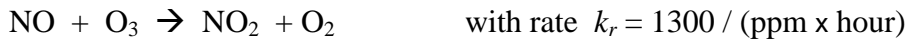
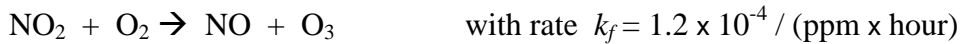


INTRODUCTION TO ENVIRONMENTAL ENGINEERING

QUIZ #2 ANSWER KEY

1. (5 points) During a sunny summer day, the chemistry of photochemical smog is governed, in first approximation, by the following two reactions:



The following concentrations are measured: $[\text{NO}_2] = 0.2 \text{ ppm}$, $[\text{NO}] = 0.02 \text{ ppm}$, $[\text{O}_2] = 21\%$ and $[\text{O}_3] = 0.1 \text{ ppm}$. Is the ozone concentration growing or decaying?

Answer: **Rate of O₃ production = $k_f [\text{NO}_2] [\text{O}_2]$**
 $= (1.2 \times 10^{-4} / (\text{ppm hr}))(0.2 \text{ ppm})(0.21 \times 10^6 \text{ ppm}) = 5.04 \text{ ppm/hr}$
Rate of O₃ decay = $k_r [\text{NO}] [\text{O}_3]$
 $= (1300 / (\text{ppm hr}))(0.02 \text{ ppm})(0.1 \text{ ppm}) = 2.60 \text{ ppm/hr}$
Production exceeds decay → Ozone concentration is growing over time.

2. (4 points) What is the mathematical equation that represents the mass balance of a pollutant of time-varying concentration C when there is a single influx with flowrate Q at concentration C_{in} , one outlet of equal flowrate Q , there is no internal source, and there is no internal decay. The volume of the system is V .

Equation is: $V \frac{dC}{dt} = Q C_{in} - Q C$

3. (4 points) What is the steady-state solution of the previous equation? What happens to this concentration if the volume is doubled but everything else remains the same?

- *Steady-state solution:* $dC/dt = 0 \rightarrow C = C_{in}$

- *If V is doubled, the steady-state concentration is... .. unchanged!*

4. (2 points) How would you call a person who for each of 350 days in the year drinks 2 liters of water, breathes 30 m³ of air, and ingests 100 mg of soil?

Answer: **A maximally exposed individual (MEI).**
 (see top frame of page 7 of lecture slides “Risk Assessment”.)
Acceptable alternative answer: EPA’s standard person.