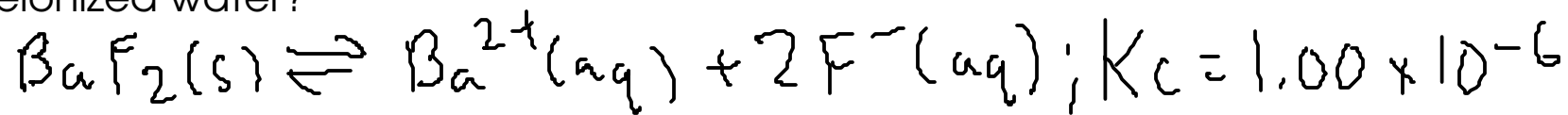What is the concentration of barium ion at equilibrium if solid barium fluoride is mixed with deionized water?

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

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

Let "x" equal the increase in barium ion concentration!

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

Plug equilibrium values back into Kc expression...

$$(x)(2x)^2 = 1.00 \times 10^{-6}$$

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

$$x = \boxed{0.00630 \, M = [Ba^{2+}] \text{ at equilibrium}}$$

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?

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

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

Since the mixture is already at equilibrium, we need to find the concentrations from the given information and plug them into the Kc expression to find Kc's value at 491 C...
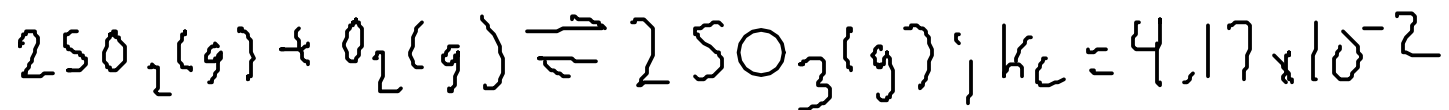
$$[HI] = \frac{2.250 \text{ mol HI}}{6.00 L} = 0.375 \text{ M HI}$$

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

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

$$K_c = \frac{(0.375)^2}{(0.0813333333)(0.0343333333)} = \boxed{50.4 = K_c \text{ at } 491\,^{\circ}C}$$

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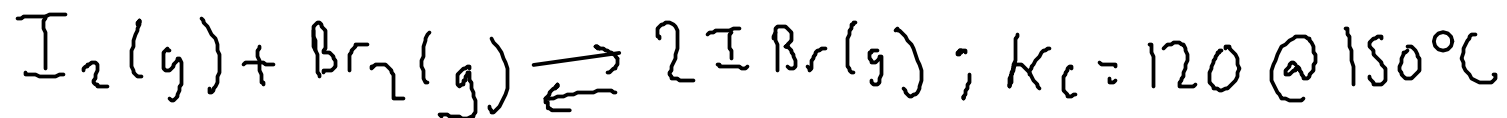
$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g); \quad k_c = 4.17 \times 10^{-2}$$

$$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]} = 4.17 \times 10^{-2}$$

$$Q = \frac{(0.40)^2}{(0.20)^2(0.10)} = 40$$

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

$$Q > K_c, \text{ so } \boxed{\text{reaction proceeds to } \underline{LEFT}}$$

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.

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

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

Let "x" equal the loss of iodine concetration...

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	$+2x$	$2x$

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

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

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

Take square root of both sides...

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

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

$$0.1825741858x = 0.00030-x$$

$$1.1825741858x = 0.00030$$

$$x = 2.536838734 \times 10^{-4}$$

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

Now find equilibrium concentrations...

$$[I_2] = 0.00030-x \approx 0.000046 \; M \; I_2$$

$$[Br_2] = 0.00030-x = 0.000046 \; M \; Br_2$$

$$[IBr] = 2x = 0.00051 \; M \; IBr$$

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?

$$FeO(s) + CO(g) \rightleftharpoons Fe(s) + CO_2(g)$$
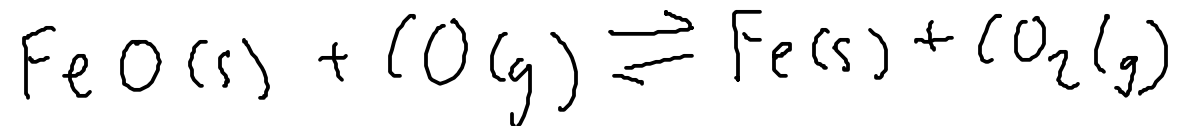
Removing carbon dioxide from the mixture lowers its concentration. This will cause the equilibrium to try to REPLACE the lost carbon dioxide by shifting to the RIGHT.

(Le Chateleir's Principle...)

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

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

ethylene   ethane
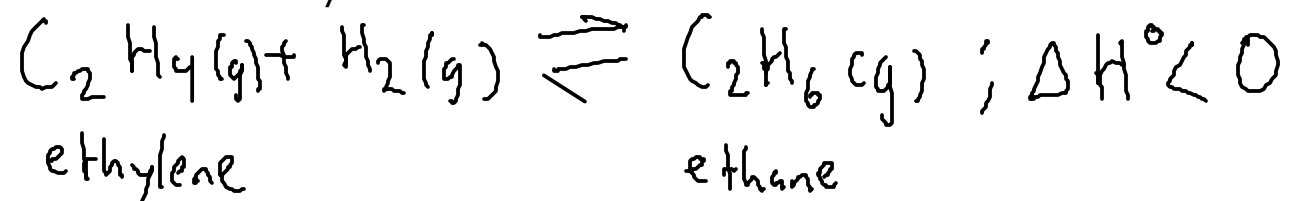
Since the enthalpy change of reaction is negative (less than zero), this is an EXOTHERMIC process - the reaction releases energy as it proceeds, and we can imagine heat as a PRODUCT of the reaction:

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

Raising the temperature ("turning up the heat") will cause the equilibrium to shift LEFT to reduce the amount of heat. This is the OPPOSITE of what we want! Instead, we should run the reaction at a LOWER temperature ... which will cause the equilibrium to shift RIGHT

Pressure? For pressure to effect a gas-phase equilibrium, we must have more moles of gas on one side than on the other. We do .. there are more moles of gas on the left side (ethylene and hydrogen).

If we compress the reaction mixture (increasing pressure), we would expect the equilibrium to shift towards the side with less gas ... in this case, the ethane side. This is exactly what we want!

Optimum conditions: LOW temperature, HIGH pressure.