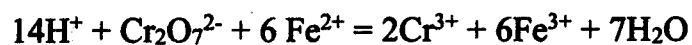


1. (10%) Please indicate the carbon source, electron donor and electron acceptor of ammonia-oxidizing archaea and ammonia-oxidizing bacteria.
2. (10%) Please explain Anaerobic ammonium oxidation (Anammox). What is the advantage of Anammox compared with traditional nitrification-denitrification in wastewater treatment?
3. (10%) Please explain Autotrophs, Heterotrophs, Phototrophs and Chemotrophs.
4. (5%) Please explain the difference between fermentation and respiration regarding the mechanism of ATP synthesis.
5. (5%) Please explain Complete ammonia oxidation (Comammox) bacteria. What is the importance of Comammox?
6. (10%) Please indicate the carbon source, electron donor and electron acceptor of acetoclastic methanogens and hydrogenotrophic methanogens.
7. (10%) Calculate the concentration of all species, including $[H^+]$, $[OH^-]$, $[HAc]$, and $[Ac^-]$ in a solution prepared by adding 0.01 M of acetic acid, CH_3COOH (HAc) to 1 liter of water at 25°C. Neglect ionic strength effects.

The equilibria on the system are shown as follows:



8. For the following equation and thermodynamic data:

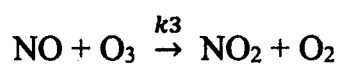
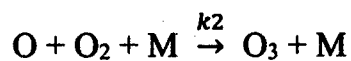
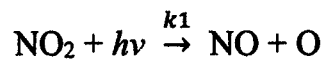


Species	ΔG_f° (standard free energy of formation; kcal/mole)
H^+	0
$Cr_2O_7^{2-}$	-315.4
Fe^{2+}	-20.30
Cr^{3+}	-51.5
Fe^{3+}	-2.52
H_2O	-56.69

- (a) (10%) Calculate the (1) equilibrium constant and (2) change in Gibbs free energy at 25°C, then justify this is a spontaneous reaction or not (universal gas constant $R = 1.987 \text{ cal/mol.K}$)
- (b) (10%) Hexavalent chromium-contaminated groundwater can be remediated by reduction reactions. Please propose a remediation method to detoxify the groundwater based on the above equation and your calculation.

見背面

9. (a) (10%) Three major reactions of basic photochemical cycle for O₃ formation during daylight are described as follows. Please derive a mathematic expression for the steady-state concentration of ozone (that is, [O₃]_{steady state}). Assumptions have to be made for derivation based on "pseudo-steady state approximation" (PSSA). Also, describe what is PSSA.



- (b) (10%) Volatile organic compounds (VOCs) have been known to enhance the production of O₃ by increasing the content of NO₂ production. According to the previous three reactions and your derivation, using CH₂O as an example, explain how VOCs influence O₃ concentration in atmosphere with daylight.

Logarithm Table

Table of base 10, base 2 and base e (ln) logarithms:

x	log ₁₀ x	log ₂ x	log _e x
0	undefined	undefined	undefined
0 ⁺	-∞	-∞	-∞
0.0001	-4.00000	-13.287712	-9.210340
0.001	-3.00000	-9.965784	-6.907755
0.01	-2.00000	-6.643856	-4.605170
0.1	-1.00000	-3.321928	-2.302585
1	0.00000	0.00000	0.00000
2	0.301030	1.00000	0.693147
3	0.477121	1.584963	1.098612
4	0.602060	2.00000	1.386294
5	0.698970	2.321928	1.609438
6	0.778151	2.584963	1.791759
7	0.845098	2.807355	1.945910
8	0.903090	3.00000	2.079442
9	0.954243	3.169925	2.197225
10	1.00000	3.321928	2.302585
20	1.301030	4.321928	2.995732
30	1.477121	4.908891	3.401197
40	1.602060	5.321928	3.688879
50	1.698970	5.643856	3.912023
60	1.778151	5.908991	4.094345
70	1.845098	6.129283	4.248495
80	1.903090	6.321928	4.382027
90	1.954243	6.491853	4.499810
100	2.00000	6.643856	4.605170
200	2.301030	7.643856	5.298317
300	2.477121	8.228819	5.703782
400	2.602060	8.643856	5.991485
500	2.698970	8.965784	6.214608
600	2.778151	9.228819	6.398930
700	2.845098	9.451211	6.551080
800	2.903090	9.643856	6.684612
900	2.954243	9.813781	6.802395
1000	3.00000	9.965784	6.907755
10000	4.00000	13.287712	9.210340

x	10 ^x
0.1	1.26
0.2	1.58
0.3	2.00
0.4	2.51
0.5	3.16
0.6	3.98
0.7	5.01
0.8	6.31
0.9	7.94