

1. Why bacterial population abundance is usually higher than fungal population in most aeration tank for domestic wastewater treatment activated sludge process? (15 pts)
2. Can we use *Escherichia coli* as disinfection efficiency indicator in water for the COVID-19 pandemic management? Why or why not? Please list your reasons. (20 pts)
3. What is anoxygenic photosynthesis? Please list an example. (15 pts)
4. Please briefly describe the three main factors for the formation of photochemical smog in metropolitan areas. (5 pts)
5. Although the measures of lockdown in some countries during the epidemic period have caused reduction in some air pollutants, the concentration of carbon dioxide (CO₂) in the atmosphere have still been rising. Now, the concentration of CO₂ is 420 ppm at 1 atm in the atmosphere. When the rainwater and the air are completely balanced, the rainwater will infiltrate into the layer of groundwater in the catchment area, where it contains calcium carbonate (CaCO₃).
 - a) What is the pH of the water when the rainwater completely balances with the air? (5 pts)
 - b) What is the total concentration of inorganic carbon in rainwater, including H₂CO₃, HCO₃⁻ and CO₃²⁻? (5 pts)
 - c) What is the pH of rainwater when it has balanced with CaCO₃ in the layer of groundwater? (5 pts)
6. Methane (CH₄) is an important greenhouse gas in the atmosphere. Currently, the average concentration of CH₄ in the atmosphere is 1.75 ppmv, and it will react with the hydroxyl radicals (•OH). The reaction formula is CH₄ + •OH → •CH₃ + H₂O, and the reaction rate R = k[CH₄] [•OH]. Where the reaction rate constant k = 3.6×10⁻¹⁵ cm³ molecule⁻¹s⁻¹. Assuming that the concentration of hydroxyl radicals (•OH) in the atmosphere is 8.5 × 10⁵ molecules cm⁻³, and 1.0 ppm CH₄ = 1.0 mole CH₄/10⁶ mole air.
 - a) What is the reaction rate of CH₄ and •OH? (Unit: g CH₄/sec mole air) (5 pts)
 - b) Assuming that the total mass concentration of the atmosphere is 5.2 × 10²¹ g, and the average molecular mass of the atmosphere is 29 g/mole. How many grams of CH₄ is reacted in the atmosphere in one year? (5 pts)
7. What is the cation-exchange capacity (CEC)? What are the factors that affect CEC? (10 pts)
8. There was an experiment that 20 L of air samples from the atmosphere were collected. The atmospheric pressure was 1.0 atm and the temperature was 25 °C. After the air samples were dried in the laboratory, the volume of the air remained 19.5 L. What is originally the weight percentage of water in the air sample? (10 pts)