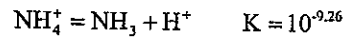
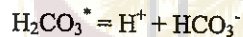


1. Ammonia (NH_3) is in chemical equilibrium with ammonium ion (NH_4^+) in water based on the following equation.



- (a) Determine the pH value where the concentrations of NH_3 and NH_4^+ are equal. (5%)
- (b) It is known that NH_3 is toxic while NH_4^+ is not. The allowable NH_3 concentration in water is 0.025 mg/L. In a small pond, the total ammonia concentration (the sum of NH_3 and NH_4^+) in the water is 0.1 mg/L and initial pH is 9.6. Is the water toxic? (atomic weight of N is 14) (10%)
- (c) In (b), if the water is toxic, to what pH should you adjust to in order to make the water with an allowable NH_3 concentration? (10%)
2. Trinitrotoluene (TNT), $\text{C}_7\text{H}_5\text{N}_3\text{O}_6$, combines explosively with oxygen to produce CO_2 , water, and N_2 . Write a balanced chemical equation for the reaction and calculate the grams of oxygen required for each 100 g of TNT. (10%)
3. The average CO_2 partial pressure in the atmosphere has been increased from $10^{-3.50}$ atm in 1960 to $10^{-3.42}$ atm in 2008.
- (a) Calculate the dissolved carbon dioxide (H_2CO_3^*) concentrations in an open water body (in contact with the atmosphere) in 1960 and 2008, respectively. Assume the exchange of CO_2 between the water body and the atmosphere has reached equilibrium and the temperature is 25°C . Henry's constant for CO_2 at 25°C is $10^{-1.46}$ mol/(L·atm) (10%)
- (b) Explain the effect of this increasing atmospheric CO_2 partial pressure on the pH value of the water body by considering the following dissociation reactions. (5%)



4. Which of the following methods will find the largest number of bacterial cells in a broth of pure culture. (5%)
Plate count, MPN, Gram staining and microscopy, DAPI viable stain, PCR followed by DGGE.
5. What object (chemical or agent) in the raw water is the major target of conventional drinking water treatment processes? (5%)
6. Why addition of methane into the contaminated aquifers will enhance the biodegradation of dichloromethane at very low concentration? (5%)
7. Oxygenic photosynthesis consists of two types of reactions. What are these reactions? And, what are the overall products of these two types of reactions? (5%)
8. What is the final product of glycolysis of glucose (Embden-Meyerhof-Parnas pathway)? What liquid and gaseous fuels can be produced by this metabolite through fermentative process? What common gas can be an inhibitor of fermentation process? (5%)
9. Which one(s) of rotaviruses, Norwalk-type virus and enteric adenoviruses is (are) causal agents of gastroenteritis? List two methods for the detection of these pathogens. (5%)
10. During an in-situ bioremediation operation for an aquifer contaminated with BTEX (benzene, toluene, ethylbenzene and xylene), what should be added into the fluid, which is to be injected into the aquifer to enhance the biodegradation of BTEX? (5%)
11. What are the impacts of (1) pH, (2) fraction of clay in soil, (3) concentration of cations, and (4) flow rate on the migrating distance of microbial pathogens through groundwater aquifers? (5%)
12. Please write down and balance the reaction of nitrification. Based on the reaction tell whether pH will go down or go up, and how many moles of alkalinity will be produced (or consumed) for one mole of ammonium ion reacted. (10%)