國立臺灣大學99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 R (gas constant) = 8.314 J mol^{-1} K^{-1}, 0.082 dm^3 atm mol^{-1} K^{-1} k (Boltzmann constant) = 1.381 x 10^{-23} J K^{-1} h (Planck's constant) = 6.626 x 10^{-34} Js N_{av} = 6.02 x 10^{23} molecule mol^{-1} Pa = Nm^{-2}	1 atm = 760 Torr = 101300 Pa = 1013 hPa Scale height = 7.4 km The radius of the Earth : 6400 km 1 ppmv = 1 x 10^{-6} mol/mol 1 ppbv = 1 x 10^{-9} mol/mol 1 pptv = 1 x 10^{-12} mol/mol

1. Figure 1 shows the summary of the principal components of the radiative forcing of climate change.

(a) (10 pts) For greenhouse gases parts, please explain in detail how CO_2, CH_4, N_2O, and halocarbons increase radiative forcing.

(b) (10 pts) What is the major sink for CH_4 in troposphere? Please use some chemical reactions to describe the process.

(c) (10 pts) Tropospheric ozone plays a warming role; please use a few chemical reactions to describe the chemical production of ozone in troposphere.

(d) (10 pts) Ozone in the stratosphere plays a cooling effect on the Earth; please describe how the ozone is produced over the stratosphere (10-50 km altitude) briefly.

(e) (10 pts) There are two types of effect by aerosols: direct effect and cloud albedo effect. Please explain these two effects in detail.

(f) (10 pts) In general, pure water has pH value of 7. However, due to the presence of CO_2, the water is slightly

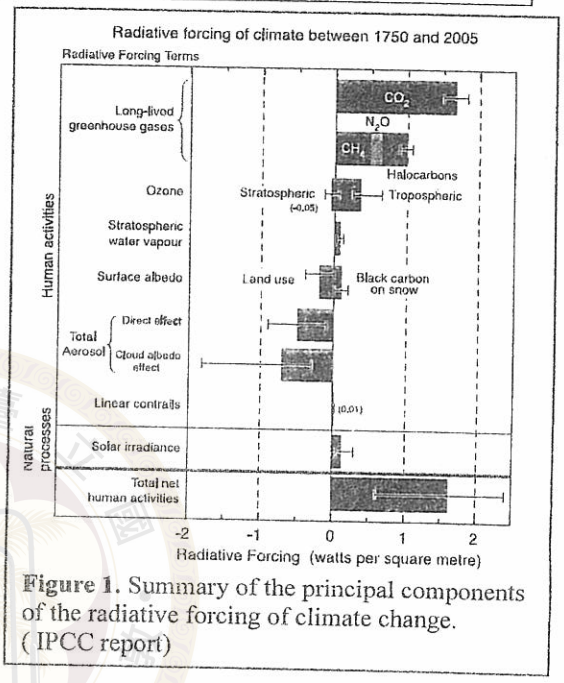

Figure 1. Summary of the principal components of the radiative forcing of climate change. (IPCC report)

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

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

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

acidified through the following reactions.

with equilibrium constants K_H = 3.0x10^{-2} M atm^{-1} , K_1 = 4.3x10^{-7} M, K_2 = 4.7 x10^{-11} M. The present atmosphere contains 380 ppmv CO_2. Please calculate the pH of the rain at equilibrium with this concentration of CO_2.

(g) 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 5x10^{12} moles S yr^{-1} and 5x10^{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) (10 pts) Calculate the resulting rainwater pH (again assuming equilibrium with H_2SO_4 and HNO_3, and 380 ppmv CO_2 (g)).

2. Cloud and snow are another physical state of water. Figure 2 shows the phase diagram of water. Please based on this diagram and answer the following questions.

(a) (i)(5 pts) A weather station reports T = 303 K, RH = 50% at sunset. What is the corresponding water vapor pressure for the above condition? (ii) (5 pts)Assuming that water vapor pressure remains constant, by how much must the temperature drop over the course of the night in order for fog(霧) to form?

(b) (10 pts)What is the mass concentration of water vapor (g H_2O per m^3 of air) in a liquid-water cloud at a temperature of 273 K (考慮氣相-液相平衡)?

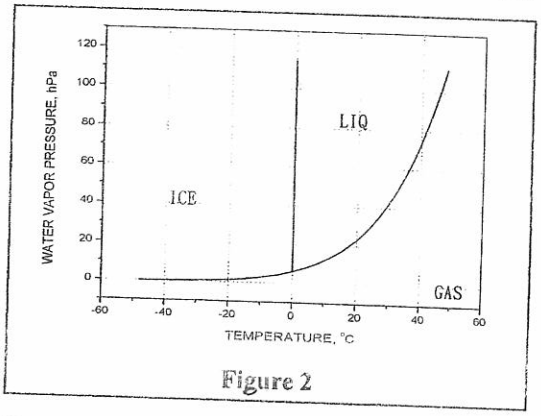

Figure 2

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