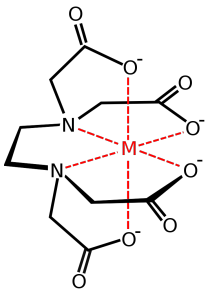
CHEM 1032 – Spring 2023 - Challenge Question 5

How can metals be removed from water?



Removing metal ions from water is an important tool in health and in the environment. One way this can be achieved is by binding the metal ion with a molecule called a chelator and then removing the metal+chelator from solution. EDTA (ethylenediaminetetraacetic acid) is an example of one of these chelators and binds in 1:1 stoichiometries with many metal ions to make (M(EDTA)) complexes (as shown at right).

You may use "EDTA" as the chemical formula below in your equations.

A. Write out the chemical reaction and equilibrium expression for the binding of EDTA with Mg^{2+} and, separately, with Li^{+}.
   Having trouble? Review questions from Chapter 13: 50 and 51.

B. EDTA binds more strongly with Mg^{2+} than with Li^{+}. With this information, assign the K values, $K_1 = 617$ and $K_2 = 4.63 \times 10^8$, to the correct metal-EDTA equilibrium expression. Explain your answer.
   Having trouble? Review questions from Chapter 13: 9, 10, and 11.

C. If a reaction were run where 100.0 mL of 0.100 M EDTA mixed with 100.0 mL of 0.100 M free metal, what would be the equilibrium concentration of free metal? Solve and show your work for one metal ion with EDTA and then repeat with the other metal ion.
   Having trouble? Review questions from Chapter 13: 17 and 18.

D. If you were to add more free metal to each of equilibrium solutions in Part C, what would you expect to happen? Explain your answer with Le Chatelier's principle and discuss the values of the reaction quotients.
   Having trouble? Review questions from Chapter 13: 36, 37, 40 and 41.

E. If Mg^{2+} free metal were added to the equilibrium solution of $Li(EDTA)^{+}$ what would you expect to happen? Consider the equilibrium constants in your answer.
   Having trouble? Review questions from Chapter 13: 86.