Round: Sample
Time: 4 minutes

Iron is required by all organisms, but its concentration in much of the surface ocean is so low that plant growth (phytoplankton) is limited. Marine phytoplankton are an important component of the global carbon cycle; therefore understanding the marine chemistry of iron is important to understanding the fate of anthropogenic carbon dioxide.

In the surface ocean, iron (Fe) exists in two forms, Fe(II) and Fe(III). Fe(II) is unstable in the presence of molecular oxygen (O_2), and oxidizes according to the reaction:

$$Fe(II) + O_2 \rightarrow Fe(III) + O_2^- \qquad (1)$$

In the surface ocean, the concentration of oxygen is very large relative to the concentration of Fe(II). As a result, reaction (1) has very little effect on the concentration of oxygen in surface waters. Because of this, the rate of this reaction can be expressed as:

$$d[Fe(II)]/dt = k\,[Fe(II)] \qquad (2)$$

Equation (2) says that the change in Fe(II) concentration over time, $d[Fe(II)]/dt$, is linearly proportional to the concentration of Fe(II), where k, the proportionality (or rate) constant.

1. In equation 2, if time is in units of seconds, and concentration is in units of picomoles per liter (pmol/L), what are the units for the rate constant, k? (5 pts)

2. Will the value of k be positive or negative? Why? (5 pts)

In a laboratory experiment, the oxidation of Fe(II) was studied by adding a known amount of Fe(II) to a seawater sample, and measuring the resulting Fe(II) concentration at various time intervals. The results from the experiment are given in Table 1.

Table 1

time (seconds)	Fe(II) concentration (picomoles/liter)
0	400
15	296
25	243
35	200
45	165
60	120
100	54
150	20
200	0

3. The half-life, $T_{1/2}$, for the oxidation of Fe(II) can be defined as the length of time required for half of the Fe(II) initially present to be oxidized to Fe(III). For these kinds of reactions, the half life is approximately related to the rate constant according to the equation: $T_{1/2} = 0.7/k$. For the experimental data shown above, what is $T_{1/2}$ for Fe(II)? (5 pts)

4. According to the results from above, give the value for the rate constant, *k*, for Fe(II) in this experiment. (5 pts)

ANSWER **ANSWER** **ANSWER**

Round: Sample
Category: Chemistry
Time: 4 minutes

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$$d[Fe(II)]/dt = k\,[Fe(II)] \qquad (2)$$

Equation (2) says that the change in Fe(II) concentration over time, $d[Fe(II)]/dt$, is proportional to the concentration of Fe(II), where k, the proportionality (or rate) constant.

1. In equation 2, if time is in units of seconds, and concentration is in units of picomoles per liter (pmol/L), what are the units for the rate constant, k? (5 pts)

   seconds^{-1} OR 1/seconds (5 pts)

2. Will the value of k be positive or negative? Why?

   Negative (2 pts)
   because Fe(II) is being lost OR the concentration of Fe(II) is decreasing (3 pts)

In a laboratory experiment, the oxidation of Fe(II) was studied by adding a known amount of Fe(II) to a seawater sample, and measuring the resulting Fe(II) concentration at various time intervals. The results from the experiment are given in Table 1.

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35 (4 pts) seconds (1 pt)

4. According to the results from above, give the value for the rate constant, *k*, for Fe(II) in this experiment. (5 pts)

- (1 pt) 0.02 (3 pts) s^{-1} (1 pt)