

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

**MARK SCHEME for the October/November 2010 question paper  
for the guidance of teachers**

**9701 CHEMISTRY**

**9701/21**

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

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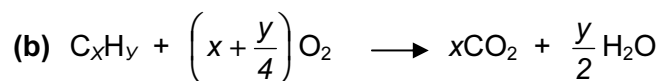
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1 (a) the actual number of atoms of each element present (1)

in one molecule of a compound (1)

[2]



$xCO_2$  (1)

$\frac{y}{2} H_2O$  (1)

[2]

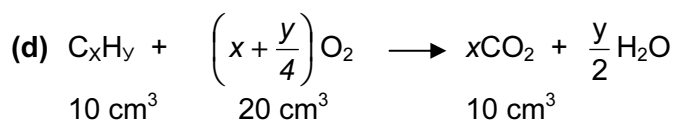
(c) (i) oxygen/ $O_2$  (1)

(ii) carbon dioxide/ $CO_2$  (1)

(iii)  $10 \text{ cm}^3$  (1)

(iv)  $20 \text{ cm}^3$  (1)

[4]



1 mol of  $C_xH_y$  gives 1 mol of  $CO_2$

whence  $x = 1$  (1)

1 mol of  $C_xH_y$  reacts with 2 mol of  $O_2$

whence  $\left(x + \frac{y}{4}\right) = 2$

and  $y = 4$  (1)

molecular formula is  $CH_4$  (1)

[3]

[Total: 11]

|        |                                        |          |       |
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2 (a)  $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$  (1) [1]

(b) temperature between 300 and 550°C (1)

correct explanation of effect of temperature on  
rate of formation of  $\text{NH}_3$  **or** on position of equilibrium (1)

catalyst of iron **or** iron oxide (1)

to speed up reaction **or** to reduce  $E_a$  (1) [4]

(c) manufacture of  $\text{HNO}_3$

**or** explosives

**or** nylon

**or** as a cleaning agent

**or** as a refrigerant (1) [1]

(d) fertiliser in rivers causes excessive growth of aquatic plants/algae (1)

when plants and algae die  $\text{O}_2$  is used up/fish or aquatic life die (1) [2]

(e) (i) CO by incomplete combustion of the hydrocarbon fuel (1)

NO by reaction between  $\text{N}_2$  and  $\text{O}_2$  in the engine (1)

(ii) CO toxic/effect on haemoglobin (1)

NO toxic/formation of acid rain (1) [4]

(f) (i) platinum/Pt – allow palladium/Pd **or** rhodium/Rh (1)

(ii)  $2\text{CO} + 2\text{NO} \rightarrow 2\text{CO}_2 + \text{N}_2$  (1) [2]

[Total: 14]

|        |                                        |          |       |
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3 (a) (i) a compound which contains **only** carbon and hydrogen (1)

(ii) separation of compounds by their boiling points (1) [2]

(b) (i) high temperature **and** high pressure (1)

high temperature **and** catalyst (1)

(ii)  $C_{11}H_{24} \rightarrow C_5H_{12} + C_6H_{12}$  **or**

$C_{11}H_{24} \rightarrow C_5H_{12} + 2C_3H_6$  **or**

$C_{11}H_{24} \rightarrow C_5H_{12} + 3C_2H_4$  (1) [3]

(c) (i)

|                        |                        |                                                                              |
|------------------------|------------------------|------------------------------------------------------------------------------|
| $CH_3CH_2CH_2CH_2CH_3$ | $CH_3CH_2CH(CH_3)CH_3$ | $  \begin{array}{c}  CH_3 \\    \\  CH_3CCH_3 \\    \\  CH_3  \end{array}  $ |
| isomer <b>B</b>        | isomer <b>C</b>        | isomer <b>D</b>                                                              |
| (1)                    | (1)                    | (1)                                                                          |

(ii) the straight chain isomer (isomer **B** above) (1)

it has the greatest van der Waals' forces (1)

because unbranched molecules have greater area of contact/  
can pack more closely together (1)

[6]

(d) enthalpy change when 1 mol of a substance (1)

is burnt in an excess of oxygen/air under standard conditions  
**or** is completely combusted under standard conditions (1)

[2]

|        |                                        |          |       |
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(e) (i) heat released =  $m c \delta T = 200 \times 4.18 \times 27.5$  (1)

$$= 22990 \text{ J} = 23.0 \text{ kJ} \text{ (1)}$$

(ii) 23.0 kJ produced from 0.47 g of E

$$2059 \text{ kJ produced from } \frac{0.47 \times 2059}{23.0} \text{ g of E (1)}$$

$$= 42.08 \text{ g of E (1)}$$

allow ecf in (i) or (ii) on candidate's expressions

[4]

(f)  $C_3H_6 = 42$

E is  $C_3H_6$

for ecf, E must be unsaturated and be no larger than  $C_5$  (1)

[1]

[Total: 18]

- 4 (a) reaction 1 reagent NaOH/KOH (1)
- solvent  $H_2O$ /water/aqueous (1)
- reaction 2 reagent  $NH_3$ /ammonia (1)
- solvent ethanol/ $C_2H_5OH$ /alcohol (1)
- reaction 3 reagent NaOH/KOH (1)
- solvent ethanol/ $C_2H_5OH$ /alcohol (1)

[6]

(b) with  $CH_3CH_2CH_2CH_2I$  rate would be faster (1)

C-I bond is weaker than C-Br bond (1)

C-I bond energy is  $240 \text{ kJ mol}^{-1}$ , C-Br bond energy is  $280 \text{ kJ mol}^{-1}$   
data **must** be quoted for this mark (1)

[3]

(c) non-toxic non-flammable

volatile/low bp unreactive (any 2)

[2]

|        |                                        |          |       |
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(d) (i) when a covalent bond breaks the two electrons in the bond are shared between the two atoms (1)

(ii)  $\text{CCl}_2\text{F}_2 \rightarrow \text{CClF}_2 + \text{Cl}$  (as minimum)

allow  $\text{CCl}_2\text{F} + \text{F}$  (1) [2]

(e) they are flammable (1) [1]

[Total: 14]

5 (a) NaBr/sodium bromide [1]

(b)  $\text{Br}_2$ /bromine or  $\text{SO}_2$ /sulfur dioxide [1]

(c) concentrated sulfuric acid is an oxidising agent  
or  
phosphoric(V) acid is **not** an oxidising agent [1]

[Total: 3]