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| Description: Vertical full colour positive | Safety Bay Senior High School | | | | |
| **CHEMISTRY UNIT 3 & 4** | | | | | |
| **Practical #1:** | | | | | |
| **Changes to Systems at Equilibrium** | | | | | |
|  | | | | | |
| **NAME:** | | |  | | |
|  | | |  | | |
| **Time allowed for this practical** | | | | | |
| Reading time: | | 5 minutes | | | |
| Working time: | | 55 minutes | | | |
|  | | | | | |
| **Structure of this paper:** | | | | | |
| Number of questions | | | | Marks available | Marks achieved |
| 3 | | | | 45 | \_\_\_\_\_\_ / 45 |

**Instructions**

***Laptops***

Parts of this test will involve watching videos of experiments and making observations from these videos. There will be instructions in the test when this is necessary (e.g. "Watch video 2A"). The videos do not have any sound.

To access the videos you will need to log into a laptop. The three video files are on USB. Copy and paste the videos to the desktop, and then pass on the USB to someone else.

You are allowed to set up the laptop and watch the videos during the initial 5 minutes reading time.

***Heating of Co(H2O)62+ / CoCℓ42- mixture***

Questions 2d-2f require you to heat a solution that is at equilibrium. Perform all experiments at the lab benches. DO NOT bring the liquids back to your desk.

At the end of the lesson the mixture will be collected. Rinse the test tubes and return all equipment to its original location.

**Reaction System #1 (10 marks)**

Consider the following reaction: C(g) + Y(g) ⇆ 3B(g) + heat

C is a colourless gas, Y is a bright yellow gas, B is a bright blue gas.

The system is initially at equilibrium and has a green colour (a mixture of yellow and blue).

The gas was separated into five containers and a change was applied to each container.

For each change:

* Describe the direction of shift in equilibrium after the change is imposed
* State how the colour of the gas mixture would change after the initial change and while the system re-establishes equilibrium. You may use terms like “more blue” or “more yellow” in your answer.

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| --- | --- | --- |
| **Imposed change** | **Direction of shift**  **(‘left’, ‘right’, or ‘no change’)** | **Changes in gas colour** |
| Removing a large quantity of C without changing the volume of the container |  |  |
| Heating the system |  |  |
| Decreasing the volume in the system |  |  |
| Adding another substance that reacts with Y to produce a yellow solid. |  |  |
| Adding a catalyst |  |  |

**Reaction System #2 (20 marks)**

The pink aqueous ion hexaaquacobalt(II), Co(H2O)62+, exists in dynamic chemical equilibrium with the tetrachlorocobalt(II) ion. The chemical equation for this reaction is shown below:

Co(H2O)62+ (aq) + 4 Cℓ- (aq) ⇌ CoCℓ42- (aq) + 6 H2O (ℓ)

pink blue

1. Write an equilibrium constant expression for this reaction. (1 mark)

**Watch Video 2A: Effect of HCℓ**

1. Describe the effect of adding concentrated hydrochloric acid to this system. Explain the reasons for this effect in terms of collision theory. (4 marks)

1. Sketch a graph which shows the effect of adding concentrated HCℓ to this system. (5 marks)

|

HCℓ added

Concentration

Time

Co(H2O)62+

Cℓ-

CoCℓ42-

|

Equilibrium established

You have been provided with samples of a mixture of Co(H2O)62+ and CoCℓ42-. The colour of the solution is due to a mixture of the pink and blue species in the reaction.

Co(H2O)62+ (aq) + 4 Cℓ- (aq) ⇌ CoCℓ42- (aq) + 6 H2O (ℓ)

pink blue

By heating the solution and observing any colour changes, it is possible to determine whether the forwards reaction is exothermic or endothermic. Heating of the solution can be achieved by submerging the test tube in a beaker of hot water from the kettle.  **Heat the mixture and then use your observations to answer questions (d) to (f).**

1. Is the forwards reaction endothermic or exothermic? Justify your answer using your observations and by applying Le Chatelier’s principle. (3 marks)

1. Describe the effect of heating the solution on the initial rate of the forwards and reverse reactions. (2 marks)

1. Draw an energy profile diagram for the reversible reaction between Co(H2O)62+ and CoCℓ42-, showing the reactants, products, Ea and ∆H. Include appropriate labels of each axis. (5 marks)

**Reaction System #3 (15 marks)**

Nitrogen dioxide (a brown gas) exists in dynamic chemical equilibrium with dinitrogen tetroxide (a colourless gas).

1. Write a chemical equation to represent the reaction between these two substances.

(2 marks)

1. Write an equilibrium expression which matches the equation given in part (a).

(1 mark)

**Watch Video 3A & 3B: Effect of Pressure**

**Both videos show the same change for the same reaction but have different lighting   
conditions and quality. Watch both to ensure you have made the correct observations.**

1. Describe the visible changes that occur when the syringe is quickly pulled outwards, increasing the volume in the syringe. (No explanation is required for part (a).) (2 marks)

1. Account for the colour changes you described in part (c). (3 marks)

1. Sketch a rough graph which shows the effect of increasing the volume of the syringe on both the forwards and reverse reaction rates for this reaction. Assume the system is initially at equilibrium.

*Note: Your definitions of “forwards” and “reverse” should match the equation you gave in part (a).* (5 marks)

Reaction rate

Time

|

Volume is increased

|

Equilibrium re-established

1. Decreasing the volume of a container is one way of increasing the pressure of a system. Another method of increasing pressure is to introduce more moles of gas without changing the volume of the container.

Predict how the addition of carbon dioxide would affect this system, assuming that it is initially at equilibrium. Provide a reason for your prediction. (2 marks)

**END OF TEST**

**SPARE GRAPHS**

**Question 2c)**

|

HCℓ added

Concentration

Time

Co(H2O)62+

Cℓ-

CoCℓ42-

|

Equilibrium established

**Question 2f)**

**Question 3e)**

Reaction rate

Time

|

Volume is increased

|

Equilibrium re-established