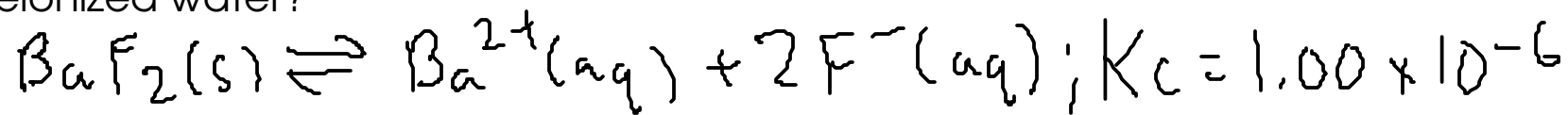


1
What is the concentration of barium ion at equilibrium if solid barium fluoride is mixed with deionized water?



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

Make a chart to express all equilibrium concentrations in terms of one variable.

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

Let "x" equal the change in barium ion concentration

Plug (Equilibrium) expressions back into the equation for K_c ...

$$(x)(2x)^2 = 1.0 \times 10^{-6}$$

$$4x^3 = 1.0 \times 10^{-6}$$

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

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 K_c at 491 C?



$$K_c = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]}$$

Since we know the composition of an equilibrium mixture, all we have to do is plug those concentrations into this K_c expression

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

$$[\text{H}_2] = \frac{0.488 \text{ mol}}{6.00 \text{ L}} = 0.08133333333 \text{ M H}_2$$

$$[\text{I}_2] = \frac{0.206 \text{ mol}}{6.00 \text{ L}} = 0.03433333333 \text{ M I}_2$$

$$K_c = \frac{(0.375)^2}{(0.08133333333)(0.03433333333)} = \boxed{50.4 = K_c}$$

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?



To find out whether this reaction is at equilibrium or what direction it will go, use the reaction quotient - Q.

$$Q = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2[\text{O}_2]} = \frac{(0.40\text{M})^2}{(0.20\text{M})^2(0.10\text{M})} = 40$$

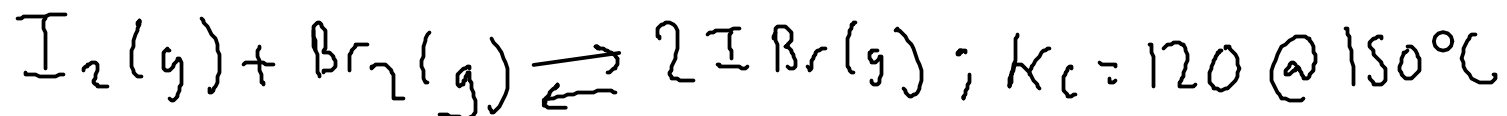
Compare Q to K_c:

$$Q > K_c$$

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

Since $Q > K_c$, the reaction will proceed to the LEFT (towards more sulfur dioxide and oxygen) as it approaches equilibrium.

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.



$$K_c = \frac{[\text{IBr}]^2}{[\text{I}_2][\text{Br}_2]} = 120$$

Need to express all these concentrations in terms of one variable!

Species	[Initial]	Δ	[Equilibrium]
I_2	$\frac{0.0015\text{mol}}{5.0\text{L}} = 0.0003$	$-x$	$0.0003 - x$
Br_2	$\frac{0.0015\text{mol}}{5.0\text{L}} = 0.0003$	$-x$	$0.0003 - x$
IBr	0	$+2x$	$2x$

Let "x" equal the change in iodine concentration

Plug (Equilibrium) expressions back into the K_c equation...

$$\frac{(2x)^2}{(0.0003-x)(0.0003-x)} = 120$$

Solve!

$$\frac{(2x)^2}{(0.0003-x)(0.0003-x)} = 120$$

$$\sqrt{\frac{(2x)^2}{(0.0003-x)^2}} = \sqrt{120}$$

Solve via quadratic equation OR take square root of both sides.

$$\frac{2x}{0.0003-x} = 10.95445115$$

$$2x = 0.00032863353 - 10.95445115x$$

$$12.95445115x = 0.00032863353$$

$$x = 0.0002536838699$$

Species	[Equilibrium]
I_2	$0.0003 - x$
Br_2	$0.0003 - x$
IBr	$2x$

Now calculate concentrations from "x" ...

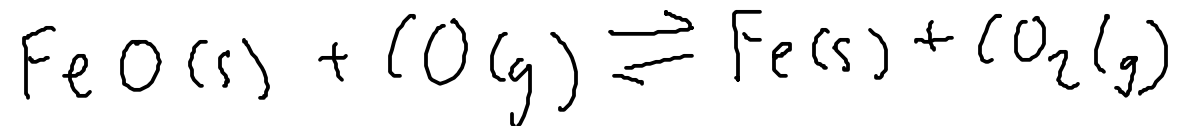
$$[I_2] = 0.0003 - x = 0.000046 \text{ M } I_2$$

$$[Br_2] = 0.0003 - x = 0.000046 \text{ M } Br_2$$

$$[IBr] = 2x$$

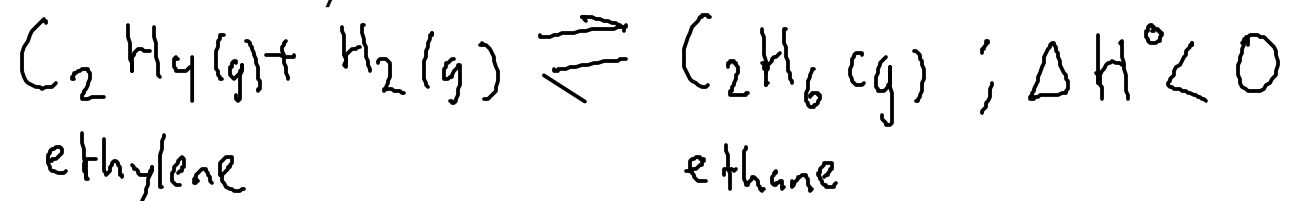
$$= 0.00051 \text{ M } IBr$$

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?

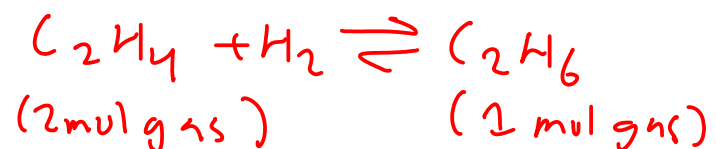


Water absorbs carbon dioxide, which REMOVES IT FROM THE EQUILIBRIUM MIXTURE. This will cause the equilibrium to shift to the right in an attempt to replace the lost carbon dioxide. (Le Chateleir's Principle)

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



We can use LE CHATELIER'S PRINCIPLE to predict the optimum conditions. Let's first talk about pressure:



If we were to allow the reaction to reach equilibrium and then compress it (increasing pressure), what would happen? The equilibrium would shift to the side with less moles of gas ... which is the ETHANE side. That's what we want, so we predict that HIGH PRESSURE WOULD BE OPTIMAL.

What about temperature? A negative value for delta H means the reaction is EXOTHERMIC.



If we increase the temperature, we're increasing the amount of HEAT. So an increased temperature would cause the equilibrium to shift away from the side with heat ... in this case, a shift to the ETHYLENE side. This is the opposite of what we want. We should instead RUN THE REACTION AT LOWER TEMPERATURES.

THE OPTIMUM CONDITIONS ARE HIGH PRESSURE AND LOW TEMPERATURE.