1. Fill in the blanks to balance the following chemical reactions and then write the net reactions:

$O_3 + Cl \rightarrow ClO + \_\mathbf{O_2}\_\_$
$ClO + \_\mathbf{O}\_\_ \rightarrow Cl + O_2$

Net: $\mathbf{O_3 + O \rightarrow 2O_2}$

$O_3 + NO \rightarrow \mathbf{NO_2} + O_2$
$\mathbf{NO_2} + O \rightarrow NO + O_2$

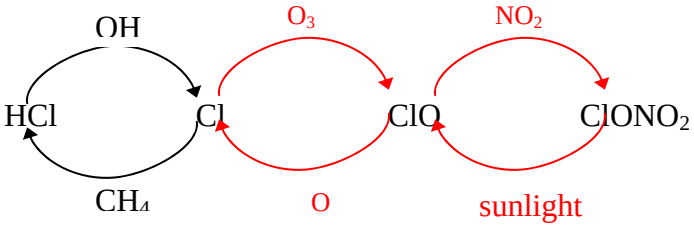
Net: $\mathbf{O_3 + O \rightarrow 2O_2}$

2. Describe how the reactions given below affect the ozone layer:

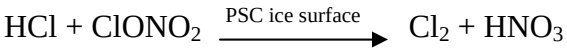
$ClO + NO_2 + M \rightarrow ClONO_2 + M$
$ClONO_2 + \text{sunlight} \rightarrow ClO + NO_2$

$ClONO_2$ is a reservoir species for chlorine and does not destroy ozone. By tying up chlorine in a reservoir species, the 1st reaction protects the ozone layer from the reactive chlorine species. However, sunlight can react with $ClONO_2$ to release ClO, which can then participate in ozone destruction.

3. Using the equations given in parts 1 and 2, add arrows and chemical names to complete the figure below.



4. Explain why the Antarctic ozone hole forms during southern hemisphere Spring. Incorporate the following reactions in your explanation:



During the summer, much of the chlorine is bound in reservoir species such as HCl and $ClONO_2$. In winter, however, the temperature above Antarctica is cold enough for PSCs to form. The 1st chemical reaction above does not happen in the air, but it can happen on the surface of the ice in the PSCs. Thus the PSCs convert chlorine from the reservoir species into Cl_2. Since there is no sunlight in winter at the pole, the Cl_2 does not break apart until spring. In spring, the sun rises and solar radiation breaks the Cl_2 into to atomic chlorine atoms, as shown in the 2nd equation above. The chlorine atoms then catalytically destroy ozone.