※ 注意：請於試卷內之「非選擇題作答區」標明題號依序作答。

1. Atmospheric ozone plays different roles based on the location, as shown in **Figure 1-1**. However, the formation of ozone at the stratosphere and troposphere is very different.

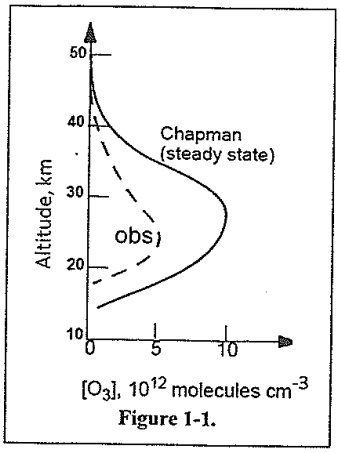

Figure 1-1.

a) (8 pts) The ozone formation over the stratosphere is based on the Chapman mechanism. Please describe the four major reactions of the Chapman mechanism.

b) (16 pts) The predicted [O_3] profile based on steady-state assumption overestimates the O_3 concentrations by a factor of 2 or more as shown in **Figure 1-1** due to the missing sinks for O_3, i.e., HOx, NOx and ClOx with the following propagation reactions:

$O_3 + X \rightarrow XO + O_2$

$O + XO \rightarrow X + O_2$

Net: $O_3 + O \rightarrow 2\ O_2$

X is a catalyst such as OH, NO, and Cl

Please describe what the initial chemical components associated with HOx, NOx, and ClOx, and where they come from, and how the initial HOx, NOx, and ClOx are formed (the initiation step for radical formation). (明確描述在平流層產生HOx, NOx and ClOx 的最原始物質及其來源為何,這些原始物質如何進到或出現在平流層,如何初步產生 HOx, NOx, and ClOx).

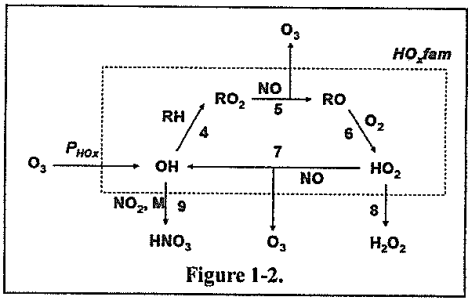

Figure 1-2.

c) (12 pts) In the troposphere, ozone can be transported from stratosphere but is mainly produced by chemical reactions. **Figure 1-2** shows the cycling of HO_x and O_3 production in a polluted atmosphere. Please describe **in detail** how the ozone is formed in the troposphere (you can use CO or CH_4 as an example to illustrate the processes).

2. PM2.5 is one of the major air pollutants globally and is composed of various chemical species. EPA-Taiwan provides the emission data on the website for the whole Taiwan. The total emission is 1.1×10^8 Kg/yr for SO_2 and 3.6×10^8 Kg/yr for NOx (assuming as NO for this exam) over the Taiwan island (此為台灣總排放量). (Atomic weight: S (32g/mole), N (14g/mole), O (16g/mole), H (1g/mole)).
Consider only local emissions. We assume that all of the emitted NOx and SO_2 are precipitated back over Taiwan as HNO_3 (1 mole of NOx forms 1 mole of HNO_3) and H_2SO_4 (1 mole of SO_2 forms 1 mole of H_2SO_4), respectively. The area of Taiwan is 36200 km^2 and the mean precipitation rate is 6 mm day^{-1}. Assume that HNO_3 and H_2SO_4 are the only impurities in the rainwater,

(a) (4 pts) Please calculate the total amount of rain over the whole Taiwan per day (in a unit of liter day^{-1}).

(b) (6 pts) Please calculate the concentration of HNO_3 and H_2SO_4 in the rain, respectively (in a unit of M, 體積莫爾濃度).

(c) (4 pts) please calculate the resulting rainwater pH (assuming equilibrium with H_2SO_4 and HNO_3, H_2SO_4 and HNO_3 are strong acids and dissociate completely).

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3. This question concerns the dissolution of CO_2 in water.
   (a) (5 pts) Write down the equilibrium reactions of the dissolution processes, including Henry's equilibrium, the first dissociation, and the second dissociation.
   (b) (5 pts) Ignore the second association and derive the hydronium concentration $[H^+]$ as a function of CO_2 partial pressure P_{CO_2}, Henry's constant H_{CO_2}, first dissociation constant k_{C1}, and water constant K_w.
   (c) (5 pts) If the ocean's pH value is 8 and the dissolved CO_2 concentration is 5×10^{-4} M, try calculated the equilibrium partial pressure of CO_2 in the atmosphere (in ppmv) using the following constants: H_{CO_2} =3.4x10^{-2} M/atm，k_{C1}=4.46x10^{-7} M，k_{C2}=4.68x10^{-11} M

4. (a) (10 pts) Describe aerosol particles' deliquescence (潮解) and efflorescence (脫水) phenomena, and explain their physical-chemical principles.
   (b) (10 pts) The water absorption capacity of a salt particle is different when the air is drying or moisturizing. Explain this hysteresis cycles (遲滯循環) and write down the involved processes.

5. Polar stratospheric clouds (極地平流層雲) can be classified into Type-I and Type-II clouds.
   (a) (5 pts) How these cloud types differ in composition?
   (b) (5 pts) How these cloud types differ in formation conditions?
   (c) (5 pts) Why both cloud types require sulfuric acid aerosols as the core for cloud particle formation?

試題隨卷繳回