Mark schemes

Q1.

(a) Trichlorofluoromethane

No other names

1

(b) $CHFCl_2 + \bullet Cl \rightarrow \bullet CFCl_2 + HCl$

Equations in either order

$\bullet CFCl_2 + Cl_2 \rightarrow CFCl_3 + \bullet Cl$

Allow dot anywhere on each radical species

Allow 1 mark for two equations with missing dots that are otherwise correct

Ignore any arrows for electron movement

2

(c) $CFCl_3 \rightarrow \bullet CFCl_2 + \bullet Cl$

Allow dot anywhere on each radical species

Ignore any arrows for electron movement

1

(d) $O_3 + \bullet Cl \rightarrow \bullet OCl + O_2$

$\bullet OCl + O_3 \rightarrow 2\ O_2 + \bullet Cl$

Equations in either order

Allow dot anywhere on each radical species

Allow 1 mark for two equations with missing dots that are otherwise correct

(Accept alternative pair of equations for M2 (both needed for M2)

$O_3 \rightarrow O + O_2$

$ClO\bullet + O \rightarrow Cl\bullet + O_2$)

2

(e) Absorbs/removes ultraviolet/UV radiation that is harmful/causes (skin) cancer/causes (cell) mutations

Answer must refer to removal of UV <u>and</u> idea of it being harmful/the harm it causes

Ignore stopping UV/blocking UV/preventing UV/protecting from UV

ignore reference to greenhouse effect/gases/absorption of IR/global warming

1

[7]

Q2.

(a) **M1** + 3 C_2H_6

M2 Zeolite/Aluminosilicate/Aluminium oxide

2

(b) Option B

1

(c) Alkenes

1

(d) **M1** Initial volume O_2 = 0.21 × 1350 = 283.5 (cm^3)

Alternative route:
M1 Vol Air decreases by 6.5 × 20 = 130 cm^3

M2 Volume of O_2 remaining = M1 - (6.5 × 20) = 153.5 cm^3

M2 = 1220 cm^3

M3 Volume of CO_2 formed = 20 × 4 = 80 cm^3

M3 Vol CO_2 produced = 4 × 20 = 80 cm^3

M4 Total volume of gas left = M2 + M3 + (0.79 × 1350) = 1300 cm^3

M4 Total Vol Air + CO_2 = 1220 + 80 = 1300 cm^3

4

(e) **M1** Acid rain

M1 Allow damages (limestone) buildings or statues/death of aquatic organisms/air pollution

M2 CaO or $CaCO_3$

2

[10]

Q3.

(a) (mixture of) compounds/substances with similar boiling points

Allow similar number of carbon atoms / chain length / M_r / size

Ignore same boiling point / number of C atoms / chain length / M_r / size

Ignore reference to similar melting points

Ignore reference to similar chemical properties

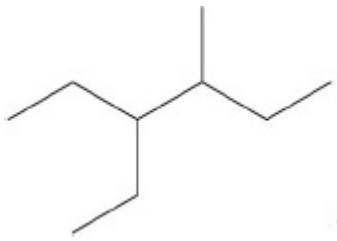
1

(b) zeolites / aluminosilicates

Ignore aluminium oxide

1

(c)



1

Must be skeletal formula

Ignore working, including other forms of structure of this compound.

1

(d) **M1** C_9H_{20}

M2 $C_9H_{20} + 14\ O_2 \rightarrow 9\ CO_2 + 10\ H_2O$

*For **M2** allow ECF from their molecular formula, providing it is an attempt at the molecular formula of a hydrocarbon*

*Penalise **M1** only for not using molecular formula*

Allow multiples and fractions

2

(e) (C=O) bonds vibrate (at IR frequency) / (IR/it makes) bonds vibrate **or**

net change in dipole moment of molecule during (asymmetric) vibration **or**

(C=O) bonds are polar

Do not allow that CO_2 is a polar molecule / has a dipole

1

(f) **M1** acid rain / respiratory problems

M1 *Allow direct consequences of acid rain; allow smog; allow production of ground level ozone*

M2 catalytic converters

M2 *allow description of process that occurs in catalytic converter but must include reference to a (named) catalyst*

2

(g) no net emissions of carbon dioxide/CO_2 to the atmosphere

Allow explanation showing that same amount of CO_2 taken in and released to the atmosphere

Answer needs to refer to carbon dioxide (not just carbon)

1

[9]

Q4.

(a) **M1** $\frac{137.5}{492.6}$ or

$\frac{12.0 + 3(35.5) + 19.0}{121.8 + 3(19.0) + 2(79.9) + 12.0 + 4(35.5)}$ or $\frac{137.5}{338.6 + 154.0}$

$\frac{12.0 + 3(35.5) + 19.0}{12.0 + 3(35.5) + 19.0 + 121.8 + 2(19.0) + 2(79.9) + 35.5}$ or $\frac{137.5}{355.1 + 137.5}$

1

M2 (× 100) = 27.9 (%)

1

__M2__ must be 3 sig figs

Correct answer scores 2 marks

Can score 1 mark for 137.5 (or working that gives this) or 492.6 (or working that gives this) in working if no other marks scored

(b) **M1** $CHCl_2F + {}^{\bullet}Cl \rightarrow {}^{\bullet}CCl_2F + HCl$

1

M2 ${}^{\bullet}CCl_2F + Cl_2 \rightarrow CCl_3F + {}^{\bullet}Cl$

1

Allow equations in either order

Allow dot anywhere on the correct radical

Ignore extra initiation and termination steps

Penalise absence of dots once only

(c) $2\ {}^{\bullet}CCl_2F \rightarrow CCl_2FCCl_2F$

Allow dot anywhere on the radical

Structural formula of product must be shown in answer (ignore additional correct molecular formula)

1

[5]