國立臺灣大學 105 學年度碩士班招生考試試題

Constants or equations that you might need	
PV= nRT for all gases discussed in this test	1 atm = 760 Torr = 101300 Pa = 1013 hPa
R (gas constant) = 8.314 J mol^{-1} K^{-1}, 0.082 L atm mol^{-1} K^{-1}	The radius of the Earth : 6400 km
k (Boltzmann constant) = 1.381 x 10^{-23} J K^{-1}	1 ppmv = 1 x 10^{-6} mol/mol=1 x 10^{-6} atm/atm
N_{av} = 6.02 x 10^{23} molecule mol^{-1}	1 ppbv = 1 x 10^{-9} mol/mol=1 x 10^{-9} atm/atm
Pa = Nm^{-2}	1 pptv = 1 x 10^{-12} mol/mol=1 x 10^{-12} atm/atm

1. Consider the following typical vertical profile of ozone (O_3) number densities measured as shown in Figure 1-1. The ozone concentration is 5 times higher than the concentration over the surface layer.

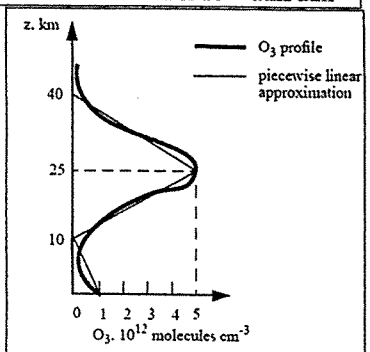

Figure 1-1

   a) (12 pts) The ozone formation over the stratosphere is based on the Chapman mechanism. Please describe **in detail** the major four reactions of Chapman mechanism.

   b) (12 pts) The sources of tropospheric ozone can be contributed via transferring from stratosphere and chemical reactions happening in troposphere. Please describe **in detail** the chemical production of tropospheric ozone. (Please use CO or CH_4 as the pollutant for the initial reactant)

   c) (10 pts) Please calculate the ozone concentration in the unit of ppmv for z = 0 km (P =1000 hPa; T =300K) and 25 km (P =35 hPa; T =220K).

   d) (12 pts) Ozone in the stratosphere can shield UV radiation for all organisms on the Earth. Figure 1-2 shows the temporal profile for several given parameters related to the formation of ozone hole. With all information provided in Figure 1-2, please describe **in detail where, when** and **how** the ozone hole is formed.

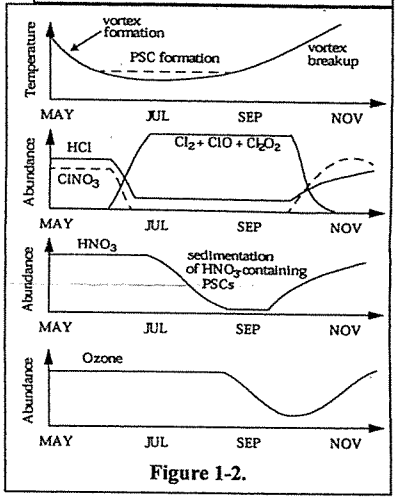

Figure 1-2.

2. Figure 2-1 shows the monthly mean atmospheric carbon dioxide at Mauna Loa Observatory, Hawaii measured by the Scripps and NOAA. The CO_2 concentration is present as mole fraction at unit of parts per million (ppmv). Based on Figure 2-1, please answer the following questions:

   a) (5 pts) The CO_2 concentration shows an increasing trend. What is this increasing rate approximately from year 2000 to year 2015 (in unit of ppmv yr^{-1})?

   b) (5 pts) Why is there fluctuation at different seasons and how the CO_2 concentration changes with season?

   c) (8 pts) What are the impact of greenhouse on the Earth (in good and in bad)?

   d) (12 pts) Aerosols play an important role to cool the surface temperature of the Earth. Please describe the mechanism in detail regarding to how aerosols cool the surface temperature of Earth via the direct and indirect effects.

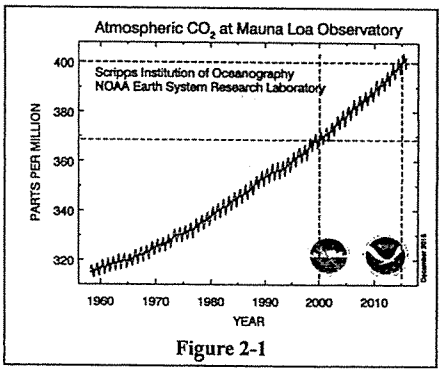

Figure 2-1

   e)(6 pts) In general, pure water has pH value of 7. However, due to the presence of CO_2, the water is slightly acidified through the following reactions.

$$CO_2(g) \overset{H_2O}{\Leftrightarrow} CO_2 \cdot H_2O \qquad (H)$$

$$CO_2 \cdot H_2O \Leftrightarrow HCO_3^- + H^+ \qquad (1)$$

$$HCO_3^- \Leftrightarrow CO_3^{2-} + H^+ \qquad (2)$$

with equilibrium constants K_H = 3.0x10^{-2} M atm^{-1} , K_1 = 9x10^{-7} M, K_2 = 7 x10^{-10} M. The present atmosphere contains 400 ppmv CO_2. Please calculate the pH of the rain at equilibrium with this concentration of CO_2.

   f) The presence of other species such as organic acids, H_2SO_4 and HNO_3 cause the pH of rain water lower. For the effect of H_2SO_4 and HNO_3, the related sources amount globally to 3x10^{12} moles S yr^{-1} and 3x10^{12} moles N yr^{-1}, respectively. Assume that all the emitted sulfur and NO_x are oxidized in the atmosphere to H_2SO_4 and HNO_3, respectively, which are then scavenged by rain.

   (i) (10 pts) Please calculate the mean concentrations (in M) of SO_4^{2-} and NO_3^- in the rain, assuming a global mean precipitation rate over the Earth of 2 mm day^{-1}.

   (ii) (8 pts) Calculate the resulting rainwater pH (again assuming equilibrium with H_2SO_4 and HNO_3, and 400 ppmv CO_2 (g)).

試題隨卷繳回