UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2009 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/22 Paper 22 (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 must be read in conjunction with the question papers and the report on the examination.

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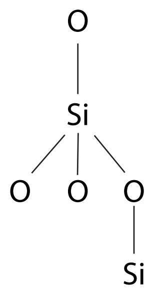
1 **(a)** CO_2 is simple molecular/simple covalent/has discrete molecules (1)
CO_2 has induced dipole – induced dipole interactions/
van der Waals' forces/weak intermolecular forces (1)
SiO_2 is giant molecular/giant covalent/macromolecular (1)
SiO_2 has strong covalent bonds (1)
[any 3]

(b) minimum is 4-valent Si-O (1)
and at least one Si-O-Si (1)
i.e.



[2]

(c) **(i)** for an ideal gas, **any four** from the following
the molecules behave as rigid spheres (1)
there are no/negligible intermolecular forces
between the molecules (1)
collisions between the molecules are perfectly elastic (1)
the molecules have no/negligible volume (1)
the molecules move in random motion (1)
the molecules move in straight lines (1)
the kinetic energy of the molecules is
directly proportional to the temperature (1)
the pressure exerted by the gas is due to the collisions
between the gas molecules and the walls of the container (1)
not an ideal gas obeys $pV = nRT$
(max 4)

(ii) there are intermolecular forces between CO_2 molecules/
CO_2 molecules have volume (1) [5]

(d) graphite has delocalised electrons (1) [1]

(e) **(i)** $SiO_2 + 2C \rightarrow SiC + CO_2$ **or**
$SiO_2 + 3C \rightarrow SiC + 2CO$ (1)

(ii) diamond **because** SiC is hard (1) [2]

[Total: 13]

2 (a) (i)

formula of chloride	$NaCl$	$MgCl_2$	$AlCl_3$	$SiCl_4$	PCl_3	SCl_2
oxidation number of element in the chloride	+1	+2	+3	+4	+3	+2

correct oxidation nos. for $NaCl$ to SCl_2 (1)

(ii) **Na to Al**
loss of outer/valence electrons (1)
to give configuration of Ne/to complete octet (1)
Si to S
gain or sharing of outer electrons (1)
to give configuration of Ar/to complete octet (1) [5]

(b) (i) giant lattice (may be in diagram) (1)
with strong ionic bonding (1)

(ii) ionic (1)

(iii) –1 (1)

(iv)

```
  . .  +                    –
: Na :                   x. H
  . .
```

correct numbers of electrons (1)
correct charges (1)

(v)

compound	MgH_2	AlH_3	PH_3	H_2S
oxidation number of element in the hydride	+2	+3	–3	–2

correct oxidation nos. for MgH_2 **and** AlH_3 (1)
correct oxidation nos. for PH_3 **and** H_2S (1) [8]

(c) (i)

chloride	sodium	magnesium	aluminium
pH	7	6.5–6.9	1–4
	(no mark)	(1)	(1)

(ii) $NaH + H_2O \rightarrow NaOH + H_2$ (1)

(iii) 10–14 (1) [4]

(d) (i) covalent (1)

(ii) $SiCl_4 + 4H_2O \rightarrow Si(OH)_4 + 4HCl$ **or**
$SiCl_4 + 4H_2O \rightarrow SiO_2.2H_2O + 4HCl$ **or**
$SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$ (1) [2]

[Total: 19]

3 (a) stage I $NaBr + H_2SO_4 \rightarrow NaHSO_4 + HBr$
allow $2NaBr + H_2SO_4 \rightarrow Na_2SO_4 + 2HBr$ (1)
stage II $C_4H_9OH + HBr \rightarrow C_4H_9Br + H_2O$ (1) [2]

(b) $n(\text{NaBr}) = n(\text{HBr}) = \dfrac{35}{103} = 0.34$ (1)

$n(C_4H_9OH) = \dfrac{20}{74} = 0.27$ (1)

NaBr/HBr is in an excess – **no mark just for this answer** [2]

(c) method 1, using mass

$C_4H_9OH \equiv C_4H_9Br$

if yield is 100%,

74 g $C_4H_9OH \rightarrow$ 137 g C_4H_9Br

15.4 g C_4H_9OH would produce $\dfrac{137 \times 15.4}{74} = 28.5$ g C_4H_9Br (1)

% yield = $\dfrac{22.5 \times 100}{28.5} = 78.9$ (1)

or methods using moles

method 2

$n(C_4H_9OH) = \dfrac{15.4}{74} = 0.208$

for 100% yield $n(C_4H_9Br)$ would be $0.208 \times 137 = 28.5$g (1)

% yield = $\dfrac{22.5 \times 100}{28.5} = 78.9$ (1)

method 3

$n(C_4H_9OH) = \dfrac{15.4}{74} = 0.208$ mol

for 100% yield $n(C_4H_9Br)$ would be 0.208 mol

actual $n(C_4H_9Br) = \dfrac{22.5}{137} = 0.164$ mol (1)

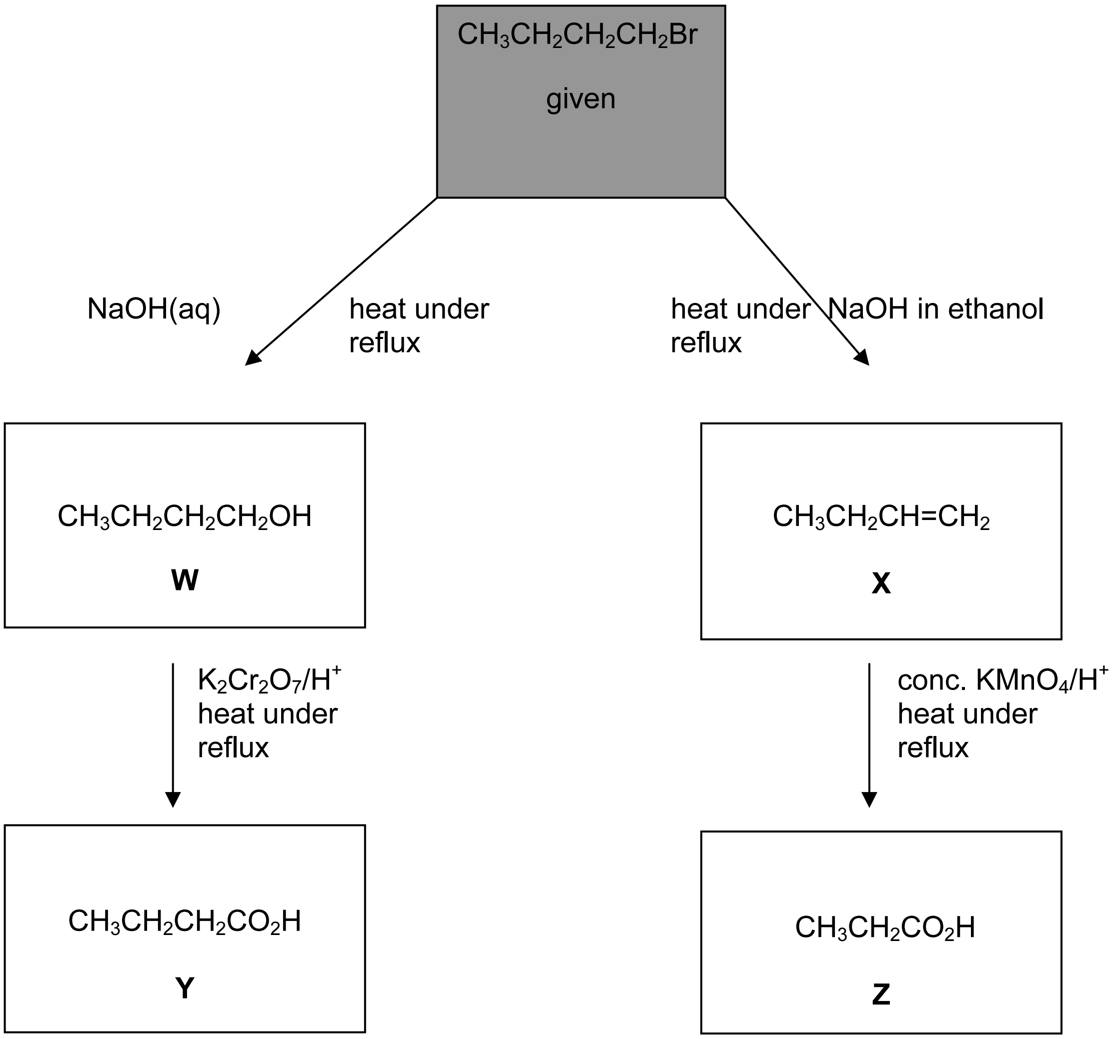
% yield = $\dfrac{0.164 \times 100}{0.208} = 78.8$ (1) [2]

(d) **inorganic by-product**
Br_2/bromine **or** sulfur dioxide/SO_2 (1)
conc. H_2SO_4 behaves as an oxidising agent (1)

organic by-product
but-1-ene/$CH_3CH_2CH{=}CH_2$
allow butane and $C_4H_9OC_4H_9$ (1)
conc. H_2SO_4 behaves as a dehydrating agent (1) [4]

[Total: 10]

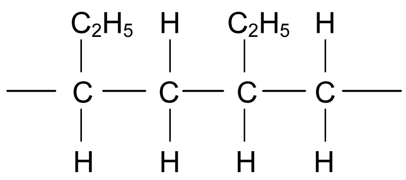
4 **(a)**



(4 × 1) [4]

(b) **(i)** **X**
allow ecf on any alkene above (1)

(ii)



allow ecf on any alkene above (1) [2]

[Total: 6]

5 **(a)** 2,4-dinitrophenylhydrazine **or** aqueous alkaline iodine (1)

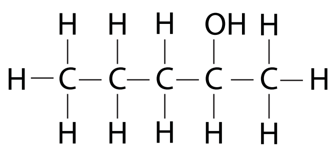
$\downarrow$ $\downarrow$

yellow-orange-red ppt. yellow ppt. (1) [2]

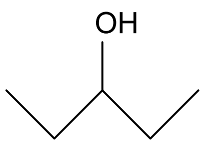
(b) colourless gas evolved **or** Na dissolves (1)
$C_4H_9OH + Na \rightarrow C_4H_9ONa + ½H_2$ (1) [2]

(c) **(i)** $CH_3CH_2CH_2CH_2CH_2OH$ (1)

(ii)



(iii)



(1) [3]

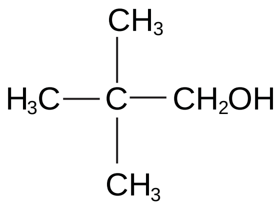
(d) **(i)** pentan-2-ol (1)

(ii)

$CH_3CH_2CH{=}CHCH_3$ product 1	$CH_3CH_2CH_2CH{=}CH_2$ product 2

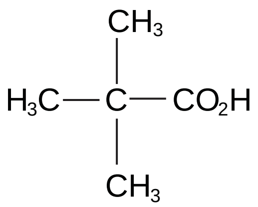
(1 + 1) [3]

(e) **(i)**



or $CH_3C(CH_3)_2CH_2OH$ (1)

(ii)



or $CH_3C(CH_3)_2CO_2H$

allow ecf on **(e)(i)** (1) [2]

[Total: 12]