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Homework #2 Due Wednesday February 1, 2017

Problems from Textbook on Units

Problem 5-2

Problem 5-4

Problem 5-6

4. An engineer plans to treat a chromium waste in a concrete tank. A chemist friend pointed out that chromium could cause deterioration of the concrete according to the following reaction:

$$3Fe^{+2}\ aq + CrO_4^{2-}\ +8H^{+}\ =\ 3Fe^{+3} + Cr^{+3} + 4H_2O$$

Loss of iron from the concrete can produce a porous concrete. Can this reaction occur and impact the concrete?

You can find relevant information for chromium at
http://www.dipteris.unige.it/geochimica/Pesto/Cr(VI)%20by%20PESTO.pdf

5. ***Acidithiobacillus ferrooxidans*** is an iron oxidizing bacteria that oxidizes ferrous iron (to obtain energy for growth) to ferric iron as follows:

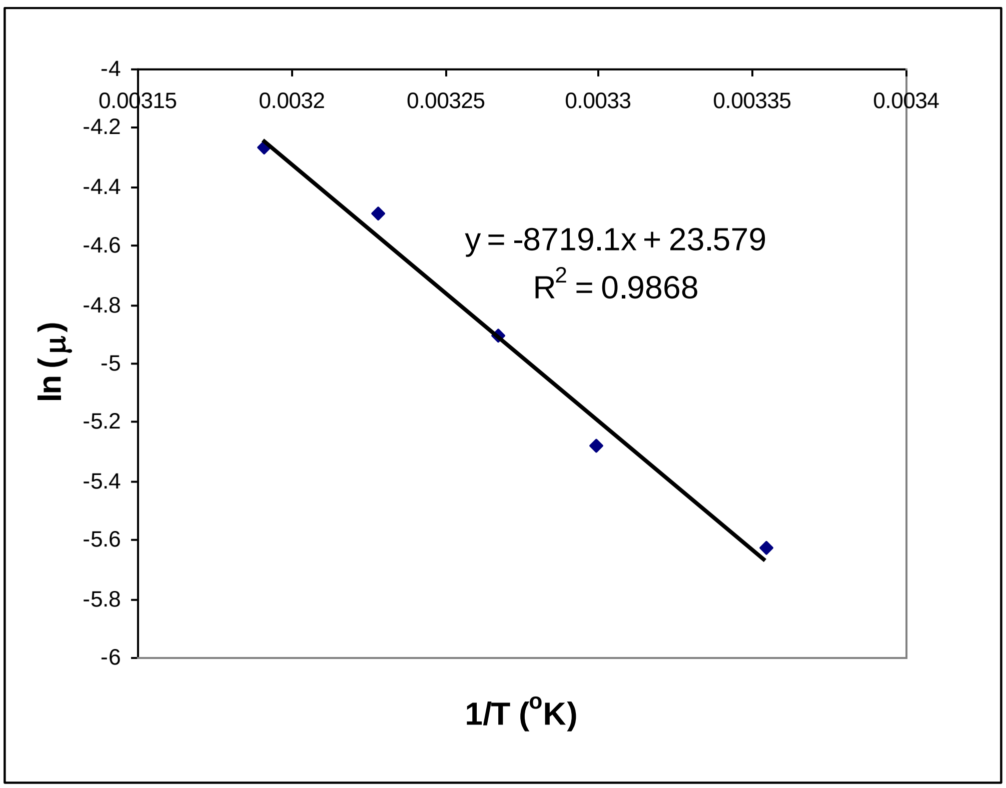
$$Fe^{+2}\ (aq) + 4H^{+}\ (aq) + O_2\ (g)\ = 4Fe^{+3}\ (aq)\ + 2H_2O\ (aq)$$

Using the Gibbs Free energy values prove that this reaction is feasible in nature. The bacteria use carbon dioxide as a carbon source.

6. The following data was obtained for conducting experiments on the effect of temperature on the growth rate of a certain bacterial species on an organic pollutant.

Temp °C (T)	μ Growth rate (hr-1)
40.4	0.014
36.8	0.0112
33.1	0.0074
30.1	0.0051
25.1	0.0036

The following plot was obtained from the above data to determine the activation energy E_a and Arrhenius constant A. What are the values and units of these parameters?



Given

Arrhenius Equation $\mu = Ae^{-Ea/RT}$
R universal gas constant = 1.987 cal mol^{-1} K^{-1}
Units of E_a = cal/mole and A = hr^{-1}

TABLE 3-1 Thermodynamic Constants for Species of Importance in Water Chemistry.[a]

Species	$\Delta \overline{H}_f^\circ$ kcal/mole	$\Delta \overline{G}_f^\circ$ kcal/mole
$Ca^{2+}_{(aq)}$	−129.77	−132.18
$CaCO_{3(s)}$, calcite	−288.45	−269.78
$CaO_{(s)}$	−151.9	−144.4
$C_{(s)}$, graphite	0	0
$CO_{2(g)}$	−94.05	−94.26
$CO_{2(aq)}$	−98.69	−92.31
$CH_{4(g)}$	−17.889	−12.140
$H_2CO^*_{3(aq)}$	−167.0	−149.00
$HCO^-_{3(aq)}$	−165.18	−140.31
$CO^{2-}_{3(aq)}$	−161.63	−126.22
CH_3COO^-, acetate	−116.84	−89.0
$H^+_{(aq)}$	0	0
$H_{2(g)}$	0	0
$Fe^{2+}_{(aq)}$	−21.0	−20.30
$Fe^{3+}_{(aq)}$	−11.4	−2.52
$Fe(OH)_{3(s)}$	−197.0	−166.0
$Mn^{2+}_{(aq)}$	−53.3	−54.4
$MnO_{2(s)}$	−124.2	−111.1
$Mg^{2+}_{(aq)}$	−110.41	−108.99
$Mg(OH)_{2(s)}$	−221.00	−199.27
$NO^-_{3(aq)}$	−49.372	−26.43
$NH_{3(g)}$	−11.04	−3.976
$NH_{3(aq)}$	−19.32	−6.37
$NH^+_{4(aq)}$	−31.74	−19.00
$HNO_{3(aq)}$	−49.372	−26.41
$O_{2(aq)}$	−3.9	3.93
$O_{2(g)}$	0	0
$OH^-_{(aq)}$	−54.957	−37.595
$H_2O_{(g)}$	−57.7979	−54.6357
$H_2O_{(\ell)}$	−68.3174	−56.690
$SO^{2-}_{4(aq)}$	−216.90	−177.34
$HS^-_{(aq)}$	−4.22	3.01
$H_2S_{(g)}$	−4.815	−7.892
$H_2S_{(aq)}$	−9.4	−6.54

Source. Condensed from the listing of R. M. Garrels and C. L. Christ, *Solutions, Minerals, and Equilibria*, Harper & Row, New York, 1965; and *Handbook of Chemistry and Physics*, Chemical Rubber Publishing Company, Cleveland, Ohio.

[a] For a hypothetical ideal state of unit molality, which is approximately equal to that of unit molarity.