

**AP<sup>®</sup> CHEMISTRY  
2001 SCORING GUIDELINES**

**Question 1**

(10 points)



- Correct charges needed to earn credit.
- Phases not necessary to earn credit.

(ii)  $\frac{8.9 \times 10^{-5} \text{ g}}{143.32 \text{ g/mol}} = 6.2 \times 10^{-7} \text{ mol (in 100 mL)}$  *1 point*

$(6.2 \times 10^{-7} \text{ mol/100 mL})(1,000 \text{ mL/1.000 L}) = 6.2 \times 10^{-6} \text{ mol/L}$  *1 point*

Note: The first point is earned for the correct number of moles; the second point is earned for the conversion from moles to molarity.

(iii)  $K_{sp} = [\text{Ag}^+][\text{Cl}^-] = (6.2 \times 10^{-6})^2 = 3.8 \times 10^{-11}$  *1 point*

Note: Students earn one point for squaring their result for molarity in (a) (ii).

(b) (i)  $n_{\text{Cl}^-} = (0.060 \text{ L})(0.040 \text{ mol/L}) = 0.0024 \text{ mol}$  *1 point*

$[\text{Cl}^-] = (0.0024 \text{ mol})/(0.120 \text{ L}) = 0.020 \text{ mol/L} = \mathbf{0.020 M}$

$n_{\text{Pb}^{2+}} = (0.060 \text{ L})(0.030 \text{ mol/L}) = 0.0018 \text{ mol}$

$[\text{Pb}^{2+}] = (0.0018 \text{ mol})/(0.120 \text{ L}) = 0.015 \text{ mol/L} = \mathbf{0.015 M}$

$Q = [\text{Pb}^{2+}][\text{Cl}^-]^2 = (0.015)(0.020)^2 = 6.0 \times 10^{-6}$  *1 point*

$Q < K_{sp}$ , therefore no precipitate forms *1 point*

Note: One point is earned for calculating the correct molarities; one point is earned for calculating  $Q$ ; one point is earned for determining whether or not a precipitate will form.

(ii)  $[\text{Pb}^{2+}] = \frac{K_{sp}}{[\text{Cl}^-]^2} = \frac{1.6 \times 10^{-5}}{(0.25)^2} = 2.6 \times 10^{-4} M$  *1 point*

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**Question 1 (cont.)**

(iii) for AgCl solution:  $[\text{Cl}^-] = \frac{K_{sp}^{\text{AgCl}}}{[\text{Ag}^+]} = \frac{1.8 \times 10^{-10}}{0.120} = 1.5 \times 10^{-9} M$  *1 point*

for PbCl<sub>2</sub> solution:  $[\text{Cl}^-] = \sqrt{\frac{K_{sp}^{\text{PbCl}_2}}{[\text{Pb}^{2+}]}} = \sqrt{\frac{1.6 \times 10^{-5}}{0.150}} = 1.0 \times 10^{-2} M$

The [Cl<sup>-</sup>] will reach a concentration of  $1.5 \times 10^{-9} M$  before it reaches a concentration of  $1.0 \times 10^{-2} M$ , (or  $1.5 \times 10^{-9} \ll 1.0 \times 10^{-2}$ ), therefore AgCl(s) will precipitate first. *1 point*

Note: One point is earned for calculating [Cl<sup>-</sup>] in saturated solutions with the appropriate Ag<sup>+</sup> and Pb<sup>2+</sup> concentrations; one point is earned for concluding which salt will precipitate first, based on the student's calculations.