



General Certificate of Education

Chemistry 5421

CHM3/W Introduction to Organic Chemistry

Mark Scheme

June examination - 2007 series

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CHM3/W**Question 1**

- (a) (i) A compound OR molecule OR contains OR consists of OR is made up of hydrogen and carbon only (1)
- (ii) *Change 1:* liquid to gas OR boiling OR evaporation/evaporating OR vaporisation. (1)
- Change 2:* gas to liquid OR condensation/condensing (1)

(Answers can be in either order and should be marked independently)

(Penalise contradictions for each specified change; "melting" may be a contradiction)

(Penalise "becomes a gas" or "becomes a liquid")

(Penalise "liquefied")

- (b) (i)
- $$\begin{array}{cc}
 \text{H} & \text{H} \\
 | & | \\
 \text{---C} & \text{---C---} \\
 | & | \\
 \text{H} & \text{H}
 \end{array}$$
- (1)

OR $\text{---CH}_2\text{---CH}_2\text{---}$

(Insist on only two CH₂ groups and on bonds on both sides of both CH₂ groups)

(Ignore brackets)

(Ignore "n" whether before or after the structure/brackets)

(Penalise lower case 'h')

(Accept a balance equation)

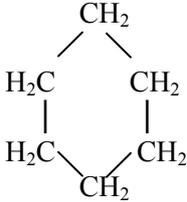
- (ii) Strained ring OR structure OR molecule OR compound (1)
- OR 60° bond angle
- OR (a statement) bond angle much less than tetrahedral/109°/109.5°
- (Do not credit "stressed" ring)*
- (Ignore "strained bond angles" and "strained bonds".)*
- (Ignore "unstable" and "weak bonds", but the latter must reference the C—O bond if a bond is specified)*

- (iii) Ethane-1,2-diol OR ethan-1,2-diol (1)

Total 6

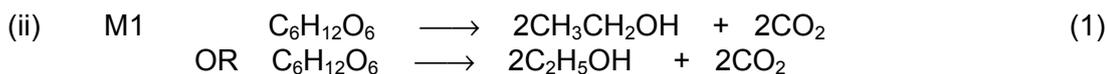
Question 2

- (a) (i) Carbocation OR carbonium ion (1)

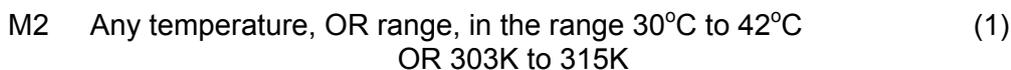
- (ii) Zeolite OR aluminosilicate OR pumice OR porous pot OR Al_2O_3 OR aluminium oxide OR ceramic
(Ignore "aluminium silicate" and "clay")
(Credit phonetic spelling of zeolite) (1)
- (b) (i) Free radical OR alkyl radical intermediate
(Penalise "carbon radical") (1)
- (ii) $\text{C}_{10}\text{H}_{22} \longrightarrow \text{C}_3\text{H}_6 + \text{C}_7\text{H}_{16}$
OR $\text{C}_{10}\text{H}_{22} \longrightarrow 2\text{C}_3\text{H}_6 + \text{C}_4\text{H}_{10}$
OR $\text{C}_{10}\text{H}_{22} \longrightarrow 3\text{C}_3\text{H}_6 + \text{CH}_4$
(Credit structures of different types provided they are correct) (1)
- (c) (i) Catalytic cracking (1)
- (ii) Excess/plentiful/lots of Oxygen OR O_2 OR air
(Penalise "good supply" or "sufficient" and penalise use of a "catalyst")
(Ignore references to T and P) (1)
- (iii)  OR  (1)
(No alternative, except that the individual bonds for each C—H can be drawn out and the H_2C on the LHS could be written CH_2)
- (iv) $\text{C}_6\text{H}_{12} + 3\text{O}_2 \longrightarrow 6\text{C} + 6\text{H}_2\text{O}$
(Credit the 3O_2 being placed over the arrow) (1)
- (d) (i) M1 $\frac{1}{2}\text{N}_2 + \frac{1}{2}\text{O}_2 \longrightarrow \text{NO}$
OR $\text{N}_2 + \text{O}_2 \longrightarrow 2\text{NO}$ (1)
- M2 spark OR high temperature OR $2500^\circ\text{C} \leq T \leq 4000^\circ\text{C}$
(Ignore references to pressure) (1)
- (ii) Platinum OR Pt OR rhodium OR Rh OR palladium OR Pd
(Penalise incorrect phonetic spelling such as "platinum")
(penalise contradictory symbol and name, but credit correct name even if the attempted symbol is inaccurate) (1)
- (iii) $\text{CO} + \text{NO} \longrightarrow \text{CO}_2 + \frac{1}{2}\text{N}_2$
OR $2\text{CO} + 2\text{NO} \longrightarrow 2\text{CO}_2 + \text{N}_2$ (1)

Total 12**Question 3**

- (a) (i) Fermentation
(Credit correct phonetic spelling) (1)



(Penalise C_2H_6O)



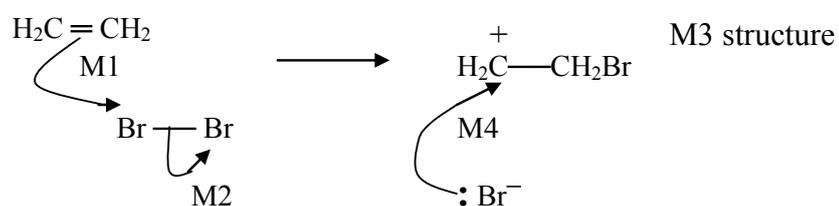
(Assume the units are correct if not specified, but penalise incorrect units)

(b) elimination (1)

(Penalise "dehydration" on its own, but not in addition to correct answer)

(Penalise any words in front of the word "elimination" except credit "acid-catalysed elimination" OR "acid elimination")

(c)



(4)

(Penalise M3 if HBr or wrong alkene is used)

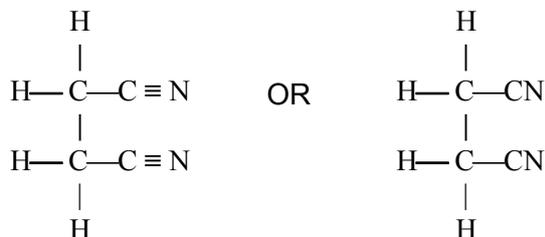
(Penalise M2 if polarity on Br-Br is incorrect or formal charges used)

(Penalise M1 if partial charges are placed on the double bond)

(d) (i) Nucleophilic substitution (1)

(Insist on both words and credit correct phonetic spelling)

(ii)



(1)

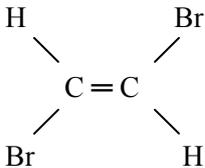
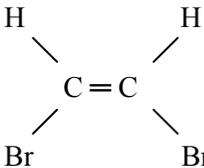
Total 10

Question 4

(a) (i) Propan-2-ol (1)

(ii) $CH_3CH_2CH_2OH$ (1)

(Credit displayed formula for propan-1-ol but insist that, if drawn, the C—OH bond is clearly from C to O)

- (b) (i) 2,3- dimethylbut-2-ene (1)
- (ii) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}=\text{CH}_2$ (1)
 OR $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}=\text{CHCH}_3$
 OR $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}_3$
- (or displayed formula for either hex-1-ene OR hex-2-ene OR hex-3-ene, clearly showing the double bond)*
- (c) (i) Pentan-3-one (1)
- (ii) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CHO}$ (1)
 OR $\text{CH}_3\text{CH}_2(\text{CH}_3)\text{CHCHO}$
 OR $(\text{CH}_3)_2\text{CHCH}_2\text{CHO}$
 OR $(\text{CH}_3)_3\text{CCHO}$
- (Credit correct structure for any of these four aldehydes)
 (If drawn out, only credit if the structure shows correct bonds)*
- (d) (i) Geometric(al) OR cis-trans (1)
- (ii)
- | | | |
|---|--|-----|
|  |  | (2) |
| M1 Trans (1,2-dibromoethene) | M2 Cis (1,2-dibromoethene) | |
- (Mark vertically, but award 1 mark for two correct structures with either no names or incorrect names)
 (Credit structures which have 90° bond angles)*
- (e) No rotation OR restricted rotation OR "it does not rotate" QoL (1)
*(Insist on reference to rotation for the QoL mark)
 (If a longer statement is made, it must be clear that the lack of rotation is of the double bond and not the whole molecule)*

Total 10**Question 5**

- (a) $\text{C}_{18}\text{H}_{36}\text{O}_2$ (1)
*(The elements could be in any order)
 (No other structures should be drawn)*
- (b) (i) $\text{C}_9\text{H}_{16}\text{O}$ (1)
*(The elements could be in any order)
 (No other structures should be drawn)*

-
- (ii) *Reagent:* Hydrogen OR H₂ (1)
Catalyst: Nickel OR Ni (1)
 (*Credit platinum OR Pt OR palladium OR Pd*)
 (*Credit phonetic spellings*)
- (c) (i) Hydration (1)
 OR (electrophilic) addition
 (*Ignore references to "direct" or indirect" hydration*)
- (ii) Both double bonds OR the other double bond could react or could (1)
 be used.
 OR addition could occur either way on the double bond
 OR other secondary/same stability/similar stability carbocations can form/occur.
 OR an ester could form between the acid and alcohol.

 (*Do not credit references which indicate simply that linoleic acid has two double bonds*)
 (*Penalise references to different stability carbocations or primary and tertiary carbocations or major or minor products due to difference in stability*)
- (d) Secondary OR 2° (1)
 (*Credit phonetic spelling*)

Total 7**Question 6**

- (a) M1 Free radical intermediate (1)
 (*Credit "chlorine radical" or "alkyl radical" OR Cl• OR C₄H₉•*)
 (*Penalise hydrogen radical*)
 (*Do not credit "radical mechanism" or "radical substitution" if these occur on their own*)
- M2 uv light OR ultra-violet light OR sunlight OR 450°C ≤ T ≤ 1000°C (1)
 (*Ignore reference to pressure and do not credit "high temperature"*)
- M3 initiation (1)
- M4 propagation (1)
- M5 termination (1)
- (*The names of the steps can be in any order and spelling may be phonetic*)
 (*Ignore equations*)
 (*Ignore references to "further substitution" as a fourth step*)
 (*Credit the word "propagation" once only and ignore reference to first and second propagation*)
- M6 C₄H₁₀ + 10Cl₂ → C₄Cl₁₀ + 10HCl (1)
-

-
- (b) M1 A nucleophile is (1)
 an electron pair donor
 OR a species/molecule which uses a pair of electrons to form a covalent or
 co-ordinate bond
 OR uses an electron pair to attack a partially positive/electron deficient carbon atom.
- M2 The nucleophile is hydroxide ion OR OH^- OR OH^- (1)
*(Ignore the word "molecule" provided the formula for the hydroxide ion is
 written)*
(Penalise OH)
(Ignore up to three lone pairs on oxygen)
- M3 The feature of 1-chlorobutane is the polar C — Cl bond (1)
 OR δ^+ on the C atom of C — Cl bond
 OR $\begin{matrix} \delta^+ & (\delta^-) \\ \text{C} & \text{---} & \text{Cl} \end{matrix}$
 OR electron deficient C atom of C — Cl bond
 QoL requires reference to the C — Cl bond
- M4 Change the conditions to
 Alcohol(ic) OR Ethanol(ic) solvent (1)
 OR Higher temperature
 OR More concentrated KOH
(Penalise "ethanoic")
- (c) M1 *Type of reaction:* oxidation OR redox (1)
*(Penalise as contradictions if Reaction 4 and Reaction 5 are given as different
 types of reaction)*
- M2 acidified potassium dichromate(VI) (1)
(Penalise dichromate (IV))
 OR $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}_2\text{SO}_4$
 OR acidified potassium manganate(VII)
 OR $\text{KMnO}_4/\text{H}_2\text{SO}_4$
(Be lenient on the name provided the formula is correct, when both are given)
(Credit HCl for dichromate but not for manganate(VII))
(Credit H^+ for either oxidising agent as an alternative to e.g. H_2SO_4)
(Penalise as contradictions if Reaction 4 and Reaction 5 use different reagents)
- M3 Heat under reflux. (1)
 OR use excess oxidising agent/excess [O]
-

OR use a more concentrated reagent/oxidising agent.

(Do not credit "higher temperature" alone)

<p>M4 Test with Tollens' reagent</p> <p><i>(Credit ammoniacal silver nitrate OR a description of making Tollens')</i></p> <p><i>(Do not credit either AgNO_3 or $[\text{Ag}(\text{NH}_3)_2^+]$ or "the silver mirror test" on their own, but mark M5)</i></p>	<p>M4 Test with Fehling's solution</p> <p><i>(Penalise $\text{Cu}^{2+}(\text{aq})$ or CuSO_4 but mark M5)</i></p>	(1)
<p>M5 silver mirror OR black solid/precipitate</p> <p><i>Do not credit M5 if no reference is given to test reagent.</i></p>	<p>M5 Red solid/precipitate <i>(Credit orange or brown solid)</i></p> <p><i>Do not credit M5 if no reference is given to test reagent.</i></p>	(1)

(Do not credit the use of acidified potassium dichromate(VI) for M4 and M5)

Total 15