Name of the Student:_____
Max. Marks : 29 Marks **Time : 29 Minutes**

Mark Schemes

Q1.

(a) **M1 Safety (in Process 1)**

Sodium hydroxide / alkali is corrosive / harmful / caustic or sodium hydroxide is alkali(ne)

Ignore references to chromium compounds

OR

Bromine compounds are toxic / poisonous

*"Carbon-neutral" alone is insufficient for **M2***

M2 Environmental

Ignore references to greenhouse gases

Process 2 could be used as a carbon sink / for carbon capture

OR

uses waste / recycled CO_2 / CO_2 from the factory / CO_2 from the bioethanol (or biofuel) production

OR

reduces or limits the amount of CO_2 released / given out (into the atmosphere)

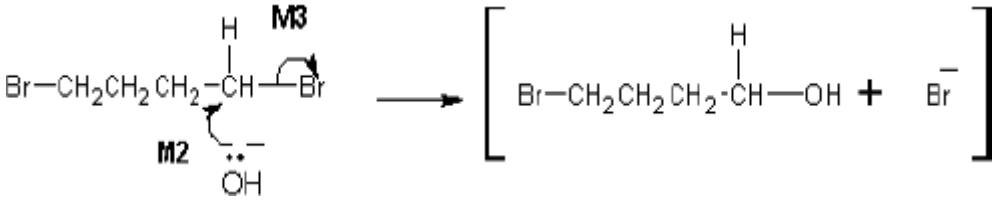
OR

Process 2 uses renewable glucose / renewable resource(s)

2

(b) (i) M1 nucleophilic substitution

*For **M1, both words** required*



M2 must show an arrow from the lone pair of electrons on the oxygen atom of the negatively charged hydroxide ion to the C atom.

*Penalise **M2** if covalent NaOH / KOH is used*

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*Penalise one mark from **M2** or **M3** if half-headed arrows are used*

M3 must show the movement of a pair of electrons from the C–Br bond to the Br atom. Mark **M3** independently provided it is from the <u>original molecule</u>

*Penalise **M3** for formal charge on C of the C–Br or incorrect partial charges on C–Br*

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

For **M2** and **M3** award full marks for an S_N1 mechanism

*For **M2** and **M3**, maximum 1 of 2 marks for the mechanism if wrong reactant is used.*

*Penalise **M3** if an extra arrow is drawn from the Br of the C–Br bond to, for example, K^+*

Accept the correct use of "sticks

NB The arrows here are double-headed

3

(ii) **M1** B

M2 C

M3 A

3

(c) **M1** <u>fermentation</u>

*Mark **M2** to **M4** independently*

Three conditions <u>in any order</u> for M2 to M4

Penalise "bacteria" and "phosphoric acid" using the list principle

M2 (enzymes from) yeast or zymase

M3 25°C ≤ T ≤ 42°C OR 298 K ≤ T ≤ 315 K

Ignore reference to "aqueous" or "water", "closed container", "pressure, "lack of oxygen",

"concentration of ethanol" and "batch process" (i.e. not part of the list principle)

M4 anaerobic / no oxygen / no air OR neutral pH

4

(d) **M1** primary OR 1° (alcohol)

Mark independently

M2 <u>acidified potassium or sodium dichromate</u>

*For **M2**, it must be a whole reagent and/or correct formulae*

OR H_2SO_4 / $K_2Cr_2O_7$ OR H^+ / $K_2Cr_2O_7$

Do not penalise incorrect attempt at formula if name is correct or vice versa

Accept phonetic spelling

If oxidation state given in name, it must be correct.

*For **M2** accept acidified potassium manganate(VII)*

OR correct combination of formula and name

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M3

$HOCH_2CH_2CH_2CH_2OH + \mathbf{4}[O] \longrightarrow HOOCCH_2CH_2COOH + \mathbf{2}H_2O$

*For **M3** structures must be correct and not molecular formula*

3

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Q2.

(a) (i) **M1 Initiation**

$Cl_2 \longrightarrow 2Cl\bullet$

Penalise absence of dot once only.

Penalise + or – charges every time

M2 First propagation

$Cl\bullet + CH_2Cl_2 \longrightarrow \bullet CHCl_2 + HCl$

Accept dot anywhere on $CHCl_2$ radical 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.

M3 Second propagation

$Cl_2 + \bullet CHCl_2 \longrightarrow CHCl_3 + Cl\bullet$

Penalise once only for double headed curly arrows

Mark independently

3

(ii) **M1 Condition**

ultra-violet / uv / sun light

OR <u>high</u> temperature

OR 400°C ≤ T ≤ 900°C

M2 Type of mechanism

(free-) <u>radical substitution</u> (mechanism)

2

(b) (i) $CHCl_3 + Cl_2 \longrightarrow CCl_4 + HCl$

Allow X as alternative to CCl_4 only if X is clearly identified as CCl_4

1

(ii) **M1** <u>Trichloromethane / $CHCl_3$ has a C–H bond</u>

OR

<u>X / CCl_4 / it has no C–H bond</u>

***M1** must refer to presence or absence of the <u>C–H bond in a compound</u>*

M2 The infrared spectrum shows
(absorption / peak for C–H in range) **<u>2850 to 3300</u>** (cm^{-1}) <u>is missing</u>

***M2** answer must refer to / imply the spectrum*

Allow the words "dip" OR "spike" OR "low transmittance" as alternatives for absorption.

Ignore references to other absorptions.

2

(c) **M1 a statement about bond breakage / formation of Cl•**

<u>C–Cl</u> / <u>carbon-chlorine bond</u> <u>breakage</u> occurs

OR Cl• / chlorine (free) radical <u>forms</u>

OR correct equation $CHClF_2 \longrightarrow Cl\bullet + \bullet CHF_2$

*Penalise **M1**, if Cl• is formed from Cl_2 as the only reaction or an additional reaction*

Do not penalise an incorrect equation using $CHClF_2$ if correct reference is made to Cl• formation or C–Cl / carbon-chlorine bond breakage

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M2 $Cl\bullet + O_3 \rightarrow ClO\bullet + O_2$

M3 $ClO\bullet + O_3 \longrightarrow Cl\bullet + 2O_2$

__M2__ and __M3__ either order

Penalise absence of dot once only.

Accept dot anywhere on ClO radical

M4 $CHClF_2$ / chlorine-containing compounds/ CFCs damage / react with / decrease the ozone layer

OR

this overall decomposition occurs; $2O_3 \longrightarrow 3O_2$

OR

without an ozone layer or with a decreased ozone layer, uv radiation is not being "filtered" / prevented from passing through the atmosphere or there is a concern about an increase in skin cancer etc.

OR

Cl• catalyses the decomposition of ozone / a single Cl• causes (chain) reaction / decomposition of many ozone molecules / ozone layer

Award __M4__ for the general idea behind the EU justification for banning the use of CFCs as refrigerants

Penalise __M4__ if overall ozone decomposition equation is incorrect

Ignore "greenhouse effect", "global warming" etc.

4

(d) (i)

All bonds must be drawn out

1

(ii) 2,3,3,3-tetrafluoropropene / it does not contain chlorine (atoms) / C–Cl (bonds)

Ignore "chlorine molecules"

OR

It does not produce Cl• / does not produce chlorine (free) radical(s)

OR

chlorodifluoromethane does contain chlorine / does produce Cl• / does produce chlorine (free) radical(s)

OR

C–F is too strong and does not break / create radicals

OR

C–F is stronger than C–Cl

1

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