ALL SAINTS' COLLEGE

Science Department

Year 12 Chemistry
2017

Test 2: Equilibrium

Name: _____

Instructions to Students:

1. 50 minutes permitted
2. Attempt all questions
3. Write in the spaces provided
4. Show all working when required
5. All answers to be in blue or black pen, diagrams in pencil.

TOTAL	Final Percentage
/48	

1. Write the equilibrium law expression for the following reactions:

(a) $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

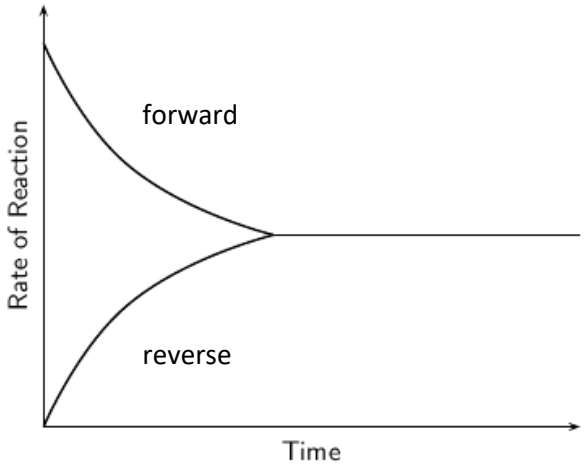
(b) $CaCO_{3(s)} \rightleftharpoons Ca^{2+}_{(aq)} + CO_3^{-2}{}_{(aq)}$

(c) $HBrO_{(aq)} + H^{+}_{(aq)} + Br^{-1}_{(aq)} \rightleftharpoons Br_{2(aq)} + H_2O_{(l)}$

(d) $BiCl_{3(aq)} + H_2O_{(l)} \rightleftharpoons BiOCl_{(s)} + 2H^{+}_{(aq)} + 2Cl^{-1}_{(aq)}$

[4 marks]

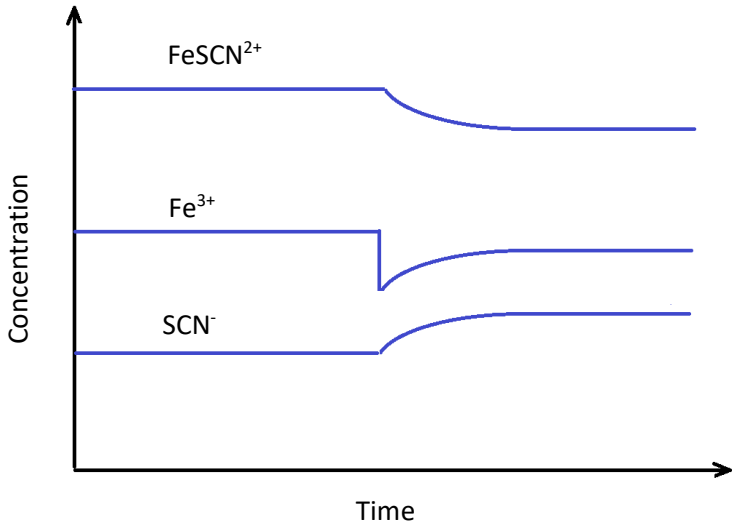
2. The following is the rate vs time graph for the forward and reverse reaction as written:



$Fe^{3+}_{(aq)} + SCN^{-1}_{(aq)} \rightleftharpoons FeSCN^{2+}_{(aq)}$

(a) Explain the changes in the rates of these reactions using collision theory.

[3 marks]



$$Fe^{3+}_{(aq)} + SCN^{-1}_{(aq)} \rightleftharpoons FeSCN^{2+}_{(aq)}$$

(b) The graph above shows the results of adding a few grains of sodium fluoride to the system at equilibrium. The equation for this process is

$$Fe^{3+}_{(aq)} + 2F^{-}_{(aq)} \rightarrow FeF^{2+}_{(aq)}$$

Account for the changes shown in the graph above:

[3 marks]

3. Consider the reaction

$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)} \quad ; \Delta H = -198kJ$$

(a) Give the equilibrium law expression for the reaction.

(b) Predict the effect on the value of K if the following changes were made:

NB: No explanation is required.

(i) Pressure is increased. _____

(ii) Temperature is increased. _____

(iii) Volume is increased. _____

(iv) A catalyst is introduced. _____

[5 marks]

c) On the axis below, draw the pressure v time graph for this equilibrium if the reaction is **cooled**.

[3 marks]

4. State Le Châtelier's Principle.

[1 mark]

5. Consider the following reaction:

$$NaNO_{3(s)} \rightleftharpoons Na^{+}_{(aq)} + NO_3^{-1}{}_{(aq)}$$

Given that the reaction is **endothermic**:

(a) What shift in equilibrium position would Le Chatalier predict if the saturated sodium nitrate solution above is heated.

_____

(b) Explain in terms of reaction rates/collision theory why this shift occurs.

[5 marks]

6. Consider the following system at equilibrium in a closed container:

$$MgSO_{3(s)} \rightleftharpoons MgO_{(s)} + SO_{2(g)}$$

In each of the following cases, predict whether the equilibrium position would shift to the left, right or remain unchanged and explain your answer in terms of Collision Theory.

(a) Pumping in SO_2 gas.

Shift: _____

Reason: _____

_____

_____

_____

_____

_____

(b) Solid magnesium sulphite of negligible volume is added.

Shift: _____

Reason: _____

_____

_____

_____

_____

_____

(c) Volume of the container is reduced.

Shift: _____

Reason: _____

_____

_____

_____

_____

_____

(d) *Water is added.
*(Given that both solids are virtually totally insoluble and that sulphur dioxide ionises).

Shift: _____

Reason: _____

_____

_____

_____

_____

_____

[12 marks]

7. Consider the system: $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$; $\Delta H = -92\ kJ\ mol^{-1}$

(a) AFTER equilibrium has been established, what effect would the following changes have on the ***yield*** of ammonia?

NB: No detailed explanation required.

(i) Decreasing the pressure. _____

(ii) Decreasing the temperature. _____

(iii) Using a catalyst. _____

(b) BEFORE equilibrium is established, what effect would the following changes have on the ***rate of attainment*** of equilibrium?

NB: No detailed explanation required.

(i) Increasing the pressure. _____

(ii) Increasing the temperature. _____

(iii) Removing the catalyst. _____

[6 marks]

8. Natural Caves with stalactites and stalagmites are often found in regions where high concentrations of calcium carbonate (limestone) deposits exist. Once the cave is formed, the formation of stalactites and stalagmites begins.

Consider the following equation:

$$CaCO_{3(s)} + CO_{2(g)} + H_2O_{(l)} \rightleftharpoons Ca^{2+}_{(aq)} + 2HCO_3^{-1}{}_{(aq)}$$

When a drop of percolating ground water containing Ca^{2+} and HCO_3^{-1} ions reaches the ceiling of the cave, it encounters new atmospheric conditions because the partial pressure of the CO_2 in the cave is low. As a result, CO_2 escapes from the solution, the equilibrium shifts towards the left, and that shift results in the deposition of calcium carbonate and stalactite formation occurs. Contrary to common thought, it is not the evaporation of water that is the principal cause of the deposition – the concentration of water vapour in the cave is quite high, and thus most caves are quite damp because of the humidity. The rate of stalactite and stalagmite formation is typically 0.2 mm/y.

(a) The length of certain stalactite is 6.0m. Assuming the average time for growth, calculate the time required for its formation.

_____

(b) Write the equilibrium expression for the formation of the stalactite as a product.

(c) Determine whether the formation of stalactites and stalagmites is favoured in each of the following cases:

NB: No explanation required, just “favoured” or “not favoured”.

(i) The pressure of CO_2 in the cave increases. _____

(ii) The hardness ($[Ca^{2+}]$) of the ground water increases. _____

(iii) The temperature in the cave increases. _____

(iv) The relative humidity of the cave decreases. _____

[6 marks]