



TOPIC 8 MS

1. M1: uv light/sunlight

OR

T = 450 °C to 1000 °C;

*(do not credit "high temperature")
 (ignore references to pressure or catalyst)
 (penalise M1 if aqueous chlorine OR chlorine water)
 (credit M1 if the condition appears over the arrow of the initiation step)*

→

1

M2: $\text{Cl}_2 \rightarrow 2\text{Cl}\cdot$;

(credit correct half arrows, but penalise (once in the question) the use of double headed arrows)

1

M3: $\text{C}_2\text{H}_6 + \text{Cl}\cdot \rightarrow \text{CH}_3\text{CH}_2\cdot + \text{HCl}$;

(credit CH_3CH_3 for ethane and $\text{C}_2\text{H}_5\cdot$ for the ethyl radical)

1

M4: $\text{CH}_3\text{CH}_2\cdot + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_5\text{Cl} + \text{Cl}\cdot$;

1

M5: $\text{CH}_3\text{CH}_2\cdot + \text{CH}_3\text{CH}_2\cdot \rightarrow \text{C}_4\text{H}_{10}$;

(penalise the absence of dots once only in this question)

(penalise subsequent ionic reactions as contradictions for each reaction contradicted)

(if neither M3 nor M4 scored, allow $\text{CH}_3\text{CH}_2\cdot +$

$\text{Cl}\cdot \rightarrow \text{C}_2\text{H}_5\text{Cl}$ for one mark)

1

[5]

2. (a) (i) $\text{CH}_4 + 3\text{F}_2 \rightarrow \text{CHF}_3 + 3\text{HF}$

1

(ii) **M1 Initiation** →

$\text{F}_2 \rightarrow 2\text{F}\cdot$

M2 First propagation

$\text{F}\cdot + \text{CHF}_3 \rightarrow \cdot\text{CF}_3 + \text{HF}$

M3 Second propagation

1

MEGA LECTURE



M4 Termination (must make C₂F₆)



Penalise absence of dot once only.

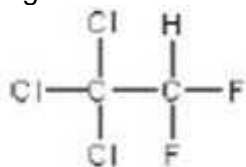
Radical dot on $\bullet CF_3$ can be anywhere but if the structure is drawn out, the dot must be on the carbon atom. Penalise this error once only.

Penalise once only for a line and two dots to show a bond.

Penalise each of "F" and lower case F, once only in this clip

4

- (b) (i) Displayed formula
e.g.



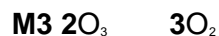
All bonds must be drawn out.

Ignore bond angles. Penalise "sticks"



1

- (ii) **M1** C-Cl bond OR carbon-chlorine bond
M2 chlorine atom OR chlorine (free) radical



M1 NOT carbon-halogen

Penalise incorrect spelling of chlorine once only in this clip

M2 ignore formulae

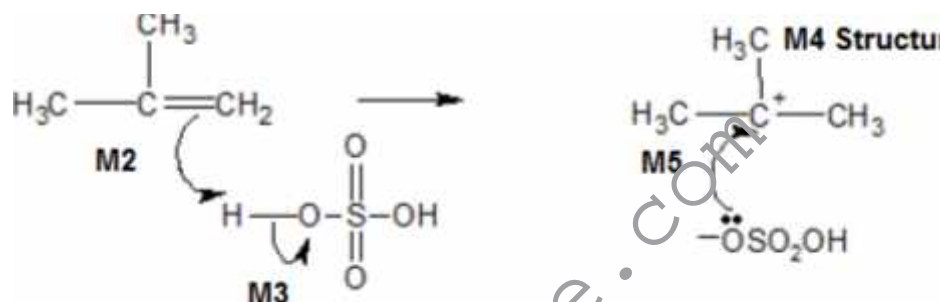
Ignore Cl₂ or Cl• or ClO• balanced on both sides of the equation

Ignore other equations leading to the overall equation

3

[9]

3. (i) **M1 Electrophilic addition**



M1 both words required.

For the mechanism

M3 Penalise incorrect partial charges on O-H bond and penalise formal charges. Ignore partial negative charge on the double bond.

M5 Not HSO₄⁻

For **M5**, credit as shown or $:\text{OSO}_3\text{H}$ ONLY with the negative charge anywhere on this ion

OR correctly drawn out with the negative charge placed correctly on oxygen.

M2 must show an arrow from the double bond towards the H atom of the O-H bond / HO on a compound with molecular formula for H₂SO₄

M2 could be to an H⁺ ion and M3 an independent O-H bond break on a compound with molecular formula for H₂SO₄

Max any 3 of 4 marks for a correct mechanism using the wrong organic reactant or wrong organic product (if shown) or a primary carbocation.

M3 must show the breaking of the O-H bond on H₂SO₄

Penalise once only in any part of the mechanism for a line and two dots to show a bond.

M5 must show an arrow from the lone pair of electrons on the



correct oxygen of the negatively charged ion towards the positively charged carbon atom on their carbocation

Credit the correct use of "sticks".

For M5, credit attack on a partially positively charged carbocation structure, but penalise M4

NB The arrows here are double-headed

5

(ii) Hydrolysis

Credit "(nucleophilic) substitution" but do not accept any other prefix.

Credit phonetic spelling.

1

(iii) Catalyst

1

[7]

5. (a) **M1** Br₂ OR bromine (water) OR bromine (in CCl₄ / organic solvent)

If M1, has no reagent or an incorrect reagent, CE=0.

Ignore 'acidified'.

M2 Isomer 1: decolourised / goes colourless / loses its colour

For M1 penalise Br (or incorrect formula of other correct reagent), but mark on.

M3 Isomer 2: remains orange / red / yellow / brown / the same
OR no reaction / no (observable) change **OR** reference to colour going to the cyclopentane layer

For M1, it must be a whole reagent and / or correct formula.

If oxidation state given in name, it must be correct. If 'manganate' OR 'manganate(IV)' or incorrect formula, penalise M1, but mark on.

Alternatives : potassium manganate(VII)

M1 KMnO₄ in acid **M2** colourless **M3** purple

M1 KMnO₄ in alkali / neutral **M2** brown solid **M3** purple

Credit for the use of **iodine**

M1 iodine (solution / in KI) **M2** colourless **M3** (brown) to purple (credit no change)

Credit for the use of **concentrated** H₂SO₄

4

MEGA LECTURE

M1 concentrated H_2SO_4 **M2** brown **M3** no change / colourless

Ignore 'goes clear'.

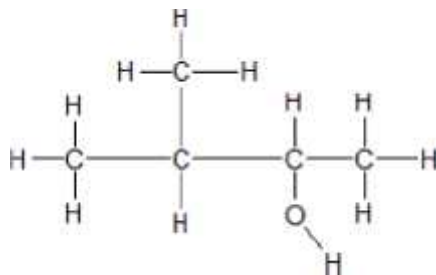
Ignore 'nothing (happens)'.

Ignore 'no observation'.

No credit for combustion observations.

3

(b)



All bonds must be drawn.

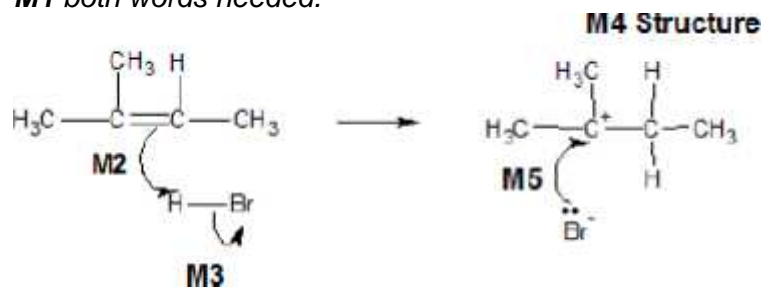
Ignore bond angles.

1

MEGA LECTURE

(c) (i) **M1 Electrophilic addition**

M1 both words needed.



Penalise one mark from their total if half-headed arrows are used.

M2 must show an arrow from the double bond towards the H atom of the H-Br molecule

M2 Ignore partial negative charge on the double bond.

M3 must show the breaking of the H-Br bond

M3 Penalise incorrect partial charges on H-Br bond and penalise formal charges.

M4 is for the structure of the tertiary carbocation

Penalise **M4** if there is a bond drawn to the positive charge.

Penalise once only in any part of the mechanism for a line and two dots to show a bond.

M5 must show an arrow from the lone pair of electrons on the negatively charged bromide ion towards the positively charged carbon atom of either a secondary or a tertiary carbocation

For **M5**, credit attack on a partially positively charged carbocation structure but penalise **M4**.

Max 3 of any 4 marks in the mechanism for wrong organic reactant or wrong organic product (if shown) or secondary carbocation.

Max 2 of any 4 marks in the mechanism for use of bromine.

Do not penalise the correct use of 'sticks'.

NB The arrows here are double-headed

5

6



- (ii) **M1** Reaction goes via intermediate carbocations / carbonium ions

M1 is a lower demand mark for knowledge that carbocations are involved.

M2 (scores both marks and depends on M1)

Tertiary carbocation / carbonium ion is more stable (than the secondary carbocation / carbonium ion)

OR

Secondary carbocation / carbonium ion is less stable (than the tertiary carbocation / carbonium ion)

M2 is of higher demand and requires the idea that the secondary carbocation is less stable or the tertiary carbocation is more stable.

Reference to incorrect chemistry is penalised.

A carbocation may be defined in terms of alkyl groups / number of carbon atoms rather than formally stated.

2

[11]

5. (a) (i) Splitting/breaking C-X/bond(s) using/by (adding)/with water

OR

Splitting/breaking the molecule/substance/compound using/by (adding)/with water

NOT simply the reaction of/with water

NOT simply the addition or adding of water.

NOT the "splitting of water"

Accept any halogen bond, but penalise other specified bonds

1

- (ii) **M1** yellow $\vec{\text{O}}$ ONLY

M2 $\text{Ag}^+ + \text{I}^- \rightarrow \text{AgI}$ ($\text{Ag}^+ \text{I}^-$)

For M1, penalise cream(y) OR white

Ignore pale or light or dark (yellow)

For M2, ignore state symbols

2

- (iii) **M1** AgF OR silver fluoride is soluble/dissolves (in water)

7



M2 No result
OR no precipitate
OR no (visible) change would occur
OR colourless solution
Accept "silver flouride"
Mark independently
Ignore reference to C – F bond breakage in M1
Ignore "no reaction" and "nothing"

2



- (b) The bond that takes less energy to break/the lower bond enthalpy (energy)/weaker bond means the precipitate/reaction/hydrolysis occurs faster/quicker/takes less time

OR

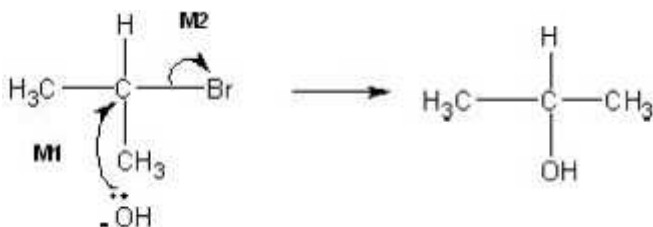
The bond that takes more energy/the higher bond enthalpy (energy)/stronger bond means the precipitate/reaction/hydrolysis occurs slower/takes longer/takes more time

Insist on comparative on both bond strength and rate of reaction

1

[6]

6. (a) (i) Nucleophilic substitution



1

2

M1 must show an arrow from the lone pair of electrons on the oxygen atom of the negatively charged hydroxide ion to the central C atom.

M2 must show the movement of a pair of electrons from the C-Br bond to the Br atom. Mark M2 independently.

Penalise M1 if covalent KOH is used

Penalise M2 for formal charge on C or incorrect partial charges

Penalise once only for a line and two dots to show a bond.

*Max 1 mark **for the mechanism** for the wrong reactant and/or "sticks"*

Ignore product

Award full marks for an S_N1 mechanism in which M1 is the attack of the hydroxide ion on the intermediate carbocation.

- (ii) 2-bromopropane ONLY

1

- (iii) Polar C-Br **OR** polar carbon-bromine bond **OR** dipole on C-Br
OR + (-)
 C atom of carbon-bromine bond is +/electron deficient **OR**
C Br

(Credit carbon–halogen bond as an alternative to carbon–bromine bond)

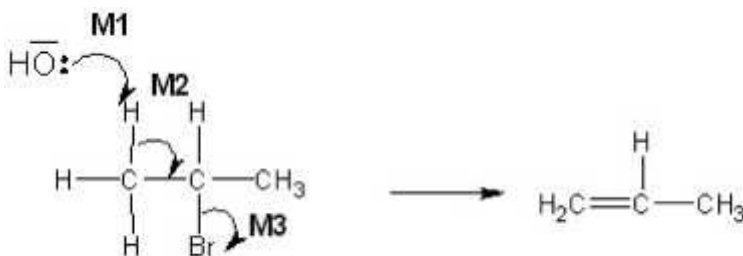
*It must be clear that the discussion is about the carbon atom of the C–Br bond. NOT just reference to a polar molecule.
Ignore X for halogen*

1

(b) Elimination

*Credit “base elimination” but NOT “nucleophilic elimination”
No other prefix.*

1



3

M1 must show an arrow from the lone pair on oxygen of a negatively charged hydroxide ion to the correct H atom

M2 must show an arrow from the correct C-H bond to the C-C bond and should only be awarded if an attempt has been made at M1

M3 is independent.

Mechanism

Penalise M1 if covalent KOH

Penalise M3 for formal charge on C or incorrect partial charges

Penalise once only for a line and two dots to show a bond.

*Max 2 marks **for the mechanism** for wrong reactant and/or “sticks”*

Ignore product

Award full marks for an E1 mechanism in which M2 is on the correct carbocation.

(c) *Any one condition from this list to favour elimination;*

Apply the list principle

- alcohol(ic)/ethanol(ic) (solvent)



- high concentration of KOH/alkali/hydroxide **OR** concentrated KOH/hydroxide
Ignore "aqueous"
- high temperature or hot or heat under reflux or T = 78 to 100°C
Ignore "excess"

1

(d) (i) Addition (polymerisation) ONLY
Penalise "additional"

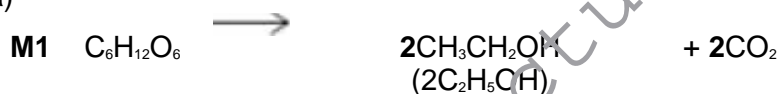
1

(ii) But-2-ene ONLY (hyphens not essential)
Ignore references to cis and trans or E/Z
Ignore butane

1

[12]

7. (a)



Penalise C_2H_6O for ethanol in M1.

M2 and M3

Mark M2 and M3 independently.

Any **two** conditions in any order for **M2** and **M3** from

- (enzymes from) yeast or zymase $\leq \leq$
- 25 °C T 42 °C OR 298 K T 315 K
- anaerobic / no oxygen / no air OR neutral pH

A lack of oxygen can mean either without oxygen or not having enough oxygen and does not ensure no oxygen, therefore only credit "lack of oxygen" if it is qualified.

Penalise 'bacteria', 'phosphoric acid', 'high pressure' using the list principle.

M4 (fractional) distillation or GLC

Ignore reference to 'aqueous' or 'water' (ie not part of the list principle).



M5 Carbon-neutral in this context means

There is no net / overall (annual) carbon dioxide / CO₂ emission to the atmosphere

OR

There is no change in the total amount / level of carbon dioxide / CO₂ present in the atmosphere

*For **M5** – must be about CO₂ and the atmosphere.*

The idea that the carbon dioxide / CO₂ given out equals the carbon dioxide / CO₂ that was taken in from the atmosphere.

5

[5]



8. (i) M1 pentan-3-one only 1

M2 $\text{CH}_3\text{CH}_2\text{CH}_2\text{COCH}_3$
(insist on $\text{C}=\text{O}$ being drawn out)
(penalise use of C_3H_7) 1

(ii) aldehyde $(\text{CH}_3)_2\text{CHCH}_2\text{CHO}$ 1

ketone $(\text{CH}_3)_2\text{CHCOCH}_3$ 1

(insist on a clear structure for the $\text{C}=\text{O}$ of the functional groups, but do not be too harsh on the vertical bonds between carbon atom on this occasion)

(If both structures correct, but wrong way around, award one mark)

(ignore names)

[4]

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9. (a) M1: $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$; 1

M2: $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$;
(penalise incorrect alcohols in part (a), but mark sequentially in part (b) and in part (c), if relevant)
(if three alcohols drawn, award MAX. 1 mark) 1

(b) M1, M2 and M3: Correct structures for butanal, butanone and butanoic acid;
(award these structure marks wherever the structures appear, but insist that the C=O is shown in each structure and additionally, the C-O in the carboxylic acid) 3

M4: balanced equation for the reaction of butan-1-ol with [O] to produce butanal and water; 1

M5: balanced equation for the reaction of butan-1-ol with [O] to produce butanoic acid and water

OR

balanced equation for the reaction of butanal with [O] to produce butanoic acid; 1

M6: balanced equation for the reaction of butan-2-ol with [O] to produce butanone and water;
(Credit condensed structures or molecular formulas in each equation, provided it is obvious to which reaction the equation refers)
(Insist that whatever formula is used in each equation that it is a conventional representation of the compound; for example penalise $\text{CH}_3\text{CH}_2\text{CH}_2\text{COH}$ for butanal) 1

(c) M1: Correct structure for 2-methylpropan-2-ol;
M2: 2-methylpropan-2-ol 1

OR

methylpropan-2-ol;
(penalise on every occasion in parts (a) and (c), structures for the alcohols that are presented)



with the alcohol functional group as C-H-O)

1

[10]

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10. (a) To prevent vigorous boiling / uneven boiling / bubbling vigorously
Reference to an effect on 'reaction' here loses this mark. 1
- (b) Condenser
Accept 'condensation chamber' or 'condensation tube'. 1
- Should show effective water jacket and central tube
*If a flask is also drawn then the condenser must be at an appropriate angle.
Apparatus must clearly work.
Ignore direction of water flow.
Diagram must have a clear flow of vapour and water eg unblocked central tube or flow indicated by arrows.* 1 [3]
11. Figure 2 1
- Further oxidation will occur / ethanoic acid formed
*Do not accept 'poor yield' without qualification
Can gain this mark if logic correct but has chosen wrong Figure* 1 [2]
12. B [1]
13. B [1]
14. A [1]
15. A [1]
16. A [1]
17. C [1]



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