**YEAR 12 CHEMISTRY - ATCHE**

**SENSORIMOTOR TEST**

**EQUILIBRIUM**

**Recommended time: 50 minutes**

**Total marks**

**/27**

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Teacher: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The purpose of this experiment is to find out how a system in equilibrium responds to a change in concentration of components in the mixture.

Introduction:

Iron (III) ions and thiocyanate ions react in solution to produce thiocyanatoiron (III), a complex ion, according to the equation:

**Fe3+(aq)  + SCN-(aq) ⇄Fe(SCN)2+(aq)**

pale yellow colourless blood-red

The colour produced by the complex ion can indicate the position of equilibrium.

Requirements:

safety glasses 4 test tubes and rack

distilled water bottle 4 x sticky labels

glass stirring rod spatula

ammonium chloride (NH4Cl) 50 mL measuring cylinder

iron (III) chloride solution (0.5 molL-1 FeCl3) potassium thiocyanate solution (0.5molL-1 KSCN)

Procedure: READ AND CARRY OUT THE FOLLOWING PROCEDURES WITH GREAT CARE

1. Mix together one drop of 0.5 molL-1 iron(III) chloride solution and one drop of 0.5 molL-1 potassium thiocyanate solution in a test tube and add 15 mL of distilled water. **Record your observations** in the Table of Results overleaf.

2. Divide this solution into four equal parts in four test tubes. Label these from 1 to 4.

3. Add one drop of 0.5 molL-1 iron (III) chloride to test tube 1 and shake well.

4. Add one drop of 0.5 molL-1 potassium thiocyanate to test tube 2 and shake well.

5. Add a spatula full of solid ammonium chloride to test tube 3 and shake well.

6. Compare the colours of these solutions with the untouched sample in test tube 4. **Enter your observations and inferences** in the Table of Results overleaf.

Note: At room temperature, ammonium chloride dissociates fully in water according to the equation below:

**NH4Cl(S) → NH4+(aq) + Cl-(aq)**

The chloride ions react with iron (III) ions in the equilibrium mixture to form the FeCl4- complex ion:

**Fe3+ (aq) + 4 Cl-(aq) → FeCl4-(aq)**

Interpretation of results:

Having made the above observations, complete the table below and then state what can be inferred about the shift in the position of the equilibrium.

Table of Results:

|  |  |
| --- | --- |
| Colour of original sample from procedure step 1. |  |

[1 mark]

|  |  |  |
| --- | --- | --- |
| **CHANGE** | **OBSERVATION**  (is the new colour **darker**/**lighter/unchanged** when compared to the original colour in test tube 4) | **INFERENCE**  (use **arrows** to show the direction of equilibrium shift, either → or ←) |
| Tube 1 – adding FeCl3 |  |  |
| Tube 2 – adding KSCN |  |  |
| Tube 3 – adding NH4Cl |  |  |

[6 marks]

Complete the concentration vs time graph below showing the variation in concentration of the species Fe3+, SCN- and Fe(SCN)2+ when the **Fe3+ is added**.

**Concentration**

**of ions**

Fe3+

SCN-

Fe(SCN)2+

Time

point at which Fe3+ is added point at which equilibrium is re-established [4 marks]

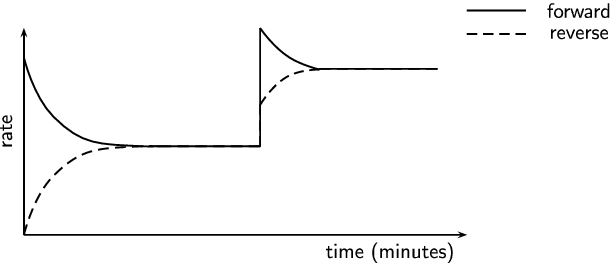
**QUESTIONS**

1. Would the addition of sodium chloride (NaCl) instead of ammonium chloride to test tube 3 have the same effect as observed? Justify with reference to **Le Chatelier’s principle**. [2 marks]

2. For the imposed change to test tube 1 (i.e. adding FeCl3) account for the change in colour using **collision theory and rates of reaction**. [5 marks]

3. Below is a rate graph obtained by a student for the equilibrium reaction **Fe(SCN)2+(aq) ⇄ Fe3+(aq)  + SCN-(aq)**

The forward reaction is known to be endothermic.



5

(a) State one (1) possible reason for the change observed at the 5-minute mark. [1 mark]

(b) With reference to the graph and c**ollision theory and rates of reaction,** explain your answer to part (a) above. [2 marks]

4. Consider a saturated solution of barium hydroxide in contact with solid barium hydroxide:

**Ba(OH)2 (S) ⇄ Ba2+(aq) + 2OH-(aq)**

Note that the forward reaction is **ENDOTHERMIC**.

In each of the following cases, predict whether the equilibrium position would shift to the forward direction (F), shift to the reverse direction (R) or remain unchanged (U).

|  |  |
| --- | --- |
| **CHANGE** | **WRITE ‘F’, ‘R’ or ‘U’** |
| (a) Dilute nitric acid is added |  |
| (b) Solid barium hydroxide is added |  |
| (c) A little water is added |  |
| (d) The temperature of the solution is decreased to a new constant value |  |

[2 marks]

5. Consider the following equilibrium:



Equal samples of the mixture were heated to two temperatures. The intensity of the pink colour of the Co2+ product was recorded every 30 seconds, the higher the intensity of the pink colour, the higher the absorbance. The results are shown in the graph:

Diagram

Description automatically generated

By referring to the graph, determine if the forward reaction is exothermic or endothermic.

[4 marks]

**THINGS TO DO AFTER YOU HAVE COMPLETED THE TEST**

**Checklist -**

|  |  |  |
| --- | --- | --- |
| 1 | Bring the test tube rack with all test tubes to the front desk.  Note: You do NOT need to wash them. |  |
| 2 | Dispose test tube content into the waste beaker provided. |  |
| 3 | Put all dirty test tubes in the **bucket** provided. |  |
| 4 | Replace dirty tubes with new ones and take the rack (with new tubes) back to your table. |  |
| 5 | Obtain new labels and place them on your table. Put waste paper/label-backing in the bin. |  |
| 6 | Top up your distilled water bottle. |  |
| 7 | Dry your table with paper towel. |  |
| 8 | If you have contaminated and/or damaged equipment then please see your teacher for replacements. |  |
| 9 | Arrange the equipment at your work station to its original state (i.e. neat and tidy) |  |
| 10 | Hand your work in. |  |

