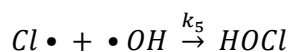
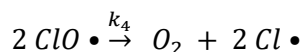
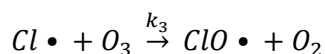
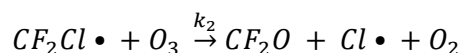
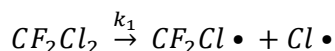


Kinetics and Reactor Design (Graduate) Ozone Destruction Mechanism

While inhalation of ozone molecules can cause lung damage and asthma attacks, ozone molecules in the Earth's stratosphere (~30 miles above Earth's surface) help protect life on Earth by shielding us from harmful solar radiation. Ozone and oxygen molecules in the stratosphere are constantly reacting as they are bombarded with ultraviolet (UV) radiation, which can create highly reactive oxygen radicals. In 1976, scientists in Antarctica detected a 10% drop in ozone level, the largest detected drop since monitoring began in 1957. While ozone layer thickness varies with seasons, this magnitude of drop was later confirmed (1985) to be caused by chlorofluorocarbons (CFCs), chemical compounds which were used in air conditioners, aerosol spray cans, industrial cleaning products, and in production of Styrofoam dating back to the 1960s.

Ozone layer depletion causes increased UV radiation which contribute to increases in certain types of skin cancers, eye cataracts, and immune deficiency disorders. This also affects physiological and developmental processes of plants, which can reduce agricultural productivity and disrupts aquatic ecosystems and food chain by damaging early developmental stages of marine animals.

The destruction of ozone by chlorofluorocarbons (CFCs) is a radical chain reaction that occurs in the atmosphere. The following steps are proposed in the destruction of ozone (O_3) in the presence of CF_2Cl_2 (CFC-12). ($\bullet OH$) radicals are present at measurable and steady state concentration in the upper atmosphere.



References

1. University Corporation for Atmospheric Research (UCAR): The Ozone Layer (<https://scied.ucar.edu/learning-zone/atmosphere/ozone-layer>)
2. European Commission: Protection of the ozone layer (https://ec.europa.eu/clima/policies/ozone_en)
3. United States Environmental Protection Agency: Health and Environmental Effects of Ozone Layer Depletion (<https://www.epa.gov/ozone-layer-protection/health-and-environmental-effects-ozone-layer-depletion>)

Questions

- a) How does the rate of ozone destruction depend on the concentration of CF_2Cl_2 , ozone, and $\bullet OH$? Provide an expression that is not dependent on any of the unobservable Cl -containing radicals.
- b) Based on Bronsted(Bell)-Evans-Polyani relationships between energies of reaction and activation energies, place k_1 , k_3 , and k_4 in their likely order (ie $k_1 > k_3 > k_4$).
- c) Overall, this process is energetically uphill as written. Why (how) does it happen at all?
- d) How do you think the impacts of ozone depletion and/or climate change may be disproportionately felt by disadvantaged communities? (Please answer with a few bullet points or in a few sentences.)