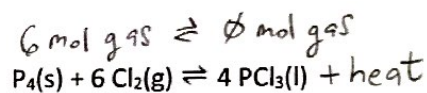


**Le Châtelier's Principle:** If a "stress" (change) is applied to a system at equilibrium, processes will occur to counteract (undo) that change.

- **Temperature** – exothermic think of heat is a product; endothermic think of heat is a reactant.
- **Adding or removing a reagent** – shift tries to reestablish K. If you remove it the reaction shifts to replace it; if you add it, the reaction shifts to get rid of it
  - UNLESS: you are adding or subtracting a solid or pure liquid: this will NOT change the concentration, and therefore this will not shift the position of equilibrium!
- **Pressure** – Increasing pressure favors a shift to side with the fewest # of moles of gas and vice versa.
  - UNLESS: you increase pressure by adding an inert (unreactive) gas: this will not increase the number of effective collisions, and therefore will not affect equilibrium position.
- **Volume** – same effect as pressure; remember Boyle's Law... Pressure and volume are inversely related, thus increasing the volume is the same as decreasing the pressure and vice versa.
- **Catalysts** – NO EFFECT on K; just gets to equilibrium faster (kinetics moment)!
- **REMEMBER** – nothing but a change in temperature will change the VALUE of K
- Increasing the temperature causes equilibrium to be reached faster (regardless of shift!)

Practice:

1. Liquid phosphorus trichloride is produced by the exothermic reaction:

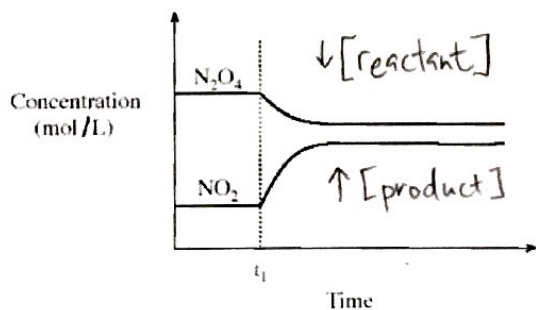


Change	Direction of shift	Effect on K?
Addition of phosphorus trichloride	none	none
Reduction of container volume	$\rightarrow$ (right)	none
Increase in temperature	$\leftarrow$ (left)	$\downarrow$ K
Increase in partial pressure of chlorine gas	$\rightarrow$ (right)	none
Decrease in temperature	$\rightarrow$ (right)	$\uparrow$ K

2. The endothermic reaction:  $\text{heat} + 2 COF_2(g) \rightleftharpoons CO_2(g) + CF_4(g)$
- 2 mol gas  $\rightleftharpoons$  2 mol gas*

Change	Direction of shift	Effect on K?
Increase in temperature	$\rightarrow$ (right)	$\uparrow$ K
Decrease in temperature	$\leftarrow$ (left)	$\downarrow$ K
Addition of <del>react gas</del> Ar(g)	none	none
Increase in pressure	none } Same #	none
Decrease in pressure	none } mol gas	none
Addition of catalyst	none	none

3. Consider the following reaction at chemical equilibrium:  $N_2O_4(g) \rightleftharpoons 2 NO_2(g)$ . At time  $t_1$ , heat is applied to the system. Which of the following best describes the equilibrium reaction and the change in  $K_c$ ?



- a. exothermic and  $K_c$  increases  
 b. exothermic and  $K_c$  decreases  
 c.  endothermic and  $K_c$  increases  
 d. endothermic and  $K_c$  decreases