Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						6	2	4	6	/	0	2	Signature	

Paper Reference(s)

6246/02

Edexcel GCE

Chemistry

Advanced

Unit Test 6B (Synoptic)

Thursday 24 January 2008 – Morning

Time: 1 hour 30 minutes

MD00659533S9

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
Total	

Materials required for examination	Items included with question papers
Nil	Nil

Candidates may use a calculator.

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initial(s) and signature.
Answer Section A in the spaces provided in this question paper.
Answer **TWO** questions in Section B in the spaces provided in this question paper. Indicate which question you are answering by marking the box (☒). If you change your mind about a question, put a line through the box (☒) and then mark your new question with a cross (☒).
Show all the steps in any calculations and state the units.

Information for Candidates

The total mark for this paper is 50. The marks for individual questions and parts of questions are shown in round brackets: e.g. **(2)**. There are 20 pages in this question paper. All blank pages are indicated.
A Periodic Table is printed on the back cover of this question paper.

Advice to Candidates

You are reminded of the importance of clear English and careful presentation in your answers. You will be assessed on your Quality of Written Communication in this paper.

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SECTION A

Answer ALL parts of this question in the spaces provided.

1. The following procedure can be used to prepare ethyl ethanoate (boiling temperature 77 °C).

- Mix 20 cm^3 of ethanol (an excess) and 12.6 g of ethanoic acid in a pear-shaped flask.
- Slowly add 8 cm^3 of concentrated sulphuric acid, with cooling and mixing.
- Heat the mixture under reflux for 15 minutes.
- Allow the apparatus to cool and then re-arrange it for distillation.
- Collect everything that distils up to 80 °C.
- Purify the distillate.

(a) Write the equation for the reaction between ethanol and ethanoic acid.

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....

(1)

(b) What is the purpose of the concentrated sulphuric acid in this reaction?

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(1)

Leave blank

(c) Draw a diagram to show how you should set up the apparatus to distil the mixture.

(3)

Leave blank

(d) 10.6 g of pure ethyl ethanoate was collected.

Calculate the percentage yield of ethyl ethanoate obtained in this experiment.

(3)

(e) Ethyl ethanoate can also be prepared from ethanol and ethanoyl chloride.

(i) Write the equation for this reaction.

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(1)

(ii) Explain why the yield obtained by this method is significantly higher than that from ethanoic acid.

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(1)

Leave blank

(f) The solid ester phenyl benzoate can be prepared from phenol and benzoyl chloride. It is purified by recrystallisation.

(i) Explain what makes a solvent suitable for use in this recrystallisation.

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.... **(1)**

(ii) Explain why the mixture is filtered after dissolving the phenyl benzoate in the minimum amount of hot solvent.

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.... **(1)**

(iii) Explain why the mixture is filtered after cooling.

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.... **(1)**

(iv) Explain why the residue is washed with a small amount of cold solvent.

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.... **(1)**

(v) State how you would check that the sample after recrystallisation was pure.

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.... **(2)**

Q1

(Total 16 marks)

TOTAL FOR SECTION A: 16 MARKS

Leave blank

SECTION B

Answer any TWO questions from this section in the spaces provided.

If you answer Question 2 put a cross in this box ☒.

2. (a) Describe the structure of solid sodium chloride.

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(2)

(b) Explain, in terms of the bonding in solid sodium chloride and in the solution, why sodium chloride is soluble in water.

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(2)

(c) Draw a labelled Hess's Law cycle for the dissolving of sodium chloride in water.

Use it and the data below to calculate the enthalpy of solution of sodium chloride.

Lattice enthalpy of NaCl	–771 kJ mol^{-1}
Hydration enthalpy of Na^+	–406 kJ mol^{-1}
Hydration enthalpy of Cl^-	–364 kJ mol^{-1}

(3)

QUESTION 2 CONTINUES ON THE NEXT PAGE

Leave blank

(d) Bromine is produced during the electrolysis of sodium bromide solution.

Identify the other **two** products of this electrolysis and write the half-equation for the reaction occurring at the anode.

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(3)

(e) (i) Write the mechanism for the addition of bromine to ethene.

(3)

Leave blank

(ii) When ethene reacts with a mixture of bromine and sodium chloride, 1,2-dibromoethane and 1-bromo-2-chloroethane are formed but no 1,2-dichloroethane.

Explain why some 1-bromo-2-chloroethane is formed but no 1,2-dichloroethane.

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(4)

Q2

(Total 17 marks)

Leave blank

If you answer Question 3 put a cross in this box ☒.

3. (a) The table below shows the results of a kinetic investigation into the alkaline hydrolysis of 2-chloro-2-methylpropane, $(CH_3)_3CCl$.

Experiment	$[(CH_3)_3CCl]$ / mol dm^{-3}	$[OH^-]$ / mol dm^{-3}	Relative Initial Rate
A	0.2	0.1	1.0
B	0.3	0.1	1.5
C	0.1	0.2	0.5

(i) Deduce the orders of reaction with respect to each of OH^- and 2-chloro-2-methylpropane, showing your working.

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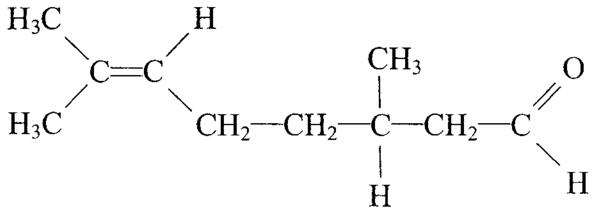
(3)

(ii) Use the orders that you have deduced in (i) to give the mechanism for the reaction of 2-chloro-2-methylpropane with aqueous hydroxide ions.

(3)

Leave blank

(b) Citronellal is the insect repellent found in a citronella candle.



(i) Identify the chiral carbon atom with an asterisk (*) on the diagram above.

(1)

(ii) Describe simple test tube experiments that would enable you to identify the **two** functional groups in citronellal.

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(4)

QUESTION 3 CONTINUES ON THE NEXT PAGE

Leave blank

(iii) Draw the formulae of the major organic products formed when citronellal reacts with

sodium tetrahydridoborate(III), $NaBH_4$, in aqueous ethanol

hydrogen bromide

(2)

Leave blank

(iv) Give the equation for the complete combustion of citronellal, $C_{10}H_{18}O$.

Calculate the maximum volume, measured at room temperature and pressure, of carbon dioxide that could be formed by the complete combustion of 1.0 g of citronellal.

[Molar mass of citronellal = 154 g mol^{-1} and the molar volume of gas at room temperature and pressure = 24 dm^3 mol^{-1}]

(4)

Q3

(Total 17 marks)

Leave blank

If you answer Question 4 put a cross in this box ☒.

4. (a) The melting temperatures of three non-metallic elements in Period 3 are given below.

Element	silicon	white phosphorus	chlorine
Melting temperature/°C	1410	44	–99

Explain, in terms of the structures and bonding of the elements, the differences between these values.

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(5)

(b) In the solid state, phosphorus pentachloride contains the ions PCl_4^+ and PCl_6^-.

Suggest the shapes of these ions and justify the shape of ONE of the ions.

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(3)

(c) Name a specific organic compound that has a functional group which reacts with phosphorus pentachloride and write the equation for the reaction.

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(2)

QUESTION 4 CONTINUES ON THE NEXT PAGE

(d) Phosphorus pentachloride dissociates as shown in the reversible reaction

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

At 420 K and a pressure of 4.0 atm, phosphorus pentachloride was 67% dissociated.

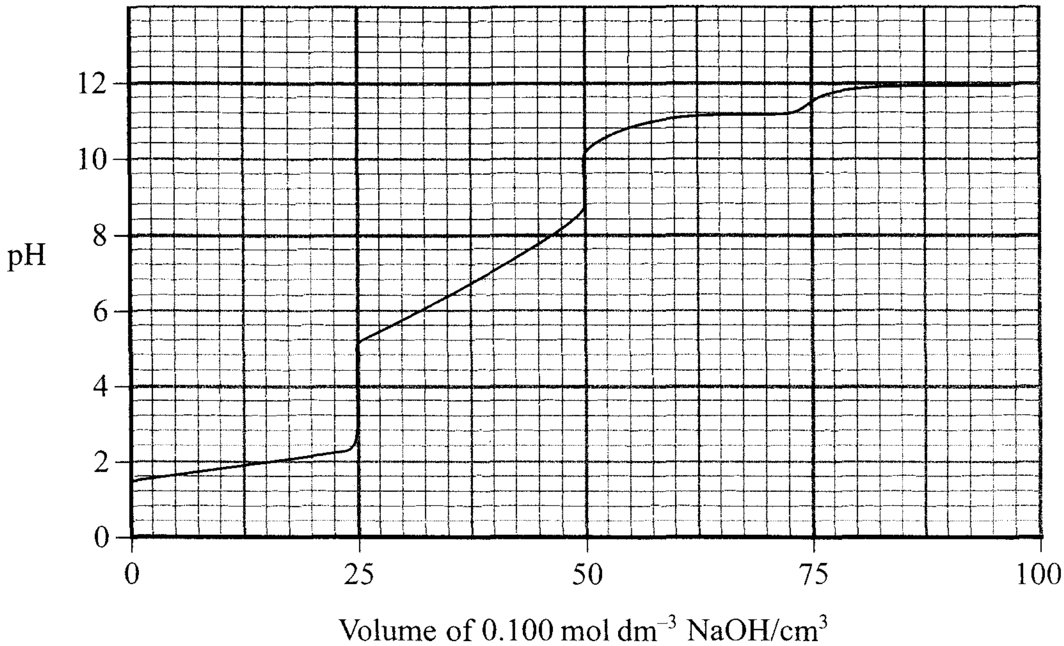
Calculate K_p at this temperature and state its units.

(5)

Leave blank

(e) Phosphorus pentachloride reacts with water to produce phosphoric(V) acid, H_3PO_4.

The titration curve when 0.100 mol dm^{-3} of sodium hydroxide is added to 25.0 cm^3 of 0.100 mol dm^{-3} of phosphoric(V) acid is shown below.



(i) Write the equation for the reaction that has occurred when 50.0 cm^3 of sodium hydroxide solution has been added.

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(1)

(ii) Mark a point on the curve with a cross (**×**) where a buffer solution would be present.

(1)

Q4

(Total 17 marks)

TOTAL FOR SECTION B: 34 MARKS

TOTAL FOR PAPER: 50 MARKS

END

THE PERIODIC TABLE

Key

Molar mass g mol^{-1}
Symbol
Name
Atomic number

Period	1	2											3	4	5	6	7	0
							Group											
1	1 H Hydrogen 1																	4 He Helium 2
2	7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
3	23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
4	39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65.4 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
5	85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
6	133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
7	223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

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

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(a)	$CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COOC_2H_5 + H_2O$ **(1)**	CH_3CO_2H $\rightarrow$ CH_3CH_2 for C_2H_5	$CH_3OCOC_2H_5$	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)	catalyst /speed up reaction **(1)**		dehydrating agent	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(c)	flask with still head **(1)** condenser and a receiver **(1)** thermometer at correct place **(1)** penalty of (1) if apparatus sealed or open at the wrong place or doesn't work for some other reason.			3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(d)	mol ethanoic acid = $\frac{12.6(0)}{60}$ = 0.21 **(1)** (mol ethyl ethanoate = 0.21) theoretical mass ethyl ethanoate = 0.21 x 88 = 18.48 g or 18.5g **(1)** % yield = $\frac{10.60}{18.48}$ x 100 = 57 **(1)** Allow 57.29 or 57.36 or 57.4 OR Theoretical mol ethanoic acid = $\frac{12.60}{60}$ = 0.21**(1)** (mol ethyl ethanoate = 0.21) actual moles of ethyl ethanoate = $\frac{10.6}{88}$ = 0.12 **(1)** % yield = $\frac{0.12}{0.21}$ x100 = 57 **(1)** Allow 57.1 or 57.14 CQ ON FORMULAE IN (a) but these must be possible compounds. IGNORE S.F.			3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(e)(i)	$C_2H_5OH + CH_3COCl \rightarrow CH_3COOC_2H_5 + HCl$ **(1)**	CH_3CH_2 for C_2H_5 $\rightleftharpoons$	$CH_3OCOC_2H_5$	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(e)(ii)	Reaction with ethanoic acid reaches equilibrium/is reversible OR Reaction with ethanoyl chloride is not reversible/goes to completion **(1)**		Reaction with ethanoic acid is incomplete	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(f)(i)	(Phenyl benzoate) must be soluble in the hot solvent and less/almost insoluble in cold solvent **(1)**			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(f)(ii)	to remove **insoluble/un-dissolved** impurities **(1)**			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(f)(iii)	to remove solid from soluble impurities **(1)**		Just 'collect the product'.	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(f)(iv)	to wash away remaining solution/soluble impurities /remove surface impurity. **(1)**			1

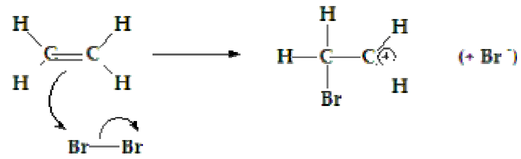
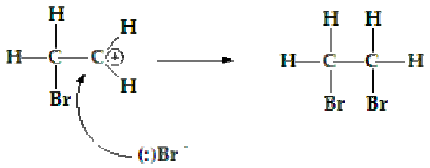
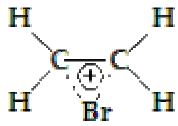
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(f)(v)	measure melting temperature **(1)** check value same as data book/sharp melting point **(1)** OR Use gas-liquid chromatography **(1)** Showing only one peak **(1)**		Mix with known sample and measure melting temperature. Any other instrumental method.	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(a)	ionic lattice **(1)** Na^+ ions have 6 nearest neighbours of Cl^- ions and vice-versa / 6:6 co-ordination **(1)**	Labelled sketch can score both marks but must have some 3D extension.		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)	electrostatic attractions (in solid NaCl) overcome **(1)** by the attractions between the ions and dipoles in water **(1)** ; this can be shown in a diagram. OR Water has a high dielectric constant/relative permittivity **(1)** which reduces the forces of attraction between ions in the solution **(1)**	Attractions overcome by solvation of ions scores **(1)** only		2

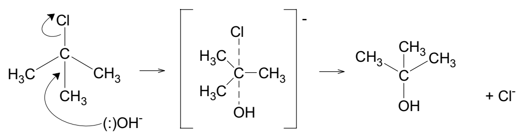
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)	$NaCl(s)\ (+aq) \rightarrow Na^+(aq) + Cl^-(aq)$ $Na^+(g) + Cl^-(g)\ (+aq)$ Cycle **(1)** Arrows labelled with names or values **(1)** *Check arrow direction agrees with label/sign of the value* $\Delta H_{soln} = -406-364-(-771)$ $= +1\ (kJ\ mol^{-1})$ **(1)** **+** sign not essential		Negative value	3

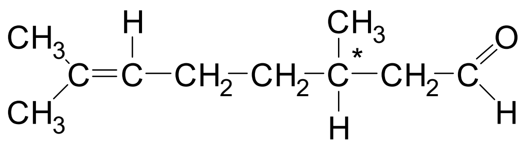
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(d)	sodium hydroxide/NaOH **(1)** hydrogen /H_2 **(1)** anode $2Br^- \rightarrow Br_2 + 2e^{(-)}$ OR $2Br^- - 2e^{(-)} \rightarrow Br_2$ **(1)** or halved.		H Br	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(e)(i)	 both arrows **(1)** carbocation structure **(1)**  arrow **(1)**	 as intermediate lone pair not essential, arrow can start at – on Br^- and go to + on C		3

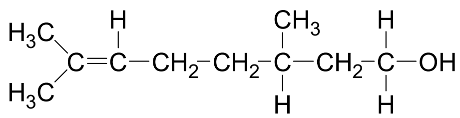
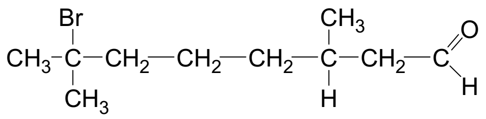
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(e)(ii)	initial attack (on ethene) is by an electrophile/$Br^{\delta+}$ **(1)** no Cl^+ / $Cl^{\delta+}$ available as the electrophile (so no dichloroethane formed) **(1)** then (nucleophilic) attack by Br^- **(1)** Cl^- can replace Br^- (as nucleophile, so 1-bromo-2-chloroethane is formed) **(1)**			4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)(i)	$[(CH_3)_3CCl]$ increases by 1.5 while $[OH^-]$ remains constant, rate increases by 1.5 OR In expts A and B, $[(CH_3)_3CCl]$ increases by 1.5 and rate increases by 1.5 **(1)** so first order **(1)** $[OH^-]$ zero order, with some explanation **(1)**			3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)(ii)	$(CH_3)_3C{-}Cl \longrightarrow (CH_3)_3C^+ + Cl^-$ (1) arrow (1) both ions $(CH_3)_3C^+ \; (:)OH^- \longrightarrow (CH_3)_3C{-}OH$ (1) arrow Must be S_N2 mechanism if 1st order wrt OH^- in (i):  each arrow (1) x 2 intermediate (1)		S_N1 mechanism if $[OH^-]$ first order	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(i)	 (1)			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(ii)	**alkene** (aqueous) bromine **(1)** orange to colourless**(1)** OR (aqueous) potassium manganate(VII) (ignore alkaline/acid) **(1)** purple to colourless/brown **(1)** **aldehyde** any one matching pair from: reagent **(1)** observation **(1)**: Fehling's solution blue (soln) to red/brown ppt Tollens' reagent silver mirror or black ppt	 Benedict's, same observation. Ammoniacal $AgNO_3$, same obs.	 Purple to green. 2,4 DNP	4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(iii)	(with $NaBH_4$)  (1) (with HBr)  (1)			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(iv)	$C_{10}H_{18}O + 14O_2 \rightarrow 10CO_2 + 9H_2O$ **(1)** Ignore any state symbols Moles citronellal = 1.0/154 **(1)** = 6.49×10^{-3} Moles CO_2 = 10x 6.49×10^{-3} **(1)** = 6.49×10^{-2} Volume CO_2 = 24 x 6.49 x10^{-2} = 1.56 dm^3 **(1)** allow 1.6 Allow cq from incorrectly balanced equation. Ignore sf OR 154g citronellal gives 240dm^3 CO_2 **(1)** Vol CO_2 from 1 g = 240/154 **(1)** = 1.56 dm^3 **(1)**			4

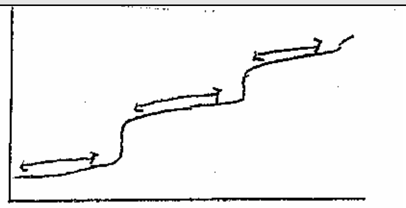
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(a)	silicon - giant atomic/ giant covalent /giant molecular/macromolecular **(1)** phosphorus **and** chlorine – (simple) molecular **(1)** covalent bonds broken in Si are stronger than intermolecular/dispersion/ Van der Waals'/ London/ induced dipole forces **(1)** phosphorus is P_4 and chlorine is Cl_2 **(1)** P_4 has more electrons (per molecule) so stronger dispersion (etc) forces **(1)**			5

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(b)	PCl_4^+ tetrahedral **(1)** PCl_6^- octahedral **(1)** 4 or 6 pairs of electrons as far apart as possible to minimise repulsion **(1)**	correct 3-D diagrams		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(c)	name of any **specific** alcohol **(1)** $ROH + PCl_5 \rightarrow RCl + HCl + POCl_3$ **(1)** [R must apply to the specific alcohol] OR name of any **specific** carboxylic acid **(1)** $RCOOH + PCl_5 \rightarrow RCOCl + HCl + POCl_3$ **(1)** [R must apply to the specific acid]	equation with 'R' if mark lost for not giving a specific example	Just 'alcohol' Just 'acid'	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(d)	$PCl_5 \rightleftharpoons PCl_3 + Cl_2$ eqm moles: 0.33 0.67 0.67 **(1)** mole fraction: $\frac{0.33}{1.67}$ $\frac{0.67}{1.67}$ $\frac{0.67}{1.67}$ **(1)** partial pressures: $\frac{0.33 \times 4}{1.67}$ $\frac{0.67 \times 4}{1.67}$ $\frac{0.67 \times 4}{1.67}$ **(1)** = 0.79 =1.605 =1.605 $K_p = \frac{pPCl_3 \times pCl_2}{pPCl_5}$ **(1)** = 3.26 **and** atm**(1)** OR $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ 1/3 2/3 2/3 eqm moles **(1)** 0.2 0.4 0.4 mole fraction **(1)** 0.8 1.6 1.6 partial press **(1)** $K_p = \frac{pPCl_3 \times pCl_2}{pPCl_5}$ **(1)** = 3.2 atm **(1)**	If eqm moles PCl_5 = 0.67 and PCl_3=Cl_2=0.33 answer = 0.5 and can score last 3 marks If 1.6 used here then final answer is 3.24		5

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(e)(i)	$H_3PO_4 + 2NaOH \rightarrow Na_2HPO_4 + 2H_2O$ **(1)** OR $H_3PO_4 + 2OH^- \rightarrow HPO_4^{2-} + 2H_2O$ **(1)**			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(e)(ii)	 any point between ⟷			1