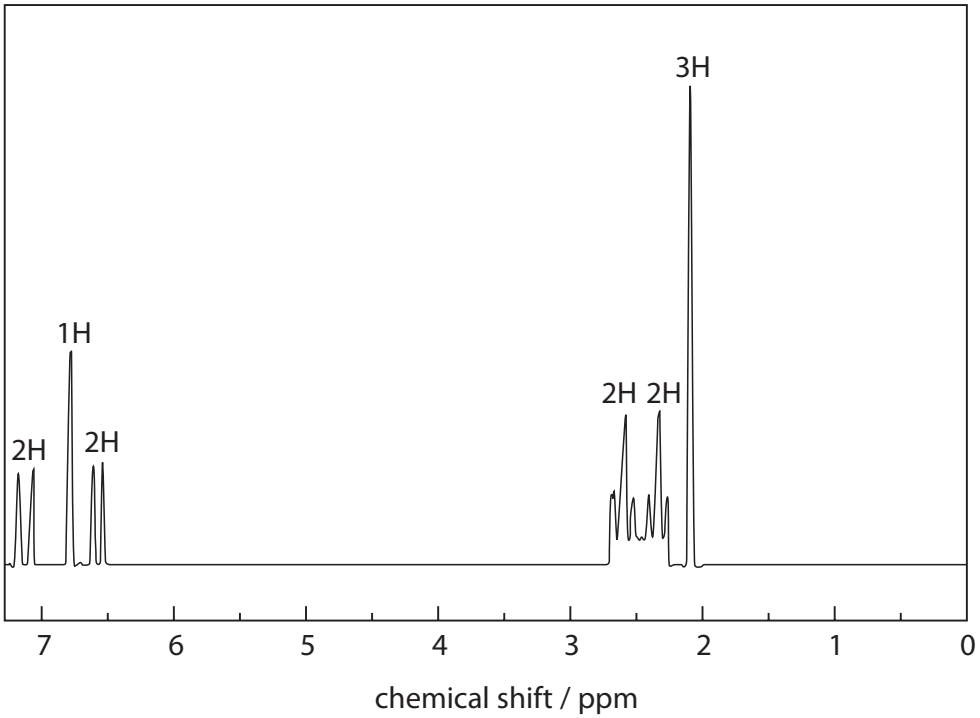
(iii) Fehling's (or Benedict's) solution remains blue when warmed with compound **X**.

(1)

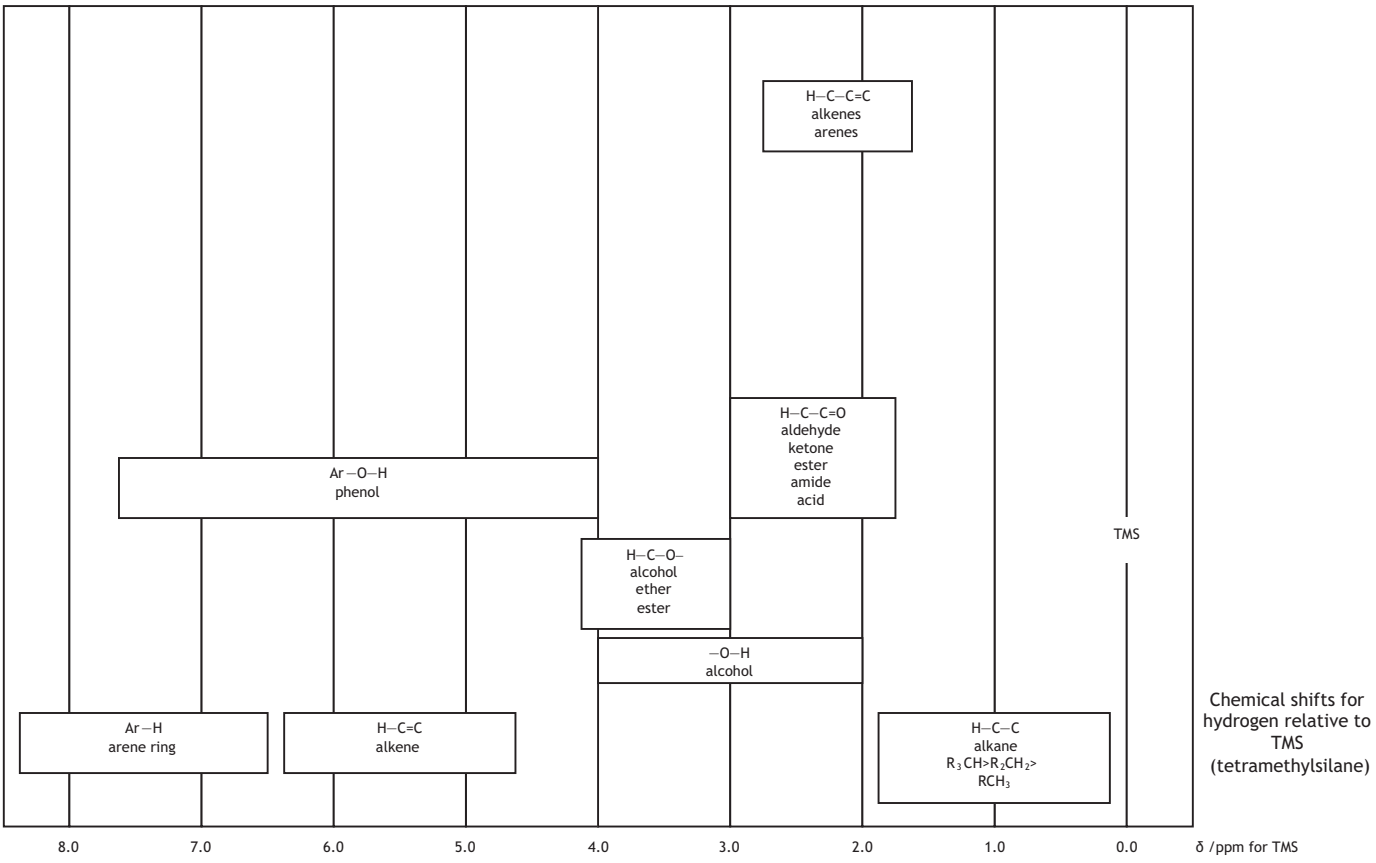
.....

.....

(c) The high resolution proton nmr spectrum of compound **X** is shown below. This spectrum shows that there are six different proton environments in the molecule of **X**. The relative number of hydrogen atoms in each environment is indicated on the spectrum. Use this spectrum, the data below and your answers to (a) and (b) to help answer the questions that follow.



Nuclear Magnetic Resonance

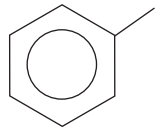


(i) Which hydrogen atoms in compound **X** are most likely to have caused the peaks at 6.5 ppm and 7.2 ppm?

(1)

.....

(ii) Compound **X** has a side chain containing four carbon atoms attached to the benzene ring. Show all the atoms on this side chain and label each hydrogen environment on the side chain with its splitting pattern.



(3)

.....

.....

.....

.....

.....

.....

(iii) Suggest the structural formula of **X**.

(1)

(d) Compound **X** can be extracted from raspberries by steam distillation. Draw a labelled diagram of the apparatus you could use to carry out this steam distillation.

(3)

(Total for Question 2 = 12 marks)

3 Glucose can be oxidized using acidified potassium manganate(VII). The kinetics of the reaction can be studied using the procedure outlined below.

1. Measured volumes of glucose solution, sulfuric acid and water were added to a conical flask.
2. A measured volume of potassium manganate(VII) solution was added to the flask. The mixture was gently swirled and a stopwatch started.
3. The time taken for the mixture in the flask to change colour was recorded and the initial rate of the reaction was then calculated.
4. The experiment was repeated using different volumes of the solutions.

The results of the experiments are shown in the table below.

Experiment	Glucose / cm^3	Sulfuric acid / cm^3	Potassium manganate(VII) / cm^3	Water / cm^3	Initial rate / mol dm^{-3} s^{-1}
A	20.0	20.0	10.0	0.0	1.0×10^{-5}
B	20.0	20.0	5.0	5.0	5.0×10^{-6}
C	10.0	20.0	10.0	10.0	9.8×10^{-6}
D	10.0	10.0	10.0	20.0	4.9×10^{-6}

(a) (i) Which piece of equipment should be used to measure out the volumes used in each experiment? Justify your choice.

(2)

(ii) What colour change would you see in step 3?

(2)

From ..... to .....

(iii) Explain why water was added to the flask in experiments B, C and D.

(1)

.....

.....

(iv) Suggest a technique that could be used to continuously monitor the change in concentration of potassium manganate(VII) during the reaction.

(1)

.....

.....

(v) State the order with respect to glucose, sulfuric acid and potassium manganate(VII) and hence write the rate equation for the reaction.

(3)

(b) Experiment A was repeated at different temperatures and the time taken for the potassium manganate(VII) to change colour was recorded. The results were processed to find values of 1/temperature and ln (rate constant) and these are shown in the table below.

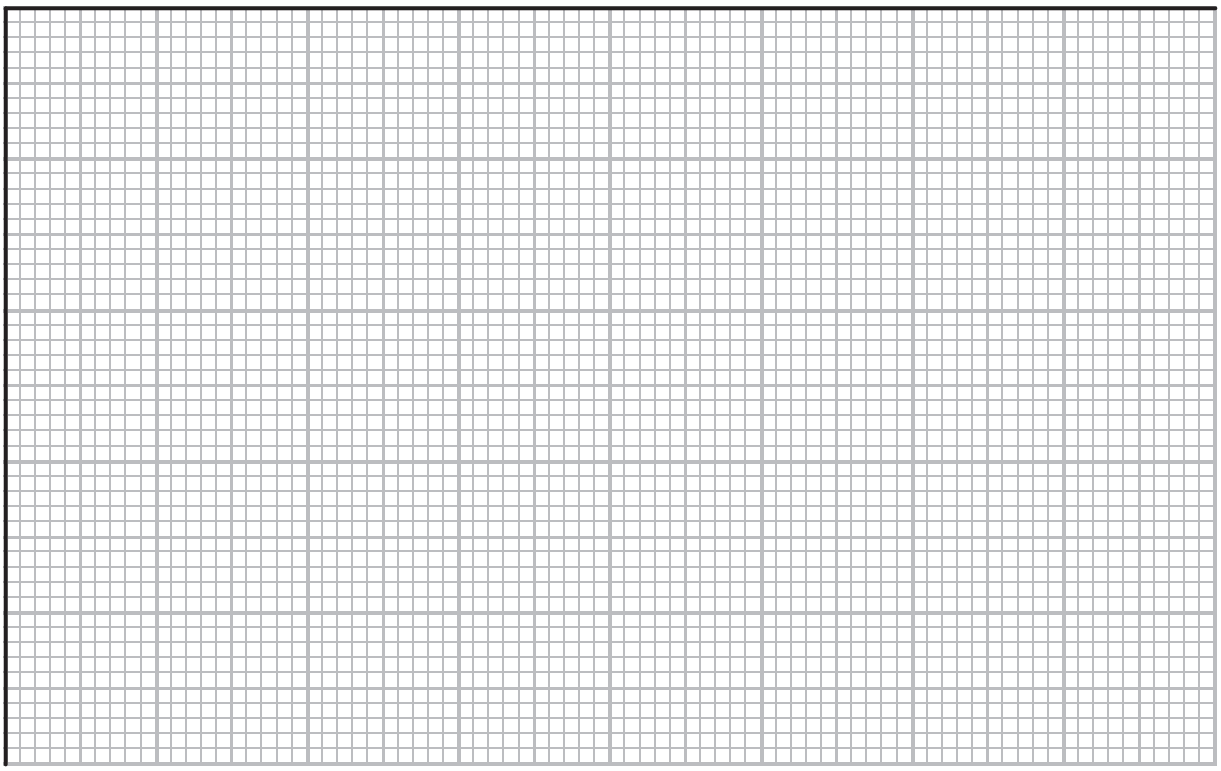
Experiment	1 / temperature / K^{-1}	ln (rate constant)
E	3.00×10^{-3}	–1.60
F	3.10×10^{-3}	–2.60
G	3.21×10^{-3}	–3.75
H	3.35×10^{-3}	–5.20

(i) Plot a graph of ln (rate constant) against 1 / temperature on the axes below.

(3)

1 / temperature / K^{-1}

ln (rate constant)



(ii) Calculate the gradient of the graph.

(1)

(iii) Use your answer to (ii) and the relationship below to calculate the activation energy, E_a, for this reaction. Include a sign and units in your answer.

$$\text{Gradient} = \frac{-E_a}{R}$$

$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$

(2)

(Total for Question 3 = 15 marks)

4 The procedure outlined below can be used to extract caffeine from tea.

1. Add 25 g of tea, 10 g of calcium carbonate and 250 cm^3 of water to a large beaker.
2. Gently boil the mixture for 15 minutes.
3. While the mixture is still warm, filter using suction filtration.
4. Transfer the filtrate to a separating funnel and separate the caffeine from the aqueous mixture using solvent extraction, with dichloromethane as the solvent.
5. Dry the extract.
6. Remove the solvent.

[Density of dichloromethane = 1.32 g cm^{-3}]

(a) (i) Outline how to carry out the solvent extraction in **step 4**, to obtain a solution of caffeine dissolved in dichloromethane.

(3)

(ii) How would you dry the extract in **step 5**? Include the name of a suitable drying agent in your answer.

(2)

(b) (i) The solvent dichloromethane is harmful and can enter the body through inhalation and skin absorption. Suggest a possible way to minimise each of these risks when using dichloromethane.

(2)

Inhalation .....

Skin absorption .....

(ii) Suggest a suitable way to remove the solvent in **step 6**.

(1)

(c) The extraction can also be carried out using liquid carbon dioxide. Suggest an advantage of using this rather than dichloromethane.

(1)

(d) A student carrying out this extraction obtained 85 mg of caffeine. Calculate the percentage by mass of caffeine obtained from the sample of tea used.

(2)

(e) Caffeine obtained in this way is often a pale green solid, due to impurities. State the name of another technique you could use to further purify the caffeine.

(1)

.....

.....

(Total for Question 4 = 12 marks)

TOTAL FOR PAPER = 50 MARKS

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8) (18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)		Key: relative atomic mass / atomic symbol / name / atomic (proton) number									(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

* Actinide 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
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

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Mark Scheme (Results)

Summer 2013

GCE Chemistry 6CH01/01
The Core Principles of Chemistry

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Summer 2013
Publications Code US035557

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when appropriate

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Section A

Question Number	Correct Answer	Reject	Mark
1	C		**1**

Question Number	Correct Answer	Reject	Mark
2	C		**1**

Question Number	Correct Answer	Reject	Mark
3	D		**1**

Question Number	Correct Answer	Reject	Mark
4	B		**1**

Question Number	Correct Answer	Reject	Mark
5	A		**1**

Question Number	Correct Answer	Reject	Mark
6	B		**1**

Question Number	Correct Answer	Reject	Mark
7	A		**1**

Question Number	Correct Answer	Reject	Mark
8	C		**1**

Question Number	Correct Answer	Reject	Mark
9	B		**1**

Question Number	Correct Answer	Reject	Mark
10	D		**1**

Question Number	Correct Answer	Reject	Mark
11	C		**1**

Question Number	Correct Answer	Reject	Mark
12	A		**1**

Question Number	Correct Answer	Reject	Mark
13	A		**1**

Question Number	Correct Answer	Reject	Mark
14	C		**1**

Question Number	Correct Answer	Reject	Mark
15	D		**1**

Question Number	Correct Answer	Reject	Mark
16a	D		**1**

Question Number	Correct Answer	Reject	Mark
16b	C		**1**

Question Number	Correct Answer	Reject	Mark
16c	A		**1**

Question Number	Correct Answer	Reject	Mark
16d	D		**1**

Question Number	Correct Answer	Reject	Mark
17	B		**1**

Total for Section A = 20 Marks

Question Number	Acceptable Answers	Reject	Mark
18(a)	<table><tr><td>Isotope</td><td>$^{131}I_{53}$</td><td>$^{127}I_{53}$</td></tr><tr><td>Number of protons</td><td>53</td><td>53</td></tr><tr><td>Number of neutrons</td><td>78</td><td>74</td></tr></table>		**2**

Question Number	Acceptable Answers	Reject	Mark
18(b)	Xenon / Xe / $_{54}$Xe / Xe_{54} / $^{131}_{54}Xe$	Anything else including: $^{130}Xe_{54}$ Xe^- Iodine / I with or without numbers Hydrogen / H with or without numbers Te	**1**

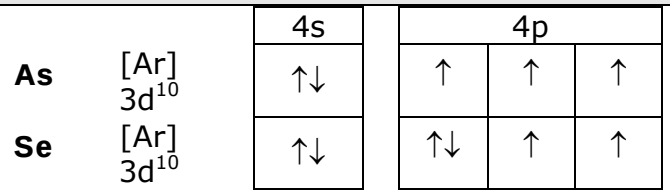
Question Number	Acceptable Answers	Reject	Mark
18(c)	Potassium iodide / KI Accept any soluble, non-toxic iodide or iodate Wrong name, correct formula (0) Correct name, wrong formula (0)	HI KI_3 Wrong formulae like CaI, MgI Wrong name like calcium idodate BaI_2 (toxic) AgI (insoluble) Potassium iodine	**1**

Question Number	Acceptable Answers	Reject	Mark
18(d)	Country /ALLOW state **and** justification Both needed for one mark e.g. Japan / New Zealand / California etc Country / state at risk from Earthquake / tsunami / flooding Further examples: Italy with volcanoes Afghanistan / middle eastern / African countries terrorist / (nuclear) weapon threat / war zone / political instability / abuse of nuclear power. USA /America / Jamaica etc risk of hurricane / tornado California San Andreas fault	…population density …landslide …too hot … surrounded by other countries Antarctica	**1**

Total for Question 18 = 5 Marks

Question Number	Acceptable Answers	Reject	Mark
19(a)	$As(g) - e^{(-)} \rightarrow As^{+}(g)$ OR $As(g) \rightarrow As^{+}(g) + e^{(-)}$ Entities **(1)** All species gaseous **(1)** providing a reasonable attempt at an ionization energy Examples: $As(g) + e^{(-)} \rightarrow As^{+}(g)$ $As(g) - e^{(-)} \rightarrow As^{-}(g)$ $As^{2+}(g) - e^{(-)} \rightarrow As^{3+}(g)$ IGNORE state symbol of electron ALLOW upper case / large S in arsenic ALLOW $As(g) + e^{(-)} \rightarrow As^{+}(g) + 2e^{(-)}$ **(2)**	$As(g)+e^{(-)} \rightarrow As^{-}(g)$ (electron affinity)	**2**

Question Number	Acceptable Answers	Reject	Mark
19(b)	AsH_3 / H_3As **(1)** H_2Se / SeH_2 **(1)** IGNORE charges ALLOW upper case / large S in arsenic **NOTE:** If two or more answers given for one element mark that element on a plus minus basis	SE for Selenium	**2**

Question Number	Acceptable Answers	Reject	Mark
19(c)(i)	 One mark for each row Arrows may be half-headed Arrows must be in same direction if in singly occupied boxes (can be down) ALLOW two arrows for Se in any 4p box Selenium two arrows must show opposite spins		**2**

Question Number	Acceptable Answers	Reject	Mark
19(c)(ii)	**For parts c(ii),d and e it is important to keep in mind the two elements involved in each part** **As and Se** **First mark:** EITHER In Se, (spin) pairing has occurred (for the first time in that p sub-shell) OR electron removed from orbital containing two electrons **(1)** ALLOW sub-shell for orbital **Second mark:** EITHER (Increase in) repulsion (so electron lost more easily) OR Half-filled (sub-) shell/allow orbital (particularly) stable (in As) ALLOW orbital for sub-shell **(1)** Mark each point independently IGNORE reference to distance from nucleus and shielding		**2**

Question Number	Acceptable Answers	Reject	Mark
19(d)	**Se and Kr** **First mark:** EITHER The nuclear charge is increasing (Nuclear must be stated or clearly implied) OR number of protons / atomic number is increasing **(1)** **Second mark:** (Outermost) electron closer to nucleus / electron is removed from the same (sub)shell / electron experiences similar shielding / (atomic) radius is smaller/ smaller **atom** **(1)** ALLOW reverse arguments for selenium IGNORE Kr has full outer shell	Ionic radius Molecule (unless monatomic)	**2**

Question Number	Acceptable Answers	Reject	Mark
19(e)	**Kr and Rb** Any two from: The **electron** (in Rb) (removed) is further from the nucleus **(1)** The **electron** is in a higher / new / another / 5s (energy quantum) shell / energy level **(1)** **More** shielded **(1)** IGNORE any reference to stability of krypton or larger atomic radius of Rb / full outer shell of Kr It is possible that two answers may be offered together in one sentence e.g. Rb outer electron is in another shell further from nucleus (2)		**2**

Question Number	Acceptable Answers	Reject	Mark
19(f)	Krypton / Kr	Anything else	**1**

Total for Question 19 = 13 Marks

Question Number	Acceptable Answers	Reject	Mark
20(a)(i)	$CuO(s) + 2H^+(aq) \rightarrow Cu^{2+}(aq) + H_2O(l)$ Left hand side **(1)** right hand side **(1)** If SO_4^{2-} are on both sides max one mark ALLOW correct entities and balancing with no or incorrect state symbols for one mark. ALLOW multiples It is sometimes difficult to be sure of the '2' on the Cu^{2+}. Give BOD provided $2H^+$ on the left of the equation	Charges within water molecule	**2**

Question Number	Acceptable Answers	Reject	Mark
20(a)(ii)	1.749/1.75/1.7 with or without working scores 2 If answer incorrect look for Mass = 79.5 x 0.02 OR =1.59 (1) OR TE from incorrect mass for one mark Their mass x 1.1= their correct answer to 2/3/4SF (g) (1) Accept crossed 7's ALLOW both ways of writing 4 and be generous if 4 looks like 9	1.74 1.8	**2**

Question Number	Acceptable Answers	Reject	Mark
20(b)(i)	Add in small portions / use a spatula / use a **small** spoon / slowly / gradually **(1)** To prevent (mixture / acid) boiling over / frothing / spilling / splashing / splash back **(1)** Mark independently Bubbles are neutral IGNORE add carefully / cautiously alone	Spitting / violent reaction / fizzing Because reaction is exothermic alone Bubbles of carbon dioxide	**2**

Question Number	Acceptable Answers	Reject	Mark
20(b)(ii)	Dip in glass rod. Remove and allow to cool. See if crystals form ALLOW any workable suggestion Examples: See crystals / salt forming around edge of beaker Depth of colour of solution increases Solution / colour becomes darker Solution / colour becomes deeper blue Dark blue solution Reduce volume by at least half / until crystals form	Solution thickens Precipitate forming	**1**

Question Number	Acceptable Answers	Reject	Mark
20(b)(iii)	Blue	Any mention of green or other colour	**1**

Question Number	Acceptable Answers	Reject	Mark
20(b)(iv)	(The ions are arranged in a) regular (way) / lattice OR The ions are arranged in the same way / have same arrangement / have uniform arrangement The term structure is neutral and should be ignored IGNORE statements about ions attracting or repelling	The ions are arranged in a similar / fixed way	**1**

Question Number	Acceptable Answers	Reject	Mark
20(c)(i)	249.6 g mol^{-1} ALLOW 249.5 g mol^{-1} ALLOW 250 g mol^{-1} value **(1)** units **(1)** Common wrong values are 159.5 / 6, 185.5 / 6, 249 ALLOW unit mark with any or no value. ALLOW g / mol for unit	g/mol^{-1}	**2**

Question Number	Acceptable Answers	Reject	Mark
20(c)(ii)	Max yield = 249.6 x 0.02 = 4.992(g) **(1)** Percentage yield = $\frac{2.7 \times 100}{4.992}$ = (54.0865) = 54% **(1)** If 249.5 is used = (54.1082) = 54% OR 2.7 / 249.6 = 0.01082 **(1)** Percentage yield = 0.01082 x 100/0.02 = 54% **(1)** ALLOW TE from any value in (i), and note 159.6 gives 84.6% 185.6 gives 72.7% IGNORE SF except one SF Correct answer, no working scores (2)		**2**

Question Number	Acceptable Answers	Reject	Mark
20(c)(iii)	(Copper(II) sulfate is soluble) so some remains in solution / some remains on the **filter paper** IGNORE other transfer errors Incomplete crystallization / not all the crystals are formed	Experimental error/ incomplete reaction Filtering alone Efflorescence	**1**

Question Number	Acceptable Answers	Reject	Mark
20(d)	This is a (chemical) test for (the presence of) water Invisible ink Moisture / humidity test Test to see if solutions are aqueous	Check to see if substance is hydrated Drying agent Quantitative measurements of water content.	**1**

Total for Question 20 = 15 Marks

Question Number	Acceptable Answers	Reject	Mark
21(a)(i)	25 x 4.18 x 11 = 1149.5 (J) ALLOW 1.1495 **kJ** Otherwise ignore units even if incorrect IGNORE sign IGNORE SF except one or two SF	1149.5 **kJ**	**1**

Question Number	Acceptable Answers	Reject	Mark
21(a)(ii)	-115 kJ mol^{-1} ALLOW -115000 J mol^{-1} Sign with correct value **(1)** Units and three significant figures **(1)** Mark independently ALLOW TE from (i) -114 kJ mol^{-1} (rounding error) scores 1 -115.0 kJ mol^{-1} scores 1 Values of -4600 and -3.86 are quite common ALLOW K and j in any case in units	J or kJ alone	**2**

Question Number	Acceptable Answers	Reject	Mark
21(b)	$2NaHCO_3(s) \square Na_2CO_3(s)+CO_2(g)+H_2O(l)$ 2HCl(aq) (2HCl(aq)) $2NaCl(aq) + 2CO_2(g) + 2H_2O(l)$ **First mark** Arrow from products in top line to lower line and correct entities **(1)** $NaCl + CO_2 + H_2O$ **Second mark** **2**$NaCl$**(aq)** + **2**CO_2**(g)** + **2**H_2O**(l)** Correct state symbols and balancing **(1)** ΔH^o = **+**91.6 OR +91.7 (kJ mol^{-1}) ALLOW no positive sign only if correct Working with correct signs given **(3)** OR **Third mark** Correct use of Hess's Law (in numbers or symbols) consistent with arrow direction **(1)** **Fourth mark** **2x**(-115) = ΔH^o - 321.6 Correct multiples and numbers **(1)** ALLOW 2 x any number (including -4600 and -3.86) except 2 x +/- 321.6 Notice Third and Fourth marks can be scored by $\Delta H^o = 2(-115) - (-321.6)$		**5**

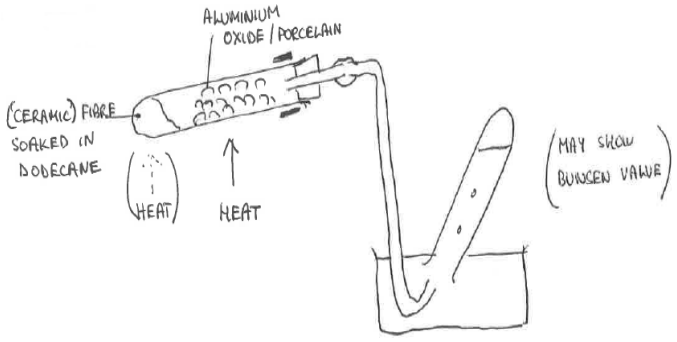
	Fifth mark ΔH^o = 2(−115) − (-321.6) = **+**91.6 (kJ mol^{-1}) OR ΔH^o = 2(−114.95) − (-321.6) = **+**91.7 (kJ mol^{-1}) Correct value for their calculation with correct sign IGNORE SF except 1 ALLOW no positive sign only if correct working with correct signs given **(1)** Omitting 2x gives +206.6 (could get 4 marks) -4600 gives -598.4 -3.86 gives +313.88		

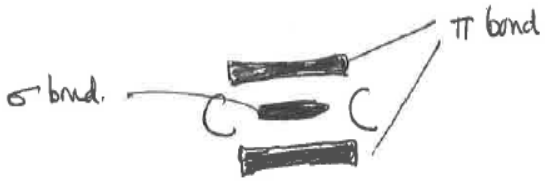
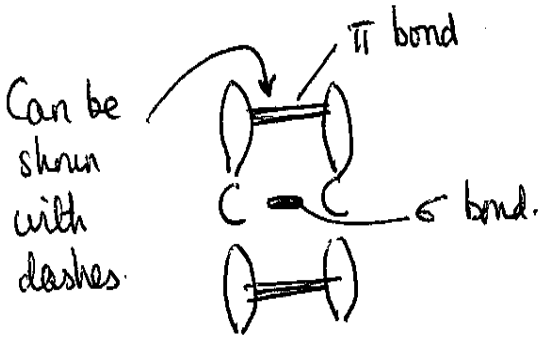
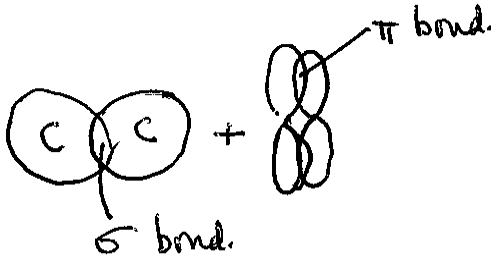
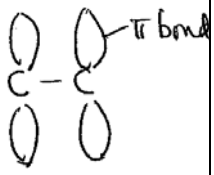
Question Number	Acceptable Answers	Reject	Mark
21(c)	((±) 0.5 x 2 x 100 /11) = (±)9.09 (%) ALLOW at 9.0909/9.091/9.1 and 9	 9.10/9.0	**1**

Question Number	Acceptable Answers	Reject	Mark
21(d)	**First mark** It is used as a raising agent / self raising flour / baking soda / baking powder OR Causes cakes / (soda) bread to rise / expand. **(1)** **Second mark** Carbon dioxide (released on heating causes cakes / bread to rise) OR It reacts with acid to form carbon dioxide (in baking powder) providing bread /cake etc is mentioned **(1)** ALLOW Used in cooking green vegetables To keep green colour	To make pastry rise Bicarbonate of soda Gas Air Neutralizing acid foods	**2**

Total for Question 21 = 11 Marks

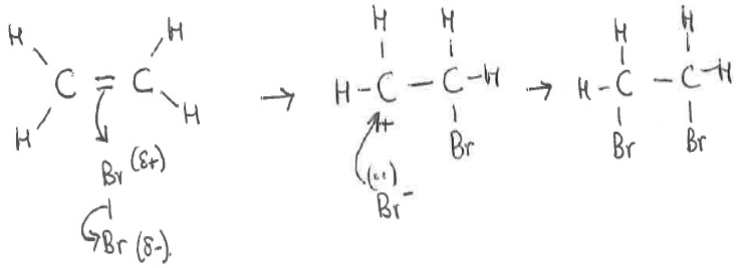
Question Number	Acceptable Answers	Reject	Mark
22(a)(i)	$C_{12}H_{26} \rightarrow C_{10}H_{22} + C_2H_4$ IGNORE state symbols even if incorrect ALLOW displayed and structural formula for ethene		**1**

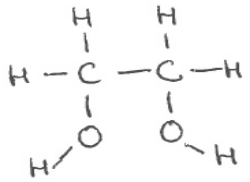
Question Number	Acceptable Answers	Reject	Mark
22 (a)(ii)	Collection over water or in gas syringe **(1)** IGNORE solid bung with delivery tube coming out / accidental sealing in drawing / clamps This is the only stand alone mark **Dependent on diagram including roughly horizontal tube:** Labelled ceramic fibre / any sort of wool (unless any named metal) (soaked in dodecane) **(1)** Aluminium oxide / porcelain pieces/catalyst / catalyst with incorrect name or incorrect formula / any named metal / anti-bump granules **(1)** Heat under catalyst/under middle of test tube **(1)**  	Delivery tube through glassware	**4**

Question Number	Acceptable Answers	Reject	Mark
22(b)	EITHER  Diagram of bonds, the single bond must be shown as a region of space and not as a single or double straight line **(1)** Labelled σ and π in correct places on correctly drawn bonds.ie this mark can only be awarded if bonds correctly drawn **(1)** OR   Labelled pi bond **(1)** Labelled sigma bond **(1)** Whichever scores more Bonds may be shown by overlap of appropriate orbitals, when any orbital or region of overlap may be labelled Only one pi lobe / bond need be labelled Carbons need not be shown Bonds may be drawn on separate diagrams	 	**2**

	IGNORE C-H bonds IGNORE any additional electron density maps IGNORE any partial charges		

Question Number	Acceptable Answers	Reject	Mark
22(c)(i)	1,2-dibromoethane **(1)** IGNORE punctuation CH_2BrCH_2Br **(1)** ALLOW displayed / skeletal formula Mark independently Bromoethane with CH_2BrCH_3 (0)	$C_2H_4Br_2$	**2**

Question Number	Acceptable Answers	Reject	Mark
22 (c)(ii)	 Arrow from double bond towards nearest bromine atom and arrow from bond between bromine atoms to furthest bromine atom **(1)** Correct formula of carbocation intermediate **(1)** Arrow from anywhere on the brom**ide** ion to positive carbon **(1)** ALLOW missing hydrogens if bonds from carbons shown ALLOW full marks for TE bromoethane formation using HBr and first arrow to H of HBr ALLOW full marks for TE 1,2 – dibromopropane		**3**

Question Number	Acceptable Answers	Reject	Mark
22(d)	 ALLOW O-H not displayed ALLOW vertical C bond to any part of OH Only penalise clear C-H-O / CH-O bond horizontally IGNORE any name whether correct or not	Skeletal formula or structural formula	**1**

Question Number	Acceptable Answers	Reject	Mark
22(e)(i)	$nCH_2=CH_2 \rightarrow (CH_2\text{-}CH_2)_n$ Left side **(1)** Right side extension bonds must be shown **(1)** Mark independently Accept $nC_2H_4 \rightarrow (CH_2\text{-}CH_2)_n$ Penalise omission of n only once ALLOW $nCH_2=CH_2 + nCH_2=CH_2 \rightarrow (CH_2\text{-}CH_2)_n$ for (2) ALLOW multiples of C_2H_4 in product	$(CH_2=CH_2)_n$ N	**2**

Question Number	Acceptable Answers	Reject	Mark
22(e)(ii)	**100%** with one of the following: …only one product OR … no by-products / no other product OR …all reactants form the product OR …as addition reaction IGNORE…same empirical formula	 No product lost / No side reaction(s) All reactants form the product**s**	**1**

Total for Question 22 = 16 Marks

Total for Paper = 80 Marks

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Mark Scheme (Results)

Summer 2013

GCE Chemistry 6CH01/01R
The Core Principles of Chemistry

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Summer 2013
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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear

  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter

  iii) organise information clearly and coherently, using specialist vocabulary when appropriate

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.

( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear

- select and use a form and style of writing appropriate to purpose and to complex subject matter

- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.

Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Section A

Question Number	Correct Answer	Mark
1	C	**1**

Question Number	Correct Answer	Mark
2	B	**1**

Question Number	Correct Answer	Mark
3	B	**1**

Question Number	Correct Answer	Mark
4	D	**1**

Question Number	Correct Answer	Mark
5	D	**1**

Question Number	Correct Answer	Mark
6	A	**1**

Question Number	Correct Answer	Mark
7	D	**1**

Question Number	Correct Answer	Mark
8	B	**1**

Question Number	Correct Answer	Mark
9	C	**1**

Question Number	Correct Answer	Mark
10	A	**1**

Question Number	Correct Answer	Mark
11	D	**1**

Question Number	Correct Answer	Mark
12	C	**1**

Question Number	Correct Answer	Mark
13	C	**1**

Question Number	Correct Answer	Mark
14	B	**1**

Question Number	Correct Answer	Mark
15	D	**1**

Question Number	Correct Answer	Mark
16	C	**1**

Question Number	Correct Answer	Mark
17	B	**1**

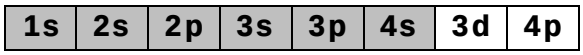
Question Number	Correct Answer	Mark
18	A	**1**

Question Number	Correct Answer	Mark
19	B	**1**

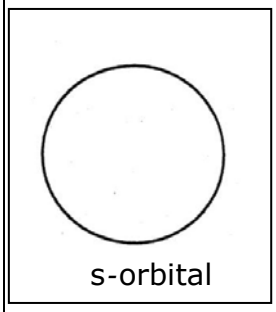
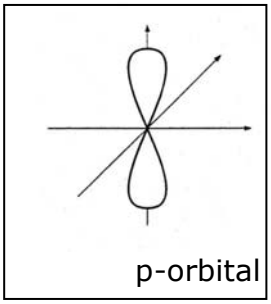
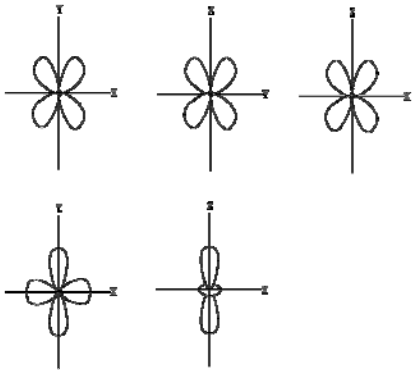
Question Number	Correct Answer	Mark
20	D	**1**

Total for Section A = 20 Marks

Section B

Question Number	Acceptable Answers	Reject	Mark
21 (a)	 3d 4p **(2)** ALLOW 4p 3d scores 1 out of 2 4p 5s scores 1 out of 2 ALLOW use of capital letters e.g. "3D and/or 4P"	'4p 4d' or '4d 4p' gets 0	**2**

Question Number	Acceptable Answers	Reject	Mark
21 (b)(i)	A region / space / volume (around the nucleus / atom) where there is a high probability / chance / likelihood / of finding an electron ALLOW 'area' / 'sub-shell' as alternative for region OR A region where an electron is likely to be found	Just 'the path an electron takes orbiting around a nucleus' Just 'Position of electrons in an atom'	**1**

Question Number	Acceptable Answers	Reject	Mark
21 (b)(ii)	 s-orbital **(1)**  p-orbital **(1)**	For s-orbital do not allow ellipse for first mark pi bond d-orbitals shown below 	**2**

Question Number	Acceptable Answers	Reject	Mark
21 (c)	11 / eleven ALLOW $2p^6 3p^5$	$1s^2 2s^2 2p^6 3s^2 3p^5$	**1**

Question Number	Acceptable Answers	Reject	Mark
21 (d)	18 / eighteen	$1s^2 2s^2 2p^6 3s^2 3p^6$	**1**

Question Number	Acceptable Answers	Reject	Mark
***21 (e)**	Enthalpy / energy / heat / heat energy per mole **required / needed** OR Enthalpy / energy / heat / heat energy **change** per mole **(1)** to remove one / an electron **(1)** from **gaseous atom(s)** **(1)** "Energy required to remove one mole of electrons from one mole of gaseous atoms" scores all **three** marks NOTE: The equation: $X(g) \rightarrow X^{+}(g) + e^{-}$ scores the last two marks NOTE: An incorrect equation given with a correct definition in words scores 2 out of 3 marks	"Energy **given out** …" for first mark	**3**

Question Number	Acceptable Answers		Mark
21 (f)	<table><tr><td>**Ionization energy / kJ mol^{-1}**</td><td>496</td><td>4563</td><td>6913</td><td>9544</td><td>13352</td><td>16611</td><td>20115</td><td>25491</td><td>28934</td><td>141367</td><td>159079</td></tr><tr><td>**Ionization number**</td><td>1st</td><td>2nd</td><td>3rd</td><td>4th</td><td>5th</td><td>6th</td><td>7th</td><td>8th</td><td>9th</td><td>10th</td><td>11th</td></tr><tr><td></td><td>✓</td><td></td><td></td><td></td><td></td><td></td><td></td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr></table> All five correct = **2** marks Four/three correct = **1** mark Two/one/none correct = **0** marks	**2**

Total for Question 21 = 12 marks

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Question Number	Acceptable Answers	Reject	Mark
22(a)(i)	**The mark is for the idea of impact by high energy electrons** **Any ONE of:** High-energy **electrons** Bombard with **electrons** Fast **electrons** (fired at sample) Accelerated **electrons** (fired at sample) (High-energy) **electrons** fired (at sample) (Sample) blasted with **electrons** **Electron** gun ALLOW "beam of **electrons**" IGNORE any comments about ionization of the sample whether correct or incorrect IGNORE descriptions of vaporisation	High-**density** electrons	**1**

Question Number	Acceptable Answers	Reject	Mark
22(a)(ii)	Electric field / (negatively) charged plates ALLOW voltage plates electrostatic field electrical field pushed by positively (charged) plate/ anode	**Positively** charged plates alone / electronic field / electric current / electricity / electrical charge / (electro) magnetic field / electric coil	**1**

Question Number	Acceptable Answers	Reject	Mark
22 (a)(iii)	Magnetic field /magnet / electromagnet /magnetic plates / electromagnetic field	**Negative** magnetic field/ negatively charged magnet	**1**

Question Number	Acceptable Answers	Reject	Mark
22(b)	(194 x 32.8) + (195 x 30.6) + (196 x 25.4) + (198 x 11.2)) ÷ 100 **(1)** = 195.262 = 195.3 **(1 d.p.)** **(1)** Method **(1)** Answer must be to **1 d.p.** IGNORE g , g mol^{-1} or amu but other wrong units lose a mark Correct answer with no working **(2)** ALLOW TE for second mark if 1 numerical slip in transferring data from the table and answer to 1 d.p		**2**

Question Number	Acceptable Answers	Reject	Mark
22(c)	d(-block) ALLOW D(-block) IGNORE Transition element(s) / transition metal(s)		**1**

Question Number	Acceptable Answers	Reject	Mark
22(d)(i)	**(Na):** ✓ and ✓ **(1)** **(Na_2O):** **X** and ✓ **(1)**		**2**

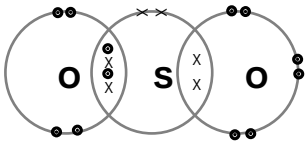
Question Number	Acceptable Answers	Reject	Mark
***22 (d) (ii)**	**Na:** conducts when **both** solid and molten due to (delocalized)**free / mobile electrons** **(1)** **Na_2O:** does not conduct when solid as no mobile **ions** / **ions** unable to move / **ions** in fixed position **(1)** **Na_2O:** conducts when molten as has mobile **ions** **(1)**	Ions with reference to either form of sodium metal electrons electrons	**3**

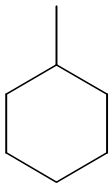
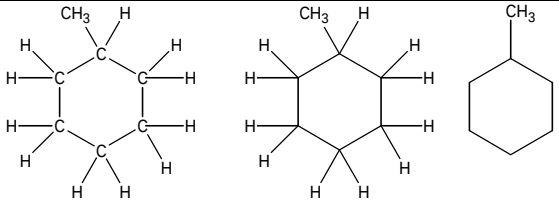
Total for Question 22 = 11 marks

Question Number	Acceptable Answers	Reject	Mark
23(a)	C_nH_{2n+2} IGNORE 'where n=1, 2, 3 etc' or 'where n is greater than 1'		**1**

Question Number	Acceptable Answers	Reject	Mark
23(b)(i)	$C_{10}H_{22} + 10½O_2 \rightarrow 10CO + 11H_2O$ ALLOW 21 / 2 O_2 ALLOW any correct multiples IGNORE state symbols, even if incorrect	21 [O]	**1**

Question Number	Acceptable Answers	Reject	Mark
23(b)(ii)	Any statement that makes it clear there is not enough air or oxygen e.g. Limited supply of air / limited supply of oxygen / not enough air / not enough oxygen / lack of oxygen / little amount of oxygen/ small amount of oxygen IGNORE "it is not completely oxidized"		**1**

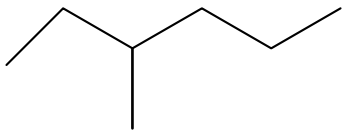
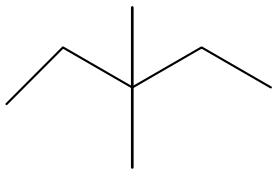
Question Number	Acceptable Answers	Reject	Mark
23(c)	**First mark** Dative pair of e^- between S and right-hand O **(1)** **Second mark** Two bond pairs between S and left-hand O **(1)** **Third mark** Two lone pairs on left-hand O, one lone pair on central S and three lone pairs on right-hand O atom **(1)** If 2 double bonds between sulfur and each oxygen then the third mark can be given for two lone pairs on both oxygens and one lone pair on central S  NOTE ALLOW dots and crosses that have been reversed Lone pair electrons can be shown as separated (rather than having to be paired up) – **it is the total number of electrons in each outer shell that matters** Stand alone marks If molecule shown as charged then 2 max		**3**

Question Number	Acceptable Answers	Reject	Mark
23(d)(i)		 benzene ring	**1**

Question Number	Acceptable Answers	Reject	Mark
23(d)(ii)	$C_7H_{16} \rightarrow C_7H_{14} + H_2$ ALLOW $C_6H_{11}CH_3$ IGNORE state symbols, even if incorrect	Formulae other than molecular formulae Any other structural or displayed formulae	**1**

Question Number	Acceptable Answers	Reject	Mark
23(d)(iii)	Any **ONE** of: (a cyclic alkane) has more efficient combustion allows smoother burning increases octane number reduces knocking / less likely to produce pre-ignition is a more efficient fuel burns better / easier to burn /combusts more easily / improves combustion IGNORE (a cyclic alkane): increases the volatility of a fuel "ignites more easily" "is a better fuel" "burns more cleanly" IGNORE (a cyclic alkane) has a lower boiling point mentions of viscosity safer fuel	Less pollution / reduce waste High atom economy Produces useful products / hydrogen Used to make polymers Produces substances in higher demand / more valuable	**1**

Question Number	Acceptable Answers	Reject	Mark
23(e)(i)	2,2-dimethylpent**ane** IGNORE missing hyphen/missing comma	2-dimethylpentane	**1**

Question Number	Acceptable Answers	Reject	Mark
23(e)(ii)	 **(1)**  **(1)** IGNORE names even if incorrect IGNORE different length bonds IGNORE direction of methyl groups		**2**

Question Number	Acceptable Answers	Reject	Mark
23(f)(i)	U.V. / U.V.light / light / sunlight ALLOW high temperature	 heat alone	**1**

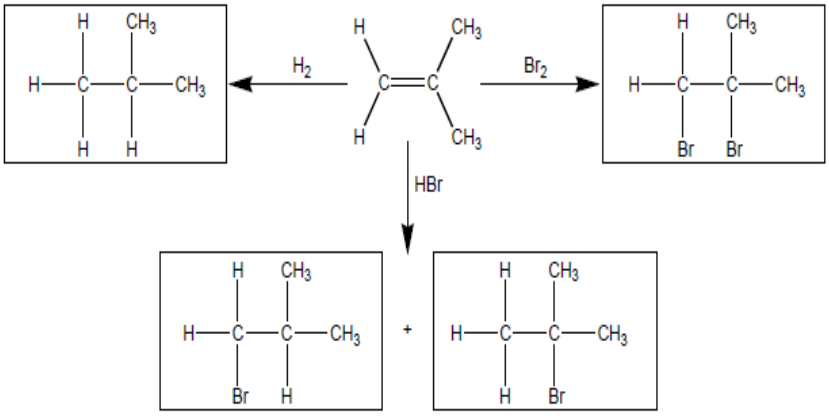
Question Number	Acceptable Answers	Reject	Mark
23(f)(ii)	$Cl_2 \rightarrow Cl\cdot + Cl\cdot$ / $Cl_2 \rightarrow 2Cl\cdot$ IGNORE any curly arrows, even if incorrect IGNORE C_4H_{10} given on both sides		**1**

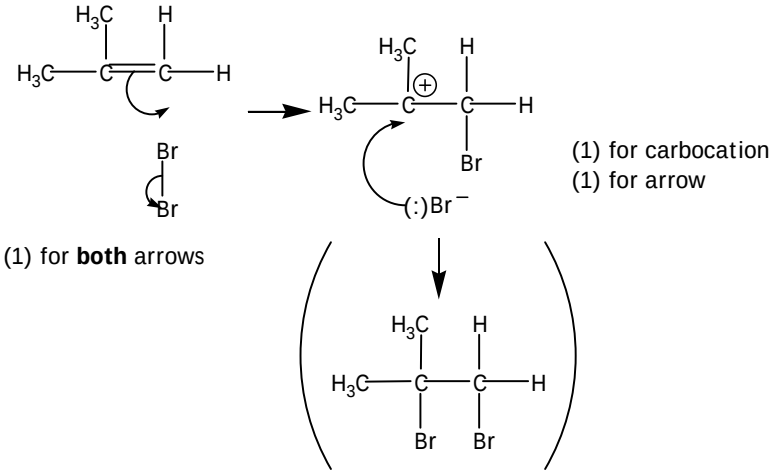
Question Number	Acceptable Answers	Reject	Mark
23(f)(iii)	Homolytic (fission) IGNORE any formulae and arrows	Photolysis (fission) / free radical (fission)	**1**

Question Number	Acceptable Answers	Reject	Mark
23(f)(iv)	**(First propagation step)** $C_4H_{10} + Cl\cdot \rightarrow C_4H_9\cdot + HCl$ **(1)** **(Second propagation step)** $C_4H_9\cdot + Cl_2 \rightarrow C_4H_9Cl + Cl\cdot$ **(1)** Formulae can be displayed 'dots' can be anywhere on free radical but no dots at all scores zero ALLOW in either order Incorrect alkane / halogenoalkane but two correct propagation steps scores 1 out of 2	Any reactions involving Hydrogen radicals scores zero Reverse of first reaction	**2**

Question Number	Acceptable Answers	Reject	Mark
23(f)(v)	Any **ONE** of: $C_4H_9\cdot + Cl\cdot \rightarrow C_4H_9Cl$ OR $Cl\cdot + Cl\cdot \rightarrow Cl_2$ OR $C_4H_9\cdot + C_4H_9\cdot \rightarrow C_8H_{18}$		**1**

Total for Question 23 = 18 marks

Question Number	Acceptable Answers	Reject	Mark
24(a)	 **(1)** for each correct product ALLOW correct displayed / skeletal / semi-skeletal / structural / semi-structural formula in each case ALLOW any order of symbols after or before each carbon ALLOW brackets or no brackets around Br/ CH_3 for example $CH_2BrCH_3CBrCH_3$		**4**

Question Number	Acceptable Answers	Reject	Mark
24(b)	 **First mark** **Double-headed** arrow from alkene must start from somewhere on C=C bond Partial charge on Br_2 molecule must be correct if shown **Second mark** is for either correct primary or secondary carbocation and is a standalone mark **Third mark** **Double-headed** arrow from bromide ion can start from the minus sign, a lone pair on Br^-, or from the Br and can go to the C or the + sign on the intermediate The **negative charge** must be present on the **bromide ion** The final product, if shown, must be correct to gain third mark Mechanisms with other electrophiles (e.g. HBr, BrOH) can score 2nd and 3rd marks	Single-headed arrow Bromine / bromide free radicals Single-headed arrow (Penalise again)	**3**

Question Number	Acceptable Answers	Reject	Mark
24(c)	**First mark is for calculating the theoretical maximum mass of ethene from 9.2 g ethanol:-** (46 g C_2H_5OH gives 28 g C_2H_4 so 9.2 g C_2H_5OH gives maximum mass of) **5.6 g** C_2H_4 **(1)** **Second mark is for calculating the percentage yield from candidate's theoretical maximum mass:-** (4.2/5.6 x 100% =) **75** (%) IGNORE s.f. except 1 s.f. OR **First mark** Amount of ethene = 4.2/28 = 0.15 (mol) and amount of ethanol = 9.2/46 = 0.20 (mol) **(1)** **Second mark** % yield = 0.15/0.20 = 75 % **(1)** **NOTE** Correct answer with no working scores **(2)** % yield TE on candidate's theoretical mass / moles only if % yield ‹100% If molar masses are reversed, award one mark for 27.8%	**(0)** for $\frac{4.2}{9.2}$ x 100%	**2**

Total for Question 24 = 9 marks

Question Number	Acceptable Answers	Reject	Mark
***25(a)**	**First mark** The enthalpy change when **one mole of water** is produced **(1)** **Second Mark** as a result of the reaction between an acid and an alkali / a base **(1)** OR **First Mark** The enthalpy change when **one mole** of H^+ / H_3O^+ / oxonium / hydronium / hydroxonium (ions) **(1)** **Second Mark** Reacts with one mole of / excess / just enough OH^- **(1)** ALLOW **First mark** The enthalpy change when **one mole of acid** is (just) neutralized **(1)** **Second Mark** By (excess) alkali / base **(1)** ALLOW reverse argument i.e. base neutralising acid	"Energy **required**…" for 1st mark	**2**

Question Number	Acceptable Answers	Reject	Mark
25(b)(i)	5643 without working score 2 marks IGNORE any signs **First mark** Recognition that volume of solution / mass of solution is 100 (cm^3 / g) **(1)** **Second mark** ΔT = 13.5 °C (energy released) = 100 x 4.18 x 13.5 = 5643 (J) **(1)** ALLOW 5.643 **kJ** IGNORE s.f. except 1 s.f. IGNORE mol^{-1}	5643 kJ	**2**

Question Number	Acceptable Answers	Reject	Mark
25(b)(ii)	(Moles HCl = c_{HCl} x V_{HCl} / 1000=) $\frac{2.00 \times 50.0}{1000}$ = 0.1(00) (mol HCl) IGNORE s.f.		**1**

Question Number	Acceptable Answers	Reject	Mark
25(b) (iii)	$H^+(aq) + OH^-(aq) \rightarrow / \rightleftharpoons H_2O(l)$ NOTE: **ALL State symbols AND ALL species are required for the mark** ALLOW equations with the "spectator ions" crossed out		**1**

Question Number	Acceptable Answers	Reject	Mark
25(b) (iv)	$-\frac{5.643}{0.1(00)} = -56.43$ **kJ mol^{-1}** **First mark:** Correct TE for calculations using answers to (b)(i) and (b)(ii) **(1)** **Second mark:** Minus sign **(1)** **Third mark:** Final answer in units of **kJ mol^{-1}** or **kJ/mol** ALLOW correct answer in J mol^{-1} if units given **(1)** IGNORE case of k and J IGNORE s.f. EXCEPT 1 s.f. NOTE: Correct answer, with or without working, scores **(3)**	Final answer to 1 s.f. kJ/mol^{-1} or just kJ just J	**3**

Question Number	Acceptable Answers	Reject	Mark
25(b)(v)	The **ionic equation** is the **same** OR number of moles of H^+ ions and OH^- is the same OR number of moles of H^+ ions and water is the same OR number of moles of OH^- ions and water is the same ALLOW Both acid and base are strong **and** produce 1 mol of water	Just 'forms one mole of water**(1)**'	**1**

Total for Question 25 = 10 marks

Total for Section B = 60 Marks

Total for Paper = 80 Marks

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