※ 考生請注意：本試題 ☑可 □不可 使用計算機

Equilibrium Chemistry. When chlorine gas is added to water during the disinfection of drinking water, it hydrolyzes with the water to form HOCl. The disinfection power of the acid HOCl is 88 times better than its conjugate base, OCl-. The pKa for HOCl is 7.5. (a) What % of the total disinfection power (i.e. HOCl+OCl⁻) exists in the acid form at pH=6? (b)At pH=7? (20 pts)

Solubility. The dimensionless Henry's constant for trichloroethene (TCE) at 25°C is 0.4. A sealed glass vial is prepared that has an air volume of 4 mL overlying an aqueous volume of 36 mL. TCE is added to the aqueous so that initially it has an aqueous phase concentration of 100 ppb. After the system equilibrates, what will be the concentration (in units of μg/L) of TCE in the aqueous phase. (20 pts).

Chemical Reaction Kinetics. The rate at which soluble iron undergoes oxidation by air is given by:
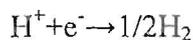$$r = k\,[O_2][Fe^{2+}][OH^-]^2$$
The water is to be treated by saturating it with air at 1.5 bar under conditions whereby the ratio of the concentration of oxygen in the water and air does not change (i,e, Henry's Law can be assumed to apply for oxygen with a constant of 0.024 atm · L/mg). If lime dosing maintains the pH at 7.8 throughout the reaction, what residence time would be required to reduce iron content from 5000 to 100 ppb for a k value of 2.12×10^{13} mol³/sec · L³)? (20 pts)

Chemical Reaction Stoichiometry Aluminum sulfate can be made by reacting crushed bauxite ore with sulfuric acid following the reaction: $Al_2O_3 + 3\,H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3\,H_2O$
The bauxite ore contains 55.4% by weight of aluminum oxide, the reminder being impurity. The sulfuric acid solution contains 77.7% pure sulfuric acid, the reminder being impurity. To produce 816 kg of pure aluminum sulfate, 490 kg of bauxite ore and 1140 kg of sulfuric acid solution are reacted. (1) Identify the excess reactant. (2) What % of the excess reactant was consumed? (3) What was the degree of completion of the reaction? (20 pts)

Chemical Reaction Thermodynamics Organic matter is converted in sequential steps by different bacterial species to methane in anaerobic methanogenesis of organic wastes. One important step is the conversion of the intermediate butyrate to acetate, for which the following electron donor and acceptor half-reactions apply:

$$1/2CH_3COO^- + 1/4CO_2 + H^+ + e^- \rightarrow 1/4CH_3CH_2CH_2COO^- + 1/4HCO_3^- + 1/4H_2O$$

$$H^+ + e^- \rightarrow 1/2H_2$$

	$CH_3COO^-(aq)$	H^+(pH=7)	$CH_3(CH_2)_2COO^-(aq)$	$HCO_3^-(aq)$	$CO_2(aq)$	$H_2O(l)$
ΔG_f^0(KJ/mol)	-369.41	-39.87	-352.63	-586.85	-386.23	-237.18

Determine ΔG_r for the resulting energy reaction under the following conditions (20 pt):

A. (1) All constitutes are at unit activities

(2) All constitutes are at unit activities, except pH=7.0

(3) The following typical activities under anaerobic conditions apply:

$[CH_3COO^-]=10^{-3}M$, $[CH_3CH_2CH_2COO^-]=10^{-2}M$, $[HCO_3^-]=10^{-1}M$, $[CO_2]=0.3$atm, pH=7.0
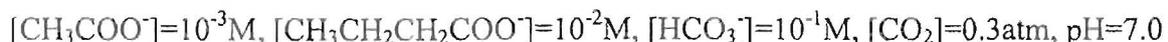
B. Under which of the above three conditions is it possible for bacteria to obtain energy for growth.