

# Mark Scheme (Results)

## January 2007

GCE

GCE Chemistry (Nuffield) (6252/01)



1	(a)	(i)	$\text{H}_2\text{SO}_4 + \text{NaCl} \rightarrow \text{NaHSO}_4 + \text{HCl}$ $\text{H}_2\text{SO}_4 + 2\text{NaCl} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{HCl}$  Correct formulae (1) Balanced (1) Second mark depends on first being correct	Either version State symbols (Ignore these) Multiples  4 correct formulae with an additional existing molecule eg $\text{H}_2$ , $\text{SO}_2$ Max 1	$\text{H}_2\text{SO}_4 + \text{NaCl} \rightarrow \text{NaSO}_4 + \text{H}_2\text{Cl}$ (0)	(2 marks)
		(ii)	White fumes/ white smoke / white solid /white powder	Added description eg dense, thick, reference to ammonium chloride with white fumes/ white smoke white smoke screen	Steamy / misty /colourless/ grey fumes/ bubbles / vapour / gas precipitate /white cloud	(1 mark)
		(iii)	Other <b>hydrogen</b> halides give same result/ hydrogen bromide/hydrogen iodide give same result	Ammonium bromide/ iodide are same colour (as ammonium chloride)	Halogens give same result. Other gases give same result. Could be another acid gas	(1 mark)
	(b)	(i)	Sulphur: from +6 to +4 (1) Bromine: from -1 to 0 (1)	Accept sign after value, Roman numerals	Incorrect signs	(2 marks)
		(ii)	Increase in ox number of bromine = $2 \times 1 / 2$ (1) <b>One S</b> decreases in ox number by 2 (1) Must be clear that one S atom is unchanged/only one S changes for second mark. [Look for oxidation no. written under elements in equation]	Increase in oxidation number of Br = decrease in oxidation number of S, without specifying values (1)	Explanations in terms of electrons	(2 marks)
	(c)	(i)	Going down group Number of electrons increases (1)  So Van der Waals force (between molecules) increases (1) <i>Ignore comments on radius of atom</i>	Reverse argument going up group	Arguments based on quantum shells.  vdw for Van der Waals	(2 marks)
		(ii)	Boiling point between 200 and 300 (K) (1) <i>-73 to +27 if value quoted in °C</i> Hydrogen bonding is present (1) Stronger forces between molecules /stronger intermolecular forces (than in other hydrogen halides.) (1)	B pt 155 - 175(K) with explanation that there are fewer electrons in HF for maximum 1 mark. Boiling point in correct range,		(3 marks)

				with comment on <b>much</b> stronger dipole in HF and stronger intermolecular forces (2)		
		(Total 13 marks)				


2	(a)	(i)	(18x1.35) = 24.3/ 24.30 (kJ) (1)			(1 mark)
		(ii)	$\text{kJ from 1 mole} = \frac{24.3 \times 44}{0.5} / \frac{24.3}{0.0114} / 24.3 \times 88(1)$ $\Delta H = -2140 \text{ (3SF) (kJ mol}^{-1}\text{) (1)}$ Second mark must have negative sign and 3SF Allow TE from incorrect value in (i)	$\Delta H = -2138.4 / -2138 / +2138$ (kJ mol <sup>-1</sup> ) for 1 mark		(2 marks)
		(iii)	Incomplete combustion / combustion to C or CO. Not complete combustion (1)		Not all of the propane burns. Comments on accuracy of equipment.	(1 mark)
	(b)	(i)	$\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})$ $+6490 \text{ kJ mol}^{-1} \quad \quad \quad \mathbf{6 \times 805 + 8 \times 464}$ $3\text{C}(\text{g}) + 8\text{H}(\text{g}) + \mathbf{10 \text{ O}(\text{g})}$ $+6490 = \Delta H_c + (6 \times 805 + 8 \times 464)$ $\Delta H_c = +6490 - 4830 - 3712$ $= -2052 \text{ kJ mol}^{-1}$ Balancing cycle with <b>5O<sub>2</sub></b> and <b>10 O(g)</b> (1) $\Delta H_1 = (6 \times 805 + 8 \times 464) = (+) 8542 \text{ (kJ mol}^{-1}\text{) (1)}$ Final value $-2052 \text{ (kJ mol}^{-1}\text{) (1)}$ <b>IGNORE SF</b> <i>Allow TE from an incorrectly calculated <math>\Delta H_1</math> if method clear.</i>	-2050 (kJ mol <sup>-1</sup> )		(3 marks)

	(ii)	H <sub>2</sub> O is gas in equation/ not standard state OR mean bond energies differ from bond energies in these compounds / Environment in these compounds changes bond energies from the mean.	H <sub>2</sub> O is liquid in $\Delta H$ combustion calculation but gas in bond energy calculation.	"Mean bond energies are used" without qualification All the substances are in the gaseous state	(1 mark)
(c)	(i)	Free radical (1) substitution (1)	Reverse order		(2 marks)
	(ii)	2C <sub>3</sub> H <sub>7</sub> • → C <sub>6</sub> H <sub>14</sub> (1)  Two (propyl) radicals may combine /a radical and a molecule may produce C <sub>6</sub> H <sub>14</sub> (in a propagation step) (1)	C <sub>3</sub> H <sub>7</sub> • + C <sub>3</sub> H <sub>7</sub> • → C <sub>6</sub> H <sub>14</sub> (1 ) Accept multiples C <sub>3</sub> H <sub>7</sub> • + C <sub>3</sub> H <sub>8</sub> → C <sub>6</sub> H <sub>14</sub> + H• (1) Full mechanisms may be shown		(2 marks)
(d)	(i)	2-chloropropane: white precipitate/ solid /cloudiness (1)  2-iodopropane: yellow precipitate / solid (1)	Ppt appears slowly with chloropropane and quickly with iodopropane (1) Pale yellow precipitate White colour and yellow colour - 1 out of 2	White colour Creamy	(2 marks)
	(ii)	Ag <sup>+</sup> (aq) + I <sup>-</sup> (aq) → AgI (s)  Formulae (1) State symbols (1) Minor error in formula with correct state symbols max 1	Max 1 out of 2 for wrong halide		(2 marks)
	(iii)	Propan-2-ol/ CH <sub>3</sub> CH(OH)CH <sub>3</sub> (1)	Displayed formula CH <sub>3</sub> -CH-CH <sub>3</sub>   OH	Molecular formula C <sub>3</sub> H <sub>7</sub> OH	(1 mark)
					Total 17 marks

3	(a)	(i)	2,2,4-trimethylpentane Ignore punctuation (Commas and hyphens may be interchanged)	2,4,4 - trimethylpentane	Pentan for pentane 2-dimethyl-4 methylpentane 2,2-dimethyl-4-methyl pentane 2-methyl-4,4-dimethyl pentane 2,4-trimethylpentane	(1 mark)
		(ii)	$C_4H_9$	$C_8H_{18} \rightarrow C_4H_9$		(1 mark)
		(iii)	$C_2H_4$		$CH_2CH_2$	(1 mark)
		(iv)	Positive because energy is required to break (C-C) bonds (and not completely replaced (from new bonds made)) OR Positive because cracking requires (continuous) supply of heat so must be endothermic	two C-C bonds are broken and one C=C made	Positive because it only occurs at high temperature	(1 mark)
		(v)	$C_8H_{18} + 17/2 O_2 \rightarrow 8CO + 9H_2O$ OR $2C_8H_{18} + 17 O_2 \rightarrow 16CO + 18H_2O$ OR $C_8H_{18} + 9/2 O_2 \rightarrow 8C + 9H_2O$ (or doubled)  Oxygen on left and correct formulae of products (1) balancing (1) Second mark depends on first and a sensible hydrocarbon formula must be used.	Balanced equations including CO and/or C with $CO_2$ 17/2 can be written 8.5 or $8\frac{1}{2}$ Allow balanced equations based on $C_8H_{18}$ with a smaller alkane in the products for 1 mark eg $C_8H_{18} + O_2 \rightarrow C_0 + C_7H_{16} + H_2O$ (1)		(2 marks)

	(b)	(i)	<p>Increase in pressure: No effect as number of moles/molecules (of gas) doesn't change during reaction (1)</p> <p>Increase in temperature: <b>more NO</b> as forward reaction endothermic OWTTE (1)</p> <p>One mark for two correct predictions with incorrect explanations</p>		Increase in temperature moves equilibrium to the right	(2 marks)
		(ii)	Rate increases as converter gets hotter (as reaction is exothermic)			(1 mark)
		(iii)	N <sub>2</sub> / nitrogen is (major) part of air/ N <sub>2</sub> unreactive/ not poisonous/ not a greenhouse gas / not acidic	Correct harmful properties of other 3 gases		(1 mark)
		(iv)	<p>Line from level of reactants to maximum labelled E<sub>A</sub> (1)</p> <p>Curve of similar shape above existing curve, starting and finishing at same levels, with maximum above original maximum(1)</p>			(2 marks)



	(c)	<p>Dot and cross for CO (1)          Dot and cross for CO<sub>2</sub> (1)</p>  <p>(CO shorter) as triple bond, not double/ higher electron density / more electrons between nuclei/ between C and O          OR CO<sub>2</sub> has double bonds, CO has double plus a dative (covalent)          Allow TE from diagrams          (1)  <i>If bond lengths are compared, CO must be shorter</i></p>	<p>All dots or all crosses</p> <p>All electrons or just outer shells</p>		(3 marks)
<b>Total 15 marks</b>					

4	(a)	It is insoluble/ unreactive/ inert		Non-carcinogenic It behaves like bone	(1 mark)
	(b)	Many electrons because it is a polymer/ very large molecule OR has large surface area for contact (1)  strong more Van der Waals forces holding molecules together (1)			(2 marks)
	(c)	scCO <sub>2</sub> gets between polymer molecules/ stops them lining up/ stops intermolecular forces acting/ New vdw forces can form between scCO <sub>2</sub> and poly (ethene)/weakens bonds between molecules			(1 mark)
	(d)	109° / 109.5 ° /109° 28' as (4) electron clouds/ ( 4 ) bonds repel equally / as bonds are as far away from each other as possible in 3 dimensions/ minimise repulsion in 3 dimensions / as it is tetrahedral with no lone pairs.		Comments referring to only atoms repelling	(1 mark)
	(e)	$  \begin{array}{cccc}  \text{H} & \text{H} & \text{H} & \text{H} \\    &   &   &   \\  \text{--- C} & \text{--- C} & \text{--- C} & \text{--- C ---} \\    &   &   &   \\  \text{H} & \text{COOH} & \text{H} & \text{COOH}  \end{array}  $	COOH/ CO <sub>2</sub> H can be adjacent or on alternate C atoms (but not on C1 and 2 or C3 and 4) Side groups can be above or below C chain. COOH may be displayed. The two repeat units may be in a bracket with bonds at end going through bracket and there may be an n outside the bracket. The product may be shown as part of an equation.		(1 mark)
	(f)	Hydration/ C			(1 mark)

(g) Examiners will need to consider each answer for (i) key points and (ii) style and use of English. Candidates should have recorded their word total at the end of their answer and this should be checked.

Up to 115 words no penalty

116 - 125 words -1

126 - 135 words -2

136 - 145 words -3

and at a rate of -1 penalty for every 5 words thereafter up to a maximum of penalty equal to the number of key points included in the answer.

Note that words appearing in the title to the summary do not count in the word total. Normally hyphenated words, numbers and chemical formulae count as one word.

One mark should be awarded for every key point clearly identified in an answer.

**Key points - word penalty = maximum 6 marks**

To gain the mark for a key point the wording used by the candidate must make clear the essential chemistry of the point.

sc CO<sub>2</sub> = 1

poly(lactic acid) = 2

poly(propenoic acid) = 2

poly(methyl methacrylate) = 2

poly(ethene) = 1

31°C = 2

**Marking for key points. Maximum of 6 marks available.**

		1	Metals/ titanium were used to pin/ repair bones but bone loss occurs (at (metal - bone) junction)	(1 mark)
		2	Artificial bones were made from poly(ethene) and hydroxyapatite/ $\text{Ca}_5(\text{PO}_4)_3(\text{OH})$	(1 mark)
		3	This (composite) is well tolerated and bone grows up to the surface / junction (of the composite) / and does not cause bone loss/ encourages bone to grow.	(1 mark)
		4	Acrylic monomers / poly (methyl methacrylate)/ perspex mixed with hydroxyapatite to make (precision-shaped) implants.	(1 mark)
		5	Acrylic polymers can be shaped accurately / are precision shaped, but are toxic / cause inflammation	(1 mark)
		6	Biodegradable implants can be made of poly(lactic acid) plus growth hormone	(1 mark)
		7	New bone can grow round biodegradable implants / biodegradable implants can be used on patients who are still growing / only biodegradable implants grow with child /stimulates growth of bone cells/ other implants don't grow with child	(1 mark)
		8	poly (lactic acid) / biodegradable polymers have to have carbon added in order to absorb laser light	(1 mark)
				Any 6 (6 marks)

		<p><b>Quality of Written Communication</b></p> <p>These should <i>be impression</i> marked on a scale 2-1-0, and the mark out of 2 should be recorded in the body of the script at the end of the answer. This mark can not be lost as a result of a word penalty.</p> <p>Candidates are expected to:</p> <ul style="list-style-type: none"> <li>• show clarity of expression;</li> <li>• construct and present coherent argument;</li> <li>• demonstrate effective use of grammar punctuation and spelling.</li> </ul> <p>The aspects to be considered are:</p> <ul style="list-style-type: none"> <li>• use of technical terms; the answer should convey a correct understanding by the writer of the technical terms used in the passage which are involved in the key points.</li> <li>• articulate expression; the answer should be well-organised in clear, concise English, without ambiguity. It should read fluently, with the links between key points in the original maintained.</li> <li>• legible handwriting; the reader should be able to read the answer without difficulty at normal reading pace, with only the occasional difficulty with a word.</li> <li>• points must be in a logical order.</li> </ul> <p>Good style and use of English, with only infrequent minor faults, no use of formulae (2)  Frequent minor or a few major faults in style and use of English (1)  Very poor style and use of English (0)</p> <p>NB: The quality of written communication mark cannot be lost through word penalties.</p>	(2 marks)
			Total 15 marks