

## **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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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



$$1200 \text{ g C}_6\text{H}_{12}\text{O}_6 \rightarrow \frac{6 \times 200}{180} \text{ mol CO}_2$$

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

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

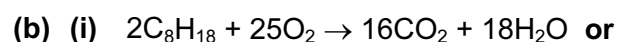


$$= 2.728 \times 10^{11} \text{ mol CO}_2$$
 (1)

$$2.728 \times 10^{11} \text{ mol CO}_2 \equiv 2.728 \times 10^{11} \times 44 = 1.20032 \times 10^{13} \text{ g}$$

$$= 1.20 \times 10^7 \text{ tonnes CO}_2 \text{ to 3 sf}$$
 (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)

$$n(\text{C}_8\text{H}_{18}) = \frac{2800}{114} = 24.56140351 \text{ mol in } 4.00 \text{ dm}^3$$

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



$$24.6 \text{ mol C}_8\text{H}_{18} \text{ produce } \frac{16 \times 44 \times 24.6}{2} \text{ g CO}_2$$

$$= 8659.2 \text{ g CO}_2$$

$$= 8660 \text{ g CO}_2 \text{ to 3 sf}$$
 (1) [5]

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(c)  $6.82 \times 10^9$  people produce  $1.20 \times 10^7$  tonnes  $\text{CO}_2$  per day

8660 g  $\text{CO}_2$  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  $1.20 \times 10^7$  tonnes  $\text{CO}_2$  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 <sub>x</sub>		SO <sub>2</sub>	H <sub>2</sub> O	C	unburned C <sub>8</sub> H <sub>18</sub>
	NO	NO <sub>2</sub>				
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]**

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- 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  $\text{H}^+$  ions in solution (1) [3]
- (b) (i) purple/violet vapour ( $\text{I}_2$ ) or black/brown solid ( $\text{I}_2$ ) **or**  
irritating/acrid gas ( $\text{SO}_2$ ) or stinking gas ( $\text{H}_2\text{S}$ ) **or**  
yellow solid (S) (1)
- (ii) conc.  $\text{H}_2\text{SO}_4$  is an oxidising agent **or** HI is a reducing agent (1)  
which oxidises HI **or** which reduces  $\text{H}_2\text{SO}_4$  (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]

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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 <sub>2</sub> O(g)	$\rightleftharpoons$	CO <sub>2</sub> (g)	+ H <sub>2</sub> (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 <sup>-3</sup>	$\frac{(0.40 - y)}{1}$	$\frac{(0.40 - y)}{1}$		$\frac{(0.20 + y)}{1}$	$\frac{(0.20 + y)}{1}$

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

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

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

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

$$1.8y = 0.12$$

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

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]**

4 (a) (i)

reaction	organic compound	reagent	structural formulae of organic product
A	$\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$	$\text{NaBH}_4$	no reaction
B	$\text{CH}_3\text{COCH}_3$	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 $\text{CH}_3\text{CO}_2^-$ + $(\text{CH}_3)_2\text{CHOH}$
D	$(\text{CH}_3)_3\text{COH}$	$\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$ heat under reflux	no reaction
E	$\text{CH}_3\text{COCH}_3$	$\text{NaBH}_4$	$\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$
F	$(\text{CH}_3)_3\text{COH}$	$\text{PCl}_5$	$(\text{CH}_3)_3\text{CCl}$
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  <b>not</b> clear

(1 + 1 + 1) [12]

**[Total: 12]**

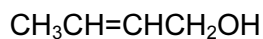
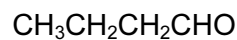
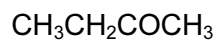
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5 (a) (i)

H

J

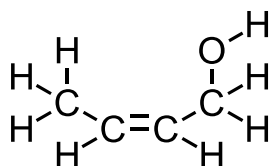
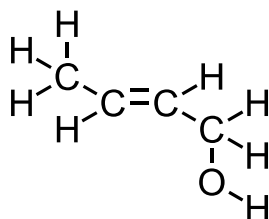
K



each correct answer gets 1

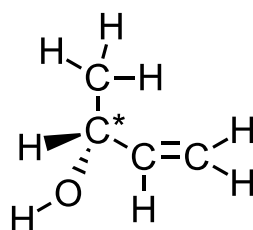
(5 x 1)

(ii)



(1)

(iii)



correct structure drawn fully displayed  
chiral centre clearly shown by\*

(1)

(1)

[8]

[Total: 8]