(c) adding heat will shift the equilibrium to the left.

IV. According to Le Châtelier's principle,

(a) adding $HCl_{(aq)}$ will shift the equilibrium to the left.

(b) adding $NaOH_{(aq)}$ will shift the equilibrium to the right.

V. According to Le Châtelier's principle,

(a) adding $Fe(NO_3)_{3\ (aq)}$ will shift the equilibrium to the right.

(b) adding $KSCN_{(aq)}$ will shift the equilibrium to the right.

(c) adding $NaOH_{(aq)}$ will shift the equilibrium to the left.

VI. According to Le Châtelier's principle,

(a) adding $NH_{3(aq)}$ will shift the equilibrium to the right.

(b) adding $HCl_{(aq)}$ will shift the equilibrium to the left.

VII. According to Le Châtelier's principle,

(a) adding $NaOH_{(aq)}$ will shift the equilibrium to the left.

(b) adding $HCl_{(aq)}$ will shift the equilibrium to the right.

(c) adding $Ba(NO_3)_{2(aq)}$ will shift the equilibrium to the left.

In each case, the equilibrium will shift to try to undo what was done to the initial equilibrium.

(b) According to the colour-change evidence gathered in this experiment, the systems are affected in the same way as predicted above.

(c)

Equilibrium System	Stress Applied	Colour Change Observed
1.	(a) cold (b) heat	lighter darker
2.	increase in pressure	solution changes from green/blue to yellow
3.	(a) adding more water (b) adding silver nitrate (c) adding heat	solution became more pink solution became more pink solution became more blue
4.	(a) adding $HCl_{(aq)}$ (b) adding $NaOH_{(aq)}$	yellow solution turned red yellow solution turned blue
5.	(a) adding $Fe(NO_3)_{3(aq)}$ (b) adding $KSCN_{(aq)}$ (c) adding $NaOH_{(aq)}$	solution became more red solution became more red solution became more yellow
6.	(a) adding $NH_{3(aq)}$ (b) adding $HCl_{(aq)}$	solution became less blue solution became more blue
7.	(a) adding $NaOH_{(aq)}$ (b) adding $HCl_{(aq)3}$ (c) adding $Ba(NO_3)_{2(aq)}$	solution became more yellow solution became more orange solution became more yellow

INVESTIGATION 7.6.1 DETERMINING THE K_{sp} OF CALCIUM OXALATE

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Evidence

(a) (See Table 3 in the text.)

Analysis

(b) to (g)

Well #	A	B	C	D	E
1	1.0×10^{-1}	1×10^{-1}	5.00×10^{-2}	5.00×10^{-2}	3×10^{-3}
2	5.00×10^{-2}	1×10^{-1}	2.50×10^{-2}	5.00×10^{-2}	1×10^{-3}
3	2.50×10^{-2}	1×10^{-1}	1.25×10^{-2}	5.00×10^{-2}	6×10^{-4}
4	1.25×10^{-2}	1×10^{-1}	6.25×10^{-3}	5.00×10^{-2}	3×10^{-4}
5	6.25×10^{-3}	1×10^{-1}	3.13×10^{-3}	5.00×10^{-2}	2×10^{-4}
6	3.13×10^{-3}	1×10^{-1}	1.56×10^{-3}	5.00×10^{-2}	8×10^{-5}
7	1.56×10^{-3}	1×10^{-1}	7.81×10^{-4}	5.00×10^{-2}	4×10^{-5}
8	7.81×10^{-4}	1×10^{-1}	3.91×10^{-4}	5.00×10^{-2}	2×10^{-5}
9	3.91×10^{-4}	1×10^{-1}	1.95×10^{-4}	5.00×10^{-2}	1×10^{-5}
10	1.95×10^{-4}	1×10^{-1}	9.77×10^{-5}	5.00×10^{-2}	5×10^{-6}
11	9.77×10^{-5}	1×10^{-1}	4.88×10^{-5}	5.00×10^{-2}	2×10^{-6}
12	4.88×10^{-5}	1×10^{-1}	2.44×10^{-5}	5.00×10^{-2}	1×10^{-6}

(extra digits carried in the calculation of columns A, C, and D)

(f) $CaC_2O_{4(s)} \rightleftharpoons Ca^{2+}_{(aq)} + C_2O^{2-}_{4(aq)}$

$K_{sp} = [Ca^{2+}_{(aq)}][C_2O^{2-}_{4(aq)}]$

(g) Well #11 was the last well in which a precipitate was observed. Therefore, the actual value of K_{sp} must lie between 1×10^{-6} and 2×10^{-6}.

Evaluation

(i) Air bubbles can easily be drawn into the pipet. This decreases the volume of solutions transferred to the next well. Doubling the volumes of all solutions initially should reduce the risk of drawing into the pipet without affecting the calculations.

(j) The accepted value of K_{sp} for calcium oxalate is 2.3×10^{-9}. The result obtained from this experiment is approximately 1000 times larger than the accepted value. Since similar results were obtained by most of my classmates, I have confidence in my data.

INVESTIGATION 7.6.2 DETERMINING K_{SP} FOR CALCIUM HYDROXIDE

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Question

(a) What is the K_{sp} for calcium hydroxide?

Prediction

(b) The accepted value for the solubility product of calcium hydroxide is 7.9×10^{-6}.

Experimental Design

(c) A filtered solution of calcium hydroxide is titration with a hydrochloric acid solution of known concentration to a bromophenol blue endpoint.

Materials

(d) 0.10 mol/L hydrochloric acid, $HCl_{(aq)}$
bromophenol blue indicator
filtered calcium hydroxide
buret, stand, and clamp
125-mL Erlenmeyer flask
funnel
two 250-mL beakers
10-mL pipet and filler