HL Paper 3

(a) (i) Explain the dependence of the dissociation of diatomic oxygen, O_2, and ozone, O_3, on the wavelength of light.

(ii) State the equations for the formation and depletion of ozone in the stratosphere by natural processes.

Formation of ozone:

Depletion of ozone:

(b) (i) State the equations for the depletion of ozone by the CFC, dichlorodifluoromethane, CCl_2F_2.

(ii) Use your answer to part (b) (i) to explain why CFCs are so effective at ozone depletion.

Markscheme

(a) (i) shorter wavelength/higher energy radiation/UV is needed to break the bond in $\mathrm{O_2}$;

because $\mathrm{O_2}$ has double/stronger bond;

Accept converse argument for O3.

(ii) *Formation of ozone*:

$\mathrm{O_2 \rightarrow 2O\bullet}$ **and** $\mathrm{O_2 + O\bullet \rightarrow O_3}$;

Allow mark for second equation only.

Depletion of ozone:

$\mathrm{O_3 \rightarrow O_2 + O\bullet}$ / $\mathrm{O_3 + O\bullet \rightarrow 2O_2}$;

Ignore state symbols.

Allow radical representation without dot throughout.

Do not allow inconsistent use of dot symbol.

(b) (i) $\mathrm{CCl_2F_2 \rightarrow CClF_2\bullet + Cl\bullet}$;

$\mathrm{Cl\bullet + O_3 \rightarrow ClO\bullet + O_2}$;

$\mathrm{ClO\bullet \rightarrow Cl\bullet + O\bullet}$;

$\mathrm{ClO\bullet + O\bullet \rightarrow O_2 + Cl\bullet}$;

Ignore state symbols.

Allow radical representation without dot throughout.

Do not allow inconsistent use of dot symbol.

(ii) $\mathrm{Cl\bullet}$ / Cl regenerated / *OWTTE*;

can deplete further ozone molecules / catalytic / *OWTTE*;

Examiners report

At HL, it was very surprising and disappointing that candidates did not do well on this question as many of the questions were based on core chemical principles applied in an environmental context. Candidates could not usually relate the strength of the oxygen to oxygen bond in ozone versus that in oxygen to energy needed to break the bond.

Some of the better candidates mentioned bond order and supported their answer with well represented diagrams. In (ii), many candidates were able to state at least one equation for either the formation or depletion of ozone, though many were not consistent with the use of the dot symbol to represent the radical. Radicals can be represented with or without a dot, but it is important that candidates are consistent in whatever representation they use. In (b), many candidates were not able to write the equations for the depletion of ozone by CFC, and only a small minority scored all three marks here. In addition, it was very disappointing that candidates could not explain why CFCs are so effective at ozone depletion.