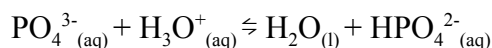


1. The reduction potential of the chlorine gas (+1.36 V) was greater than oxidation potentials of the metals: copper (-0.34 V), lead (+0.13 V), and iron (+0.44 V). This results in an overall positive cell potential indicating a spontaneous reaction, and the oxidation of the metal releasing soluble metal ions into the water is what is known as “corrosion.”
2. Lead(II) has a standard reduction potential of -0.13 V, while the reduction of copper(II) has a standard potential of +0.34 V. In this reaction, lead(II) is oxidized at the anode while copper(II) is reduced at the cathode. The overall standard cell potential would be +0.47 V, and a positive overall cell potential corresponds to a spontaneous reaction.

3.



$$K_{\text{sp}} = \gamma_{\text{Pb}}[\text{Pb}^{2+}]^3 \gamma_{\text{PO}_4}[\text{PO}_4^{3-}]^2$$

(γ is the activity coefficient)

At different pHs: At lower pHs, the hydrogen ion concentration increases, causing more phosphate ions from the mineral layer to react. As these phosphate ions are removed from the system, the reaction will have to shift to restore equilibrium by producing more lead(II) and phosphate ions.

Ionic strengths: As ionic strength increases, the activity coefficient of each species decreases. As a result, the solubility product constant decreases and more reactants will be present at equilibrium since it will be harder to overcome the intramolecular forces.

4. If the Pb^{2+} production was increased to be much higher than the safe limit, the water will still be protected by the also increased amount of phosphate groups added to the pipes. These phosphate groups, also called orthophosphate groups, would maintain the protective barrier between the lead pipe and the water, and thus a better maintained barrier would prevent the Pb^{2+} ions from getting mixed with the water.

5. Doing partial replacements of the lead pipe when the Pb action levels are above 15ppb is more dangerous because these LSLs will still be prone to water contamination by pipe corrosion. The addition of the partial LSL replacement of a different metal will only worsen the water contamination through galvanic corrosion (as described in problem 2). The jarring movements from cutting the pipes when being replaced will also disrupt the protective phosphate coating.