	Marks
• What is the solubility of $Cu(OH)_2$ in mol L^{-1}? K_{sp} ($Cu(OH)_2$) is 1.6×10^{-19} at 25 °C.	2

Answer:

Marks
6

- All forms of life depend on iron and the concentration of iron in the oceans and elsewhere is one of the primary factors limiting the growth rates of the most basic life forms. One reason for the low availability of iron(III) is the insolubility of the hydroxide, $Fe(OH)_3$, which has a K_{sp} of only 2×10^{-39}.

  Calculate the maximum possible concentration of Fe^{3+}(aq) in the pre-industrial era ocean which had a pH of about 8.2.

[Fe^{3+}(aq)] =

How many Fe^{3+}(aq) ions are present in a litre of seawater at this pH?

Answer:

The pH of the ocean is predicted to drop to 7.8 by the end of this century as the concentration of CO_2 in the atmosphere increases. What percentage change in the concentration of Fe^{3+}(aq) will result from this fall in pH?

Answer:

Marks 4

- The ocean contains a variety of forms of CO_3^{2-} and CO_2 with a variety of acid-base and solubility equilibria determining their concentrations. There is concern that increasing levels of CO_2 will lead to increased dissolution of $CaCO_3$ and critically affect the survival of life forms that rely on a carbonaceous skeleton.

  Calculate the concentrations of Ca^{2+} and CO_3^{2-} in a saturated solution of $CaCO_3$. (The K_{sp} of $CaCO_3$ is 3.3×10^{-9}.)

$[Ca^{2+}]$ =	$[CO_3^{2-}]$ =

  Calculate the pH of such a solution. (The pK_a of HCO_3^- is 10.33).

pH =

THIS QUESTION CONTINUES ON THE NEXT PAGE

Marks
4

The pH of surface ocean water is currently 8.10 (having fallen from a pre-industrial era level of 8.16), the concentration of HCO_3^- is 2.5×10^{-3} M, and it is saturated with $CaCO_3$. Calculate the concentration of Ca^{2+} in these conditions.

$[Ca^{2+}]$ =

The pH is expected to drop to about 7.8 by the end of the century as CO_2 levels increase further. What effect will this have on the solubility of $CaCO_3$ in sea water? Use chemical equations to assist with explaining your answer.

Marks
2

- In order to reduce the incidence of dental cavities, water is fluoridated to a level of 1 mg L^{-1}. In regions where the water is "hard" the calcium concentration is typically 100 mg L^{-1}. Given that the K_{sp} of calcium fluoride is 3.9×10^{-11} M^3, would it precipitate in these conditions? Show all working.

Answer:

- 2.00 g of solid calcium hydroxide is added to 1.00 L of water. What proportion of the calcium hydroxide remains undissolved when the system has reached equilibrium? $K_{sp}(Ca(OH)_2) = 6.5 \times 10^{-6}$ M^3

4

Answer:

What volume (in mL) of 10.0 M nitric acid must be added to this mixture in order to just dissolve all of the calcium hydroxide? Assume the volume of the nitric acid is small and can be ignored in the calculation of the total volume.

Answer:

Marks

- Calcium oxalate is a major constituent of kidney stones. Calculate the solubility product constant for calcium oxalate given that a saturated solution of the salt can be made by dissolving 0.0061 g of $CaC_2O_4 \cdot H_2O(s)$ in 1.0 L of water. **2**

Answer:

- A sample of 2.0 mg of $Cu(OH)_2$ is added to 1.0 L of a solution buffered at a pH of 8.00. Will all of the $Cu(OH)_2$ dissolve? Show all working. **3**
(The K_{sp} of $Cu(OH)_2$ is 4.8×10^{-20} M^3.)

Answer:

In the presence of excess hydroxide ion, Mg^{2+} can be precipitated as $Mg(OH)_2$(s). What amount (in mol) of solid sodium hydroxide must be added to a 0.10 M solution of $Mg(NO_3)_2$ to just cause precipitation of $Mg(OH)_2$(s). The solubility product constant of $Mg(OH)_2$ is 7.1×10^{-12} M^3.

ANSWER:

In a separate experiment, the $Mg(OH)_2$ is precipitated by adding 0.10 mol of $Mg(NO_3)_2$ to 1.0 L of a 0.10 M NH_3 solution. What amount (in mol) of NH_4Cl must be added to this solution to just dissolve the precipitate? The pK_a of NH_4Cl is 9.24.

ANSWER:

Marks
4

- The solubility product constant of $Fe(OH)_3$ is 1×10^{-39} M^4. What is the concentration of Fe^{3+}(aq) in equilibrium with $Fe(OH)_3$ at pH 7.0?

ANSWER:

To what value does the pH need to be increased to decrease the concentration of Fe^{3+}(aq) to a single Fe^{3+}(aq) ion per litre of solution?

ANSWER:

Marks

- Teeth are made from hydroxyapatite, $Ca_5(PO_4)_3OH$. Why does an acidic medium promote tooth decay and how can the decay be stopped using fluoridation of drinking water? Use chemical equations where appropriate. **2**