What is the concentration of barium ion at equilibrium if solid barium fluoride is mixed with deionized water?

$$BaF_2(s) \rightleftharpoons Ba^{2+}(aq) + 2F^-(aq);\ K_c = 1.00 \times 10^{-6}$$

$$K_c = \boxed{1.00 \times 10^{-6} = [Ba^{2+}][F^-]^2}$$

| Species | [Initial] | Δ | [Equilibrium] |
|---|---|---|---|
| $Ba^{2+}$ | 0 | $+x$ | $x$ |
| $F^-$ | 0 | $+2x$ | $2x$ |

Define "x" as the change in barium ion concentration...

$$[Ba^{2+}][F^-]^2 = \boxed{(x)(2x)^2 = 1.00 \times 10^{-6}}$$

$$4x^3 = 1.00 \times 10^{-6}$$

$$x^3 = 2.50 \times 10^{-7}$$

$$x = \boxed{0.00630\ M = [Ba^{2+}]}$$

A 6.00 L reaction vessel contains 0.488 mol hydrogen gas, 0.206 mol iodine vapor, and 2.250 mol HI at equilibrium at 491 C. . What is the value of Kc at 491 C?

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

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$$K_c = \frac{[HI]^2}{[H_2][I_2]}$$

$$[HI] = \frac{2.250 \text{ mol HI}}{6.00 \text{ L}} = 0.375 \text{ M HI}$$

$$[H_2] = \frac{0.488 \text{ mol } H_2}{6.00 \text{ L}} = 0.0813333333 \text{ M } H_2$$

$$[I_2] = \frac{0.206 \text{ mol } I_2}{6.00 \text{ L}} = 0.0343333333 \text{ M } I_2$$

$$K_c = \frac{(0.375)^2}{(0.0813333333)(0.0343333333)} = \boxed{50.4}$$

What is the direction of reaction when a mixture of 0.20 M sulfur dioxide, 0.10 M oxygen gas, and 0.40 M sulfur trioxide approaches equilibrium?

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g);\ K_c = 4.17 \times 10^{-2}$$

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$$Q = \frac{[SO_3]^2}{[SO_2]^2[O_2]} = \frac{(0.40)^2}{(0.20)^2(0.10)} = 40$$

$$40 > 4.17 \times 10^{-2}$$

$Q > K_c$, so reaction proceeds to the left (to make more reactants!)

A 5.0 L vessel initially contains 0.0015 mol of each reactant. Find the equilibrium concentrations of all species in the vessel at equilibrium at 150 C.

$$I_2(g) + Br_2(g) \rightleftharpoons 2IBr(g) \; ; \; K_c = 120 \text{ @ } 150°C$$

$$K_c = \boxed{120 = \frac{[IBr]^2}{[I_2][Br_2]}}$$

Let "x" equal the change in iodine concentration...

| Species | [Initial] | Δ | [Equilibrium] |
|---|---|---|---|
| $I_2$ | $\frac{0.0015 mol}{5.0 L} = 0.00030$ | $-x$ | $0.00030 - x$ |
| $Br_2$ | $\frac{0.0015 mol}{5.0 L} = 0.00030$ | $-x$ | $0.00030 - x$ |
| $IBr$ | 0 | $+2x$ | $2x$ |

$$120 = \frac{(2x)^2}{(0.00030 - x)(0.00030 - x)}$$

$$120 = \frac{(2x)^2}{(0.00030 - x)^2}$$

$$\sqrt{120} = \sqrt{\frac{(2x)^2}{(0.00030-x)^2}}$$

$$10.95445115 = \frac{2x}{0.00030-x}$$

$$10.95445115(0.00030-x) = 2x$$

$$0.0032863353 - 10.95445115x = 2x$$

$$0.0032863353 = 12.95445115x$$

$$0.000254 = x$$

$$[I_2] = 0.00030 - x = 0.00005 \text{ M } I_2$$

$$[Br_2] = 0.00030 - x = 0.00005 \text{ M } Br_2$$

$$[IBr] = 2x = 0.00051 \text{ M } IBr$$

Alternatively, you can solve this with the quadratic equation!

| Species | [Equilibrium] |
|---|---|
| $I_2$ | $0.00030 - x$ |
| $Br_2$ | $0.00030 - x$ |
| $IBr$ | $2x$ |

When carbon dioxide is removed from the equilibrium mixture by passing the gases through water (which preferentially absorbs carbon DIOXIDE), what is the direction of net reaction as a new equilibrium is achieved?

$$FeO(s) + CO(g) \rightleftharpoons Fe(s) + CO_2(g)$$

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We can answer this question using Le Chateleir's Principle. The water REMOVES carbon dioxide from the equilibrium mixture, slowing the rate of the reverse reaction ... meaning the equilibrium will proceed to the RIGHT to make more iron and carbon dioxide.

Alternately, we can view the equilibrium as trying to regenerate the carbon dioxide we have taken away ... again causing the reaction to shift to the right.

Predict the optimal conditions (temperature and pressure) for maximum conversion of ethylene to ethane.

$$C_2H_4(g) + H_2(g) \rightleftharpoons C_2H_6(g) \; ; \; \Delta H^\circ < 0$$

ethylene ethane

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This is an EXOTHERMIC process, since the sign of the enthalpy change (delta H) is NEGATIVE.

$$C_2H_4 + H_2 \rightleftharpoons C_2H_6 + heat$$

Increasing temperature causes the equilibrium to shift left, making LESS ethane! Lower temperatures would cause more ethane to be produced. RUN THE REACTION AT LOW TEMPERATURE.

Since this is a gas-phase equilibrium, pressure may have an effect. Compressing (increasing pressure) the mixture will cause a shift to the right, as the right side has less molecules of gas. This will make more ethane, so RUN THE REACTION AT HIGH PRESSURE.