Name of the Student:_____
Max. Marks : 26 Marks **Time : 26 Minutes**

Mark Schemes

Q1.

(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 high temperature

OR 400°C ≤ T ≤ 900°C

M2 **Type of mechanism**

(free-) radical substitution (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** Trichloromethane / $CHCl_3$ has a C–H bond

OR

X / CCl_4 / it has no C–H bond

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

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

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

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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•**

C–Cl / carbon-chlorine bond breakage occurs

OR Cl• / chlorine (free) radical forms

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

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

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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Q2.

(a) (i) Crude oil / oil / petroleum

Do not allow 'petrol'

1

(ii) Fractional distillation / fractionation / fractionating

Not distillation alone

1

(b) (i) 5

Allow five / V

1

(ii) Chain (isomerism)

Allow branched chain / chain branched / side chain (isomerism)

Ignore position (isomerism)

Do not allow straight chain / geometric / branched / function

1

(c) (i) $C_{12}H_{26}$ / $H_{26}C_{12}$

Only

1

(ii) Thermal cracking

If not thermal cracking, CE = 0/2

If blank mark on

1

High temperature

Allow 'high heat' for 'high temperature'

(400°C $\leq$ T $\leq$ 900°C) or (650 K $\leq$ T $\leq$ 1200 K)

Not 'heat' alone

If no T, units must be 650 – 900

and

High pressure ($\geq$ 10 atm, $\geq$ 1 MPa, $\geq$1000 kPa)

1

(iii) To produce substances which are (more) in demand / produce products with a high value / products worth more

Ignore 'to make more useful substances'

1

(d) (i) Corrosive or diagram to show this hazard symbol

Ignore irritant, acidic, toxic, harmful

1

(ii) $\left(\frac{120.5}{(86 + 71)} \times 100\right)$

=76.75(%) or 76.8(%)

Allow answers > 3 sig figs

1

(e) 2,2-dichloro-3–methylpentane

Ignore punctuation

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Any order

1

C_3H_6Cl

1

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