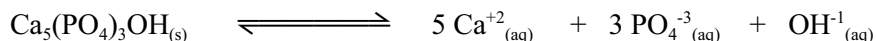


REVIEW QUESTIONS: QUALITATIVE EQUILIBRIUM

SCH4UE 05 - 06

1. Is sugar candy really bad for your teeth? Tooth decay is the result of the dissolving of tooth enamel, $\text{Ca}_5(\text{PO}_4)_3\text{OH}_{(s)}$. In the mouth the following equilibrium is established:



When sugar ferments on the teeth, H^+ ion is produced. What effect does this increased H^+ ion have on tooth enamel?

2. Consider the following reaction: $\text{Reactants} \rightleftharpoons \text{X}_{(g)}$

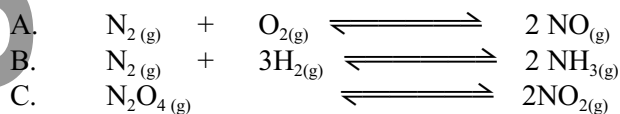
X is a product of a gaseous reaction, which results in a gaseous mixture being formed. The percentage of **X** in the equilibrium mixture at various temperatures and pressures is shown below:

Temperature ($^{\circ}\text{C}$)	Pressure		
	100 kPa	200 kPa	300 kPa
550	0.77	6.70	11.9
650	0.032	3.02	5.71
750	0.016	1.54	2.99
850	0.009	0.87	1.68

Use this data to deduce, giving your reasoning:

- Is the production of **X** endothermic or exothermic?
- Does the production of **X** involve an increase or a decrease in the number of mol of gas present?
- What is (are) the best conditions to obtain the greatest yield of **X**.
- The production of **X** also involves the use of titanium as a catalyst. Explain:
 - why a transition metal catalyst is employed.
 - will the catalyst have any effect on the equilibrium position?
 - why the catalyst used is actually in a finely divided form or a fine wire mesh.

3. Consider each of the following reactions:

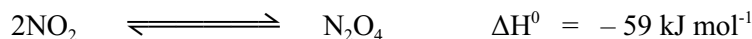


Sketch a graph demonstrating how the percentage yield of the product in each reaction mixture would vary with an increase in pressure for each of the three reactions A, B, and C given above. (I am asking for a sketch of all three graphs on the same axis: percentage product in the reaction mixture vs. pressure)

4. Nitrogen dioxide may be produced by the following method:



- What is the oxidation number of nitrogen in the reactants and the products?
- Balance the equation using oxidation numbers.
- Name the type of reaction observed here.
- Draw the Lewis structure for NO_2
- State and explain what feature of the electronic structure of NO_2 would suggest that NO_2 is likely to form the molecule N_2O_4 according to the following equation:



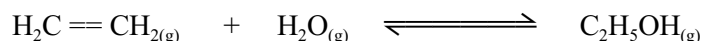
f. N_2O_4 , is a colourless gas, but in its liquid state it was used as one of the fuels on the lunar lander for the NASA Apollo missions. In the gas phase, it decomposes to the red-brown gas NO_2 . State and explain the visible change that takes place as:

- a result of a decrease in pressure
- if an equilibrium mixture of $\text{NO}_2(\text{g})$ and $\text{N}_2\text{O}_4(\text{g})$ is placed in an ice bath.
- if an equilibrium mixture of $\text{NO}_2(\text{g})$ and $\text{N}_2\text{O}_4(\text{g})$ is placed in a hot water bath.

5. Consider the following equilibrium reaction:



- State and explain the effect on the position of equilibrium of:
 - an increase in the temperature at constant pressure
 - an increase in total pressure at constant temperature.
 - Although the reaction is exothermic in the forward direction, there is no appreciable reaction between sulphur dioxide and oxygen at room temperature. Use this reaction to explain the ideas of thermodynamic and kinetic stability.
 - Although the reaction is an equilibrium reaction, industrially this and similar reactions do not achieve equilibrium. Suggest why.
6. Ethanol, $\text{C}_2\text{H}_5\text{OH}$, is made by the direct hydration of ethene at 300°C and 700 atm pressure in the presence of phosphoric (V) acid as catalyst, according to the following equation:



- Explain why the synthesis of ethanol is carried out at:
 - increased pressure, and
 - a high temperature in the presence of a catalyst.
- State and explain the effect of increasing the proportion of steam in the reaction mixture of ethene and steam.