Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

the second reaction gives the Cl atom back; so Cl is not used up and acts as a catalyst, attacking ozone again and again

2.2

polar stratospheric clouds form in the dark, cold winter and hold chlorine compounds on their ice; when sunlight returns in spring (September to October), UV releases the chlorine, which destroys ozone fast

2.3

more UV-B reaches the sea and damages phytoplankton; phytoplankton are the producers at the base of ocean food webs, so there is less food for fish

3.1

(a) about 300 DU until the mid 1970s; then a fast fall to about 135 DU by the mid 1990s, with little change to 2000

(b) CFCs released since the 1950s drifted up to the stratosphere; UV split off chlorine atoms, which destroyed ozone

(c) CFCs stay in the atmosphere for 50 to 100 years; so chlorine is still being released and still destroys ozone

3.2

(a) the higher the UV index, the more skin cancer (positive correlation); from 8 cases per 100 000 at UV index 3 to 50 at UV index 12

(b) UV-B damages the DNA in skin cells; the mutations can make cells divide out of control, forming a tumor

(c) any two: skin color of the population; time spent outdoors; use of sunscreen; age of the population; how often cancers are found by doctors

(d) any two: use sunscreen; wear hats and long sleeves; stay in the shade at midday; avoid sunbeds

3.3

(a) only the polar winter stratosphere gets cold enough, below about $-80\,^{\circ}\mathrm{C}$; winds circling the pole (the polar vortex) keep this air apart, so it stays cold

(b) the reactions need UV light to release chlorine; in the polar winter there is no sunlight, so the reactions start only when the Sun returns in spring

(c) the stratosphere warms, so the clouds disappear and no more chlorine is released; the vortex breaks up and ozone-rich air mixes in from other latitudes

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(d) ozone-poor air can drift north over them in spring and early summer; so more UV-B reaches the ground, raising the risk of skin cancer and harm to crops and animals