2009 Chemistry

Higher

Finalised Marking Instructions

Higher Chemistry

General information for markers

The general comments given below should be considered during all marking.

1 Marks should **not** be deducted for incorrect spelling or loose language as long as the meaning of the word(s) is conveyed.

Example: Answers like 'distilling' (for 'distillation') and 'it gets hotter' (for 'the temperature rises') should be accepted.

2 A right answer followed by a wrong answer should be treated as a cancelling error and no marks should be given.

Example: What is the colour of universal indicator in acid solution?

The answer 'red, blue' gains no marks.

3 If a right answer is followed by additional information which does not conflict, the additional information should be ignored, whether correct or not.

Example: Why can the tube not be made of copper?

If the correct answer is related to a low melting point, 'It has a low melting point and is coloured grey' would **not** be treated as having a cancelling error.

4 Full marks are usually awarded for the correct answer to a calculation on its own; the part marks shown in the marking scheme are for use when working is given. An exception is when candidates are asked to 'Find, by calculation, …..'.

5 A half mark should be deducted in a calculation for each arithmetic slip.

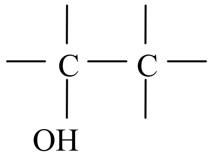
6 A half mark should be deducted for incorrect or missing units **only when stated in the marking scheme**. No marks should be deducted for incorrect or missing units at intermediate stages in a calculation.

7 Where a wrong numerical answer (already penalised) is carried forward to another step, no further penalty is incurred provided the result is used correctly.

8 Ignore the omission of one H atom from a full structural formula provided the bond is shown.

9 With structures involving an – OH or an – NH_2 group, a half mark should be deducted if the 'O' or 'N' are not bonded to a carbon, ie OH–CH_2 and NH_2–CH_2.

10 When drawing structural formulae, a half mark should be deducted if the bond points to the 'wrong' atom, eg



11 A symbol or correct formula should be accepted in place of a name **unless stated otherwise in the marking scheme**.

12 When formulae of ionic compounds are given as answers it will only be necessary to show ion charges if these have been specifically asked for. However, if ion charges are shown, they must be correct. If incorrect charges are shown, no marks should be awarded.

13 If an answer comes directly from the text of the question, no marks should be given.

Example: A student found that 0·05 mol of propane, C_3H_8 burned to give 82·4 kJ of energy.

$$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(\ell)$$

Name the kind of enthalpy change which the student measured.

No marks should be given for 'burning' since the word 'burned' appears in the text.

14 A guiding principle in marking is to give credit for (partially) correct chemistry rather than to look for reasons not to give marks.

Example 1: The structure of a hydrocarbon found in petrol is shown below.

$$\begin{array}{c} CH_3 \\ | \\ CH_3-CH_2-CH-CH_2-CH_2-CH_3 \end{array}$$

Name the hydrocarbon.

Although the punctuation is not correct, '3, methyl-hexane' should gain the full mark.

Example 2: A student measured the pH of four carboxylic acids to find out how their strength is related to the number of chlorine atoms in the molecule. The results are shown.

Structural formula	**pH**
CH_3COOH	1·65
$CH_2ClCOOH$	1·27
$CHCl_2COOH$	0·90
CCl_3COOH	0·51

How is the strength of the acids related to the number of chlorine atoms in the molecule?

Although not completely correct, an answer such as 'the more Cl_2, the stronger the acid' should gain the full mark.

15 Unless the question is clearly about a non-chemistry issue, eg costs in industrial chemistry, a non-chemical answer gains no marks.

Example: Why does the (catalytic) converter have a honeycomb structure?

A response such as 'to make it work' may be correct but it is not a chemical answer and the mark should not be given.

16 When it is very difficult to make a decision about a partially correct answer, a half mark can be awarded.

17 When marks have been totalled, a half mark should be rounded up.

2009 Chemistry Higher

Marking Scheme

Section A

1	D	11	C	21	A	31	D
2	C	12	C	22	C	32	A
3	C	13	D	23	B	33	D
4	A	14	A	24	A	34	B
5	D	15	D	25	B	35	B
6	A	16	C	26	B	36	D
7	B	17	D	27	C	37	D
8	D	18	C	28	A	38	B
9	A	19	B	29	C	39	A
10	B	20	D	30	A	40	C

Mark Scheme				Worth ½	Worth 0
1	**(a)**	increases (or gets bigger or rises)	**1**		
	(b)	more energy is needed to remove the electron from a full shell (or complete shell or noble gas shell) **or** an electron is being removed from an energy level closer to the nucleus **or** there is a greater nuclear pull on the electron being removed **or** second energy level is nearer the nucleus **or** second energy level is full (or complete), etc.	**1**		
	(c)	forces of attraction **between** molecules (or intermolecular forces or van der Waals' forces) increase **or** energy needed to separate the molecules increases.	**1**	molecular size increases **or** iodine molecules (or atoms) are bigger then fluorine	bonding is stronger in iodine than fluorine **or** any mention of stronger covalent bonds

Mark Scheme				Worth ½	Worth 0
2	**(a)**	**x** = 7 **y** = 8	**1**		
	(b)	non-polluting **or** no greenhouse gases **or** no carbon dioxide produced **or** burns to produce water only **or** a cleaner fuel, etc.	**1**	burns to form water	a renewable source **or** any answer to do with more efficient burning
	(c)	renewable (or not a finite resource or carbon-neutral)	**1**	reduces CO emissions **or** more complete combustion	less polluting **or** any answer to do with more efficient burning, eg mention of knocking

			Mark Scheme		Worth ½	Worth 0
3	**(a)**	**(i)**	ratio of oxygen:hydrogen atoms increased (or ratio of hydrogen:oxygen atoms decreased) **or** removal of hydrogen	**1**	removal of hydrogen molecules	loss of electrons
		(ii)	orange to green (or blue/green)	**1**	goes green (or blue/green) **or** orange colour is lost	orange to incorrect colour (or colourless) **or** incorrect colour (or colourless) to green
	(b)	**(i)**	Any mention of separate layer **or** any mention of (ester) smell	**1**		
		(ii)	$CH_3-CH_2-\overset{\overset{\displaystyle O}{\parallel}}{C}-O-CH_2-CH_2-CH_3$ (accept equivalent full **or** shortened structural formula)	**1**		

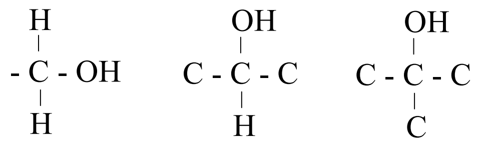
		Mark Scheme		Worth ½	Worth 0
4	**(a)**	absorbs (harmful) UV radiation **or** reduces (or stops) UV radiation reaching earth	**1**	reflects (harmful) UV **or** absorbs harmful radiation	absorbs rays (or light) from Sun **or** anything to do with greenhouse effect **or** IR
	(b)	heterogeneous	**1**		heterozygous
	(c)	$3O_2 \rightarrow 2O_3$ 1 mol $\rightarrow$ 2/3 mol 1 mol = 6×10^{23} molecules **(½)** 2/3 mol = 4×10^{23} molecules **(½)**	**1**	2×10^{23} **or** 9×10^{23} (without any working)	

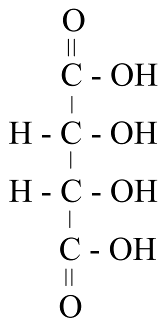
Mark Scheme					Worth ½	Worth 0
5	**(a)**	**(i)**	amino acids	**1**		
		(ii)	breaking up (bonds in) a molecule by the addition of (the elements from) water	**1**		breaking up (bonds in) a molecule **or** addition of water **or** reverse of condensation
	(b)	**(i)**	ester	**1**		
		(ii)	functional groups are only at the end of the monomers (or monomers have only two functional groups) **or** no chance of cross-linking	**1**	no chance of forming bonds with other polymer molecules	no double bonds **or** no hydrogen bonds

Mark Scheme					Worth ½	Worth 0
6	**(a)**	**(i)**	initial and final temperature (or temperature range) (½) volume (or mass) of water (½)	**1**		temperature **or** mass (or weight) of burner **or** mass of methanol used
		(ii)	0.370 g ↔ 3.86 kJ 32 g (1 mol CH_3OH) ↔ $\frac{3.86 \times 32}{0.370}$ **(½)** = 333.8 kJ mol^{-1} include negative sign in final answer -333.8 kJ mol^{-1} **(½)** (units not required; (in this case) no deduction for incorrect units)	**1**		
	(b)		complete combustion (or incomplete combustion in lab method) **or** richer supply of oxygen (or burns in air in lab method) **or** no evaporation of methanol	**1**	burns in oxygen **or** idea that heat is better distributed	

Mark Scheme				Worth ½	Worth 0
7	(a)	use an (upturned) measuring cylinder (or graduated tube) filled with water **or** collect gas over water **or** correct diagram	1	as for 1 mark but use of a non-graduated tube **or** count the number of bubbles produced under water	use a measuring cylinder (or graduated tube)
	(b)	mass (or weight) **or** pH **or** concentration of acid **or** conductivity	1		

Mark Scheme	Worth ½	Worth 0
8 **(a)** continuous **1**		
(b) **(i)** yield decreases at high temperature **(½)** idea that equilibrium moves to the left (or to reactant side) at high temperature **(½)** **or** corresponding explanation based on higher yield at lower temperatures **1** **(ii)** idea that the formation of ammonia decreases the number of molecules (or reduces the pressure) **(1)** idea that high pressure causes the equilibrium position to move to right (or product side) **or** high pressure favours the reaction that reduces the pressure **(1)** **2**	backward reaction removes heat	
(c) 1 mol N_2 → 2 mol NH_3 28 g → 34 g **(½)** 500 kg → $\frac{500 \times 28}{34}$ = 607 kg **(½)** % yield = $\frac{\text{actual}}{\text{theoretical}} \times 100$ = $\frac{405}{607} \times 100$ **(½)** = 66.7% **(½)** **or** no. of moles of N_2 = $\frac{500\ 000}{28}$ = 17 860 mol no. of moles of NH_3 = 35 720 mol **(½)** = 607 kg **(½)** **2**		

Mark Scheme	Worth ½	Worth 0
9 **(a)**  primary secondary tertiary **or** Primary: hydroxyl group attached to C attached to two H atoms (or hydroxyl group attached to C attached to one C atom) Secondary: hydroxyl group attached to C attached to one H atom (or hydroxyl group attached to C attached to two C atoms) Tertiary: hydroxyl group attached to C attached to no H atoms (or hydroxyl group attached to C attached to three C atoms) **or** correct answer in terms of oxidation **1**	2 out of 3 correct	
(b) addition **1**		
(c) pentan-3-one **1**	pentanone **or** pentan-2-one	pentone **or** pentan-1-one

Mark Scheme	Worth ½	Worth 0
10 **(a)** neutralisation **1**		titration
(b)  (accept equivalent full or shortened structural formula) **1**		
(c) 1 mol $C_4H_6O_6$ $\rightarrow$ 2 mol CO_2 = 48 l **(½)** 150 g **(½)** $\rightarrow$ 48 l $\frac{150 \times 0.105}{48}$ g $\rightarrow$ 0.105 l = 0.33 g **(½)** mass in 1 sweet = 0.0165 g **(½)** **or** no. of moles of CO_2 = $\frac{0.105}{24}$ **=** 0.0044 mol **(½)** no. of moles of $C_4H_6O_6$ **=** 0.0022 mol **(½)** = 0.0022 × 150 = 0.33 g **(½)** mass in 1 sweet = 0.0165 g **(½)** (no units required; deduct ½ mark for incorrect units) **2**		

Mark Scheme				Worth ½	Worth 0
11	**(a)**	more collisions with energy greater or equal to E_a **or** more collisions leading to an activated complex **or** correct energy distribution diagram	**1**	more successful collisions	just increases the number of collisions
	(b)	the outer electron in potassium is further from the nucleus **or** the outer electron is in a higher (or the fourth) energy level **(½) or** the inner shells screen (or shield) the outer electron from the (pull of the) nucleus **(½) or** corresponding explanation based on chlorine	**1**		

		Mark Scheme	Worth ½	Worth 0
12	**(a)**	no. of moles sulphuric acid $= 0.05 \times 0.01 = 0.0005$ **(½)** $28\ cm^3 \leftrightarrow 0.0005$ mol 1 litre $\leftrightarrow \dfrac{0.0005 \times 1000}{28} = 0.018\ mol\ l^{-1}$ **(½)** **or** $0.01 \times 50 = c \times 28$ **(½)** $c = 0.018\ mol\ l^{-1}$ **(½)** (no units required; deduct ½ mark for incorrect units) **1**		
	(b)	ions in barium sulphate are not free to move **(1)** water contains few ions (or is made up mainly of molecules) **(1)** **2**	there are few ions to conduct **or** water is a poor conductor	a precipitate is formed **or** a neutralisation reaction takes place **or** there are no ions in the products **or** any mention of flow of electrons

Mark Scheme				Worth ½	Worth 0
13	**(a)**	add an ammeter **(½)** and a variable resistor (or constant current supply) **(½)**	**1**		
	(b)	no. of moles Ag = $\frac{0.365}{107.9}$ = 0.0034 **(½)** 2 mol Ag ↔ 1 mol Cu **(½)** no. of moles Cu = 0.0017 **(½)** mass of Cu = 0.0017 × 63.5 = 0.107 g **(½)** **or** Ag 107.9 g ↔ 96 500 C **(½)** 0.365 g ↔ $\frac{96\,500 \times 0.365}{107.9}$ = 326.4 C **(½)** Cu 2 × 96 500 C ↔ 63.5 g **(½)** 326.4 C ↔ $\frac{63.5 \times 326.4}{2 \times 96\,500}$ = 0.107 g **(½)** (deduct ½ mark for incorrect or no units)	**2**		

Mark Scheme					Worth ½	Worth 0
14	**(a)**		Exp. 2 lower Exp. 3 same	**1**		
	(b)	**(i)**	pH = 1.0 $[H^+] = 1 \times 10^{-1}$ mol l^{-1} **(½)** $[OH^-] = \frac{1 \times 10^{-14}}{1 \times 10^{-1}} = 1 \times 10^{-13}$ mol l^{-1} **(½)** (units not required; deduct ½ mark for incorrect units)	**1**		
		(ii)	more chlorine atoms, the greater the strength of acid **(1)** strength of acid related to conc. of H^+ (aq) ions, **(1)** **or** strength of acid related to degree of dissociation **(1)**	**2**		

Mark Scheme				Worth ½	Worth 0
15	**(a)**	$Al_4C_3 + 12H_2O \rightarrow 4Al(OH)_3 + 3CH_4$	**1**		
	(b)	$SiO_2(s) + 2H_2O(\ell) \rightarrow SiH_4(g) + 2O_2(g)$ +1517 kJ **(½)** $Si(s) + O_2(g) \rightarrow SiO_2(s)$ - 911 kJ **(½)** $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ - 572 kJ **(½)** addition = 34 kJ mol^{-1} **(½)** (3 'sensible' numbers required for ½ mark for addition based on following through; no units required; deduct ½ mark for incorrect units)	**2**		

Mark Scheme				Worth ½	Worth 0
16	**(a)**	$^{227}Th \rightarrow {}^{223}Ra + \alpha$ (or alpha or He) (atomic numbers not required)	**1**		
	(b)	alpha is low penetrating **or** range of travel is short **or** does not pass through wood	**1**		non-ionising **or** weak radiation **or** too small a dose
	(c)	idea of 3 half-lives **(½)** initial mass = 0.48 g **(½)** (no units required; deduct ½ mark for incorrect units)	**1**	3.36g	1.68g

Mark Scheme						Worth ½	Worth 0
17	**(a)**	1.17 (or 7:6)			**1**	p:n = 6:7	
	(b)	**(i)**	left to right	3, 2, 1	**1**		
		(ii)	but-2-ene		**1**	butene **or** butan-2-ene	

Mark Scheme				Worth ½	Worth 0
18	(a)	$2S_2O_3^{2-}(aq) \rightarrow S_4O_6^{2-}(aq) + 2e^-$ (state symbols not required)	**1**		
	(b)	starch (solution)	**1**		
	(c)	no. of moles of $S_2O_3^{2-}(aq) = 0.0504 \times 0.10 = 0.00504$ **(½)** mole ratio 2:5 **(1)** no. of moles of CO = 0.0125 **(½)** **or** no. of moles of $S_2O_3^{2-}(aq) = 0.504 \times 0.10 = 0.00504$ **(½)** moles of iodine : thiosulphate is 1:2 moles of iodine = 0.0025 **(½)** moles of CO : iodine is 5:1 **(½)** moles of CO = 0.0125 **(½)**	**2**		

[END OF MARKING INSTRUCTIONS]