

Key

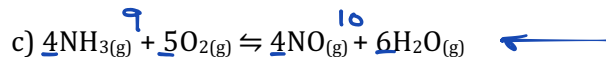
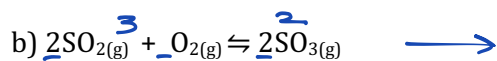
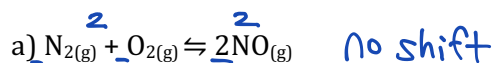
1. State Le Chatelier's Principle. Give an example in your answer.

A system at equilibrium will shift to alleviate an imposed stress

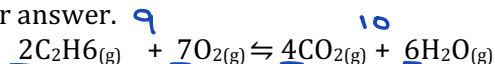
2. In order to decide what effect a change in total pressure will have on an equilibrium system with gases, what is the first thing you should do when given the balanced equation?

Add the number of moles of gas on each side of the equation (look @ coefficient)

3. Predict which way the following equilibrium systems will shift when the total pressure is increased. (NOTE: Some may have no shift)

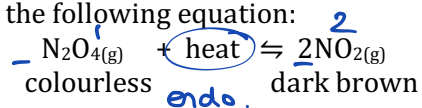


4. Which way will the following equilibrium shift if the total pressure on the system is decreased? Explain your answer.



↓ Pressure means ↑ volume
= shift to side w/ more gas molecules
= shift right

- For the questions 5, 6, and 7, use the following equation:



5. Explain why a flask filled with $\text{NO}_2(\text{g})$ and $\text{N}_2\text{O}_4(\text{g})$ will get darker when heated.

Heating will shift right
= $[\text{NO}_2] \uparrow$

6. Explain why a syringe containing NO_2 gas will first get darker and then lighter in colour when compressed.

Compression means ↓ volume means ↑ pressure
= shift to side with less gas molecules
= shift left

7. Explain why a flask containing NO_2 will get lighter in colour when put into ice water.

Remove heat = shift left

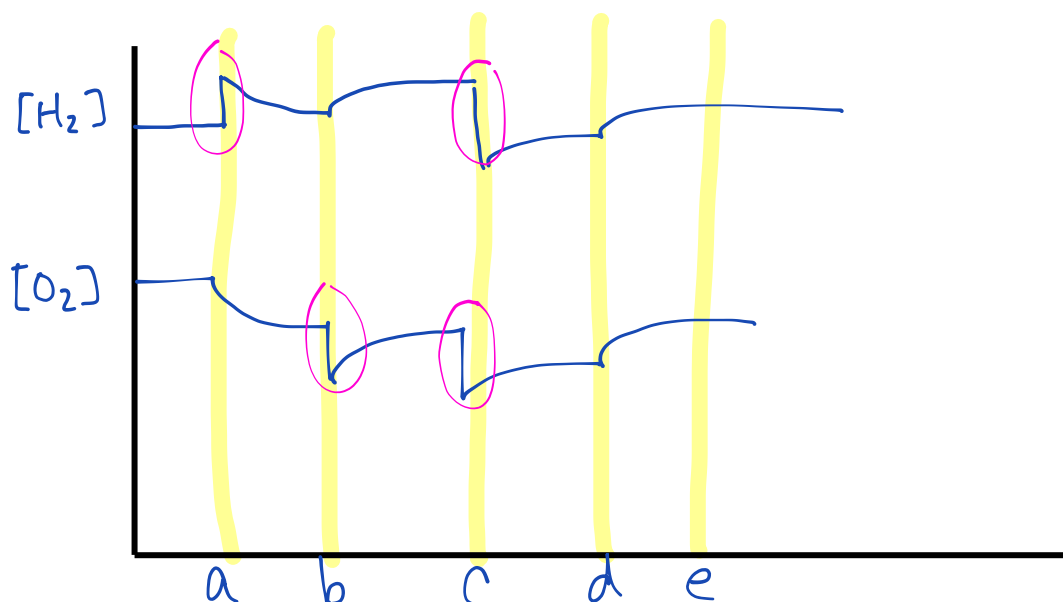
8. Hydrogen peroxide decomposes as follows:



Predict the direction of equilibrium shift (left or right) by each of the following imposed changes:

- a) Increase the $[\text{H}_2]$ \leftarrow
 b) Decrease the $[\text{O}_2]$ \longrightarrow
 c) Decrease the total pressure \longrightarrow
 d) Increase the temperature \longrightarrow
 e) Add MnO_2 as a catalyst *no shift*

f) Sketch a graph of the relative concentrations of each species as the process outlined in a-e of this question is carried out.



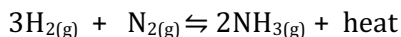
9. For the reaction:



state the optimal pressure and temperature conditions necessary for maximum production of NOCl .

(high or low?) high pressure and (high or low?) low temperature

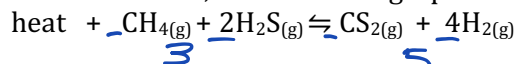
10. For the reaction:



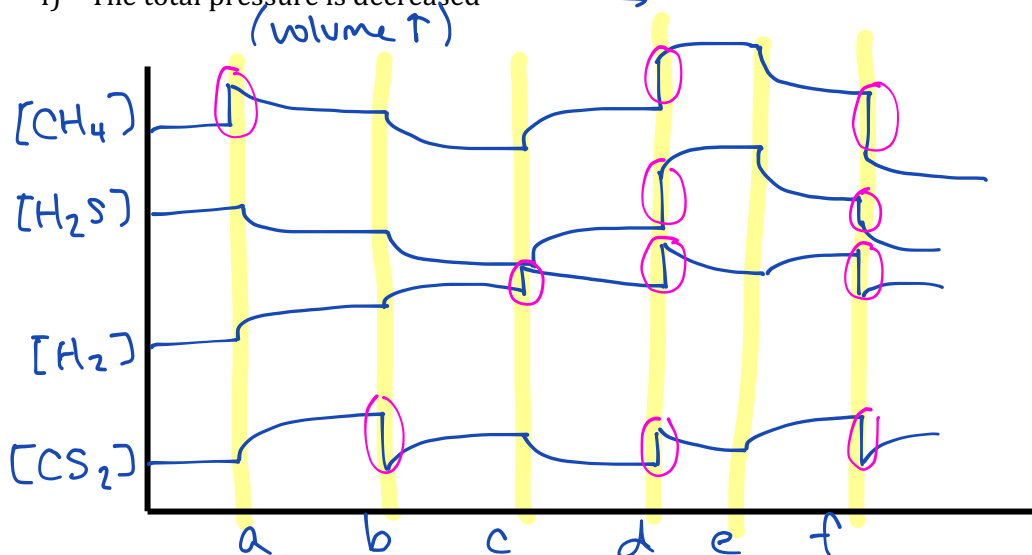
state the optimal conditions for a high yield of ammonia (NH_3).

(high or low?) high pressure and (high or low?) low temperature

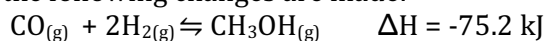
11. Consider the following equilibrium and state which way (left or right) the equilibrium shifts when each of the changes below are made, then sketch a graph of the relative concentrations.



- a) CH₄ gas is added →
- b) CS₂ gas is removed →
- c) H₂ gas is added ←
- d) The total volume of the container is decreased ←
- e) The temperature is increased →
- f) The total pressure is decreased →

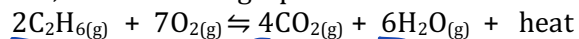


12. Using the following equilibrium, state what would happen to the equilibrium concentration of CH₃OH gas when each of the following changes are made:

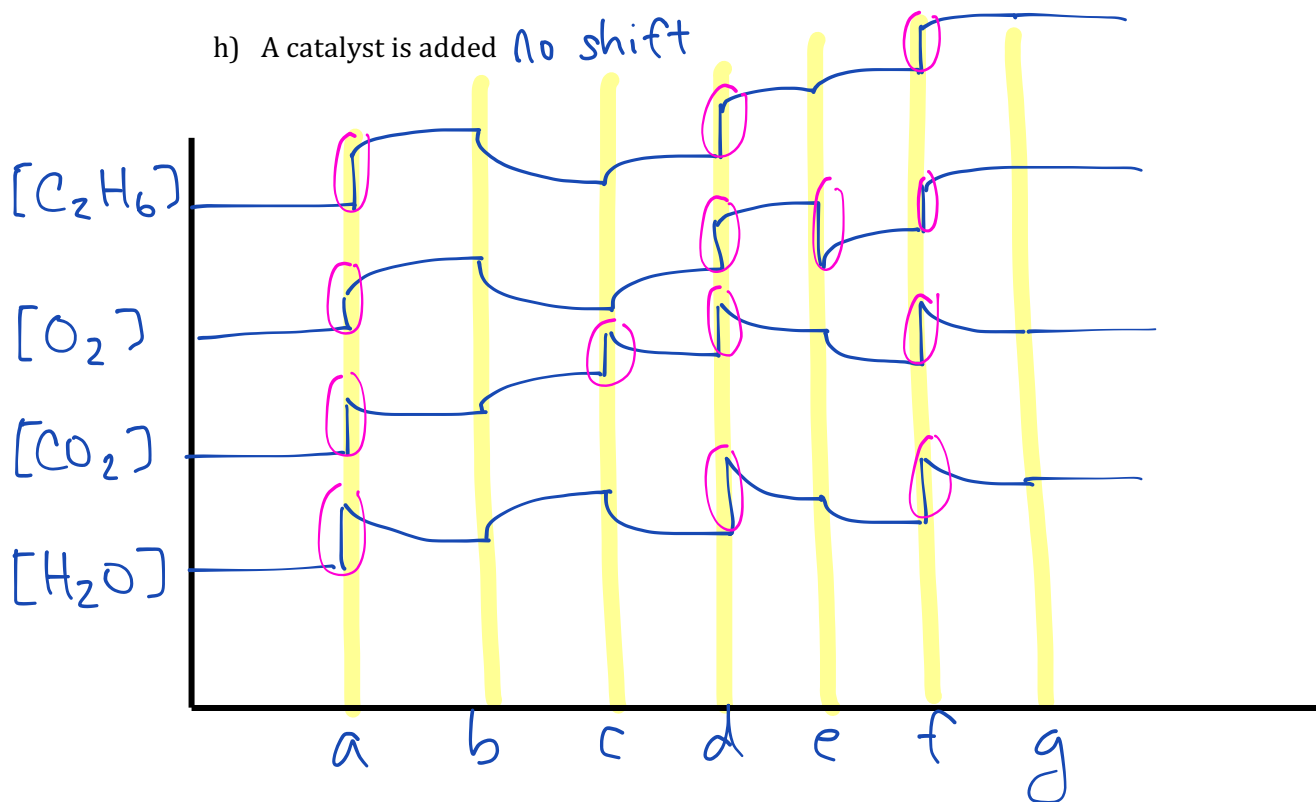


- a) CO gas is added to the container →
- b) The temperature is increased ←
- c) The total pressure of the system is increased →
- d) H₂ gas is removed from the system ←
- e) A catalyst is added *no shift*
- f) The total volume of the container is increased ←

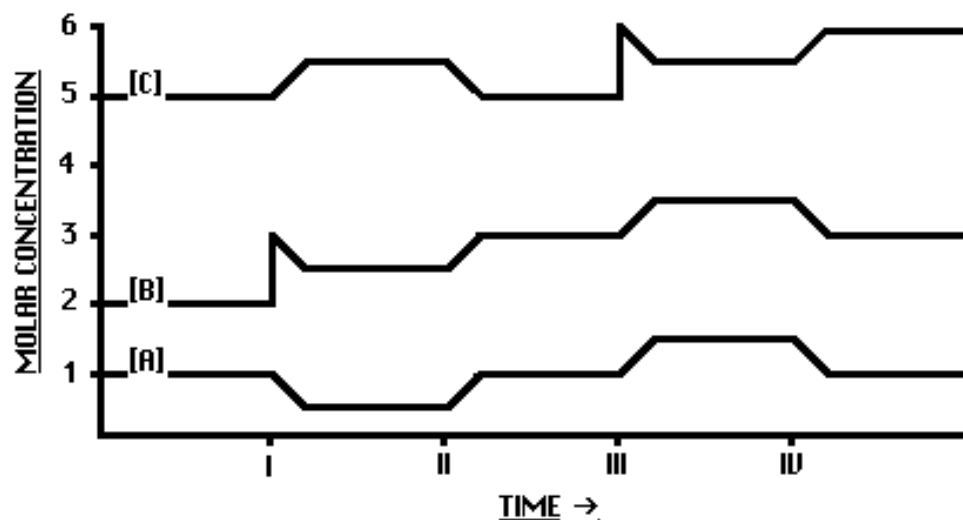
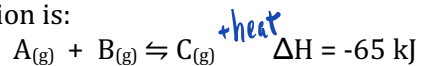
13. Given the following equilibrium system, state which way the equilibrium will shift when the changes below are made, then sketch a graph of the relative concentrations.



- a) The volume of the container is halved \leftarrow
- b) The temperature is decreased \rightarrow
- c) CO_2 is added to the container \leftarrow
- d) The total pressure is increased \leftarrow
- e) O_2 gas is removed from the system \leftarrow
- f) Neon gas is added to increase the total pressure \leftarrow
- g) A catalyst is added *No shift*



14. Given the following graph showing the concentrations of species A, B and C, fill in the table below. The equilibrium equation is:



	Time I	Time II	Time III	Time IV
[A] Decrease or increase?	↓	↑	↑	↓
[B] Decrease or increase?	spike, then ↓	↑	↑	↓
[C] Decrease or increase?	↑	↓	spike, then ↓	↑
Shift?	→	←	←	→
Imposed stress?	add B	add heat	add C	remove heat