

CAMBRIDGE INTERNATIONAL EXAMINATIONS
GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2012 series

9701 CHEMISTRY

9701/23

Paper 2 (AS Structured Questions), maximum raw mark 60

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

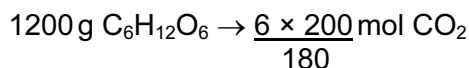
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Page 2	Mark Scheme: Teachers' version	Syllabus	Paper 1
	GCE AS/A LEVEL – October/November 2012	9701	

1 In this question, numerical answers should be given to three significant figures.



$$= 40.0 \text{ mol to 3 sf}$$

allow ecf on wrong equation and/or wrong M_r (1)

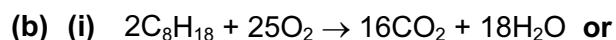


$$= 2.728 \times 10^{11} \text{ mol } CO_2$$
 (1)

$$2.728 \times 10^{11} \text{ mol } CO_2 \equiv 2.728 \times 10^{11} \times 44 = 1.20032 \times 10^{13} \text{ g}$$

$$= 1.20 \times 10^7 \text{ tonnes } CO_2 \text{ to 3 sf}$$
 (1) [5]

allow ecf on answer from (ii)



$$\text{mass of } 4.00 \text{ dm}^3 \text{ of octane} = 4000 \times 0.70 = 2800 \text{ g}$$
 (1)

$$n(C_8H_{18}) = \frac{2800}{114} = 24.56140351 \text{ mol in } 4.00 \text{ dm}^3$$

$$= 24.6 \text{ mol to 3 sf}$$
 (1)



$$24.6 \text{ mol } C_8H_{18} \text{ produce } \frac{16 \times 44 \times 24.6}{2} \text{ g } CO_2$$

$$= 8659.2 \text{ g } CO_2$$

$$= 8660 \text{ g } CO_2 \text{ to 3 sf}$$
 (1) [5]

Page 3	Mark Scheme: Teachers' version	Syllabus	Paper 1
	GCE AS/A LEVEL – October/November 2012	9701	023Based.com

(c) 6.82×10^9 people produce 1.20×10^7 tonnes CO_2 per day

8660 g CO_2 produced when car travels 100 km

when travelling 1 km, car produces $\frac{8660}{100} = 8.66 \times 10^{-1}$ g

$= 8.66 \times 10^{-5}$ tonnes (1)

to produce 1.20×10^7 tonnes CO_2 car must travel

$\frac{1.20 \times 10^7}{8.66 \times 10^{-5}}$

$= 1.385681293 \times 10^{11} = 1.39 \times 10^{11}$ km to 3 sf (1) [2]

(d) possible pollutants and the damage they cause

CO	NO _x		SO ₂	H ₂ O	C	unburned C ₈ H ₁₈
	NO	NO ₂				
toxic	toxic	toxic	toxic			
	global warming	respiratory problems	respiratory problems	global warming	respiratory problems	respiratory problems
	photochemical smog	acid rain	acid rain			

compound (1)

damage (1) [2]

[Total: 14]

Page 4	Mark Scheme: Teachers' version	Syllabus	Paper 1
	GCE AS/A LEVEL – October/November 2012	9701	

- 2 (a) (i) white fumes/steamy fumes (1)
- (ii) $\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HCl}$ **or**
 $2\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{HCl}$ (1)
- (iii) an acid that is completely ionised in solution **or**
 an acid that is completely dissociated into H^+ ions in solution (1) [3]
- (b) (i) purple/violet vapour (I_2) or black/brown solid (I_2) **or**
 irritating/acrid gas (SO_2) or stinking gas (H_2S) **or**
 yellow solid (S) (1)
- (ii) conc. H_2SO_4 is an oxidising agent **or** HI is a reducing agent (1)
 which oxidises HI **or** which reduces H_2SO_4 (1) [3]
- (c) (i) white ppt formed – **not** creamy white or off white (1)
 which dissolves in $\text{NH}_3(\text{aq})$ (1)
- (ii) $\text{NaCl}(\text{aq}) + \text{AgNO}_3(\text{aq}) \rightarrow \text{AgCl}(\text{s}) + \text{NaNO}_3(\text{aq})$ **or**
 $\text{Cl}^-(\text{aq}) + \text{Ag}^+(\text{aq}) \rightarrow \text{AgCl}(\text{s})$
- equation (1)
 all state symbols correct (1)
- $\text{AgCl}(\text{s}) + 2\text{NH}_3(\text{aq}) \rightarrow [\text{Ag}(\text{NH}_3)_2]^+ \text{Cl}^-(\text{aq})$ **or**
 $\text{AgCl}(\text{s}) + 2\text{NH}_3(\text{aq}) \rightarrow [\text{Ag}(\text{NH}_3)_2] \text{Cl}(\text{aq})$
- equation (1)
 all state symbols correct (1)
- (iii) precipitate is yellow (1)
 precipitate does not dissolve (1) [8]

[Total: 14]

Page 5	Mark Scheme: Teachers' version	Syllabus	Paper 1
	GCE AS/A LEVEL – October/November 2012	9701	023Based.com

- 3 (a) manufacture of ammonia/Haber process or hydrogenation of fats/oils or making margarine or hydrocracking (1) [1]
- (b) (i) **increasing the pressure**
 equilibrium will move to LHS (1)
 fewer moles/molecules on LHS or more moles/molecules on RHS (1)
- (ii) **decreasing the temperature**
 equilibrium will move to LHS (1)
 forward reaction is endothermic (1) [4]
- (c) rate will increase (1)
 collisions will occur more frequently (1) [2]

(d) (i)
$$K_c = \frac{[\text{CO}_2][\text{H}_2]}{[\text{CO}][\text{H}_2\text{O}]}$$
 (1)

(ii)

	CO(g)	+ H ₂ O(g)	=	CO ₂ (g)	+ H ₂ (g)
initial moles	0.40	0.40		0.20	0.20
equil moles	(0.40 – y)	(0.40 – y)		(0.20 + y)	(0.20 + y)
equil concn./mol dm ⁻³	$\frac{(0.40 - y)}{1}$	$\frac{(0.40 - y)}{1}$		$\frac{(0.20 + y)}{1}$	$\frac{(0.20 + y)}{1}$

$$K_c = \frac{(0.20 + y)^2}{(0.40 - y)^2} = 6.40 \times 10^{-1} \quad (1)$$

$$\frac{(0.20 + y)}{(0.40 - y)} = \sqrt{6.40 \times 10^{-1}} = 0.8$$

$$(0.20 + y) = 0.8 \times (0.40 - y)$$

$$0.20 + y = 0.32 - 0.8y$$

$$1.8y = 0.12$$

$$\text{gives } y = 0.067 \quad (1)$$

at equilibrium

$$\begin{aligned} n(\text{CO}) = n(\text{H}_2\text{O}) &= (0.40 - 0.067) = 0.33 \text{ mol and} \\ n(\text{CO}_2) = n(\text{H}_2) &= (0.20 + 0.067) = 0.27 \text{ mol} \end{aligned} \quad (1)$$

allow ecf as appropriate [5]

[Total: 12]

Page 6	Mark Scheme: Teachers' version	Syllabus	Paper 1
	GCE AS/A LEVEL – October/November 2012	9701	

4 (a) (i)

reaction	organic compound	reagent	structural formulae of organic product
A	$\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$	NaBH_4	no reaction
B	CH_3COCH_3	Tollens' reagent warm	no reaction
C	$\text{CH}_3\text{CO}_2\text{CH}(\text{CH}_3)_2$	$\text{KOH}(\text{aq})$ warm	$\text{CH}_3\text{CO}_2\text{K}$ or CH_3CO_2^- + $(\text{CH}_3)_2\text{CHOH}$
D	$(\text{CH}_3)_3\text{COH}$	$\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$ heat under reflux	no reaction
E	CH_3COCH_3	NaBH_4	$\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$
F	$(\text{CH}_3)_3\text{COH}$	PCl_5	$(\text{CH}_3)_3\text{CCl}$
G	$\text{CH}_3\text{CH}=\text{CHCH}_2\text{OH}$	$\text{MnO}_4^-/\text{H}^+$ heat under reflux	$\text{CH}_3\text{CO}_2\text{H}$ + $\text{HO}_2\text{CCO}_2\text{H}$

each correct answer gets 1

(9 × 1)

(ii)

reaction	colour at the beginning of the reaction	colour at the end of the reaction
G	purple	colourless not clear

(1 + 1 + 1) [12]

[Total: 12]

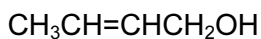
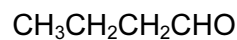
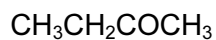
Page 7	Mark Scheme: Teachers' version	Syllabus	Paper 1
	GCE AS/A LEVEL – October/November 2012	9701	023Based.com

5 (a) (i)

H

J

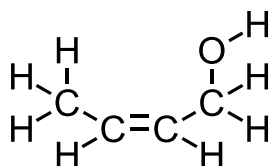
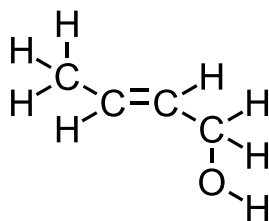
K



each correct answer gets 1

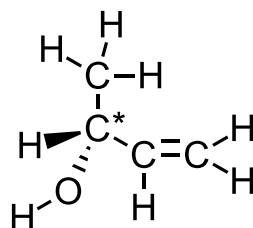
(5 x 1)

(ii)



(1)

(iii)



correct structure drawn fully displayed
chiral centre clearly shown by*

(1)

(1)

[8]

[Total: 8]