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AQA GCSE Chemistry Answer Sheet – Reversible Reactions and Dynamic Equilibrium

Model Answers and Mark Schemes | Total Marks: 30

Quick Check

Question 1 (1 mark)

> *1. (1 mark) What is the symbol used to represent a reversible reaction?*

MODEL ANSWER

⇌

MARK SCHEME

- ✓ ⇌ [1 mark]

Question 2 (2 marks)

> *2. (2 marks) Define the term 'dynamic equilibrium'.*

MODEL ANSWER

Dynamic equilibrium occurs in a closed system when the rates of the forward and reverse reactions are equal, so the concentrations of reactants and products remain constant.

MARK SCHEME

- ✓ Rates of forward and reverse reactions are equal [1 mark]
- ✓ Concentrations of reactants and products remain constant / closed system [1 mark]

Question 3 (2 marks)

> *3. (2 marks) Hydrated copper(II) sulfate is heated. State the colour change that occurs and whether the reaction is exothermic or endothermic.*

MODEL ANSWER

The colour changes from blue to white. The reaction is endothermic.

MARK SCHEME

- ✓ Blue to white [1 mark]
- ✓ Endothermic [1 mark]

Apply Your Knowledge

Question 4 (2 marks)

> *4. (2 marks) State Le Chatelier's Principle.*

MODEL ANSWER

If a system is at equilibrium and a change is made to any of the conditions, the system responds to counteract the change.

MARK SCHEME

- ✓ If a change is made to conditions of a system at equilibrium [1 mark]
- ✓ The system responds to counteract the change [1 mark]

Question 5 (2 marks)

> *5. (2 marks) Consider the reaction: $A + B \rightleftharpoons C + D$. If the concentration of A is increased, what will happen to the equilibrium position? Explain your answer.*

MODEL ANSWER

The equilibrium position will shift to the right (towards the products). This is because the system will try to counteract the change by using up the extra A added.

MARK SCHEME

- ✓ Equilibrium shifts to the right / towards products [1 mark]
- ✓ To counteract the change / use up the added A [1 mark]

Question 6 (3 marks)

6. (3 marks) Nitrogen reacts with hydrogen to form ammonia: N₂(g) + 3H₂(g) ⇌ 2NH₃(g). The forward reaction is exothermic. Explain the effect on the equilibrium yield of ammonia if the temperature is decreased.

MODEL ANSWER

The equilibrium yield of ammonia will increase. A decrease in temperature causes the equilibrium to shift in the exothermic direction to counteract the change and produce heat. Since the forward reaction is exothermic, more ammonia is produced.

MARK SCHEME

- ✓ Yield of ammonia increases [1 mark]
- ✓ Equilibrium shifts in the exothermic direction (to the right) [1 mark]
- ✓ To counteract the change / increase the temperature [1 mark]

Question 7 (3 marks)

7. (3 marks) For the same reaction (N₂(g) + 3H₂(g) ⇌ 2NH₃(g)), explain the effect on the equilibrium yield of ammonia if the pressure is increased.

MODEL ANSWER

The equilibrium yield of ammonia will increase. An increase in pressure causes the equilibrium to shift to the side with fewer gas molecules to counteract the change. There are 4 molecules of gas on the left and 2 molecules on the right, so the equilibrium shifts to the right.

MARK SCHEME

- ✓ Yield of ammonia increases [1 mark]
- ✓ Equilibrium shifts to the side with fewer gas molecules (to the right) [1 mark]
- ✓ Because there are 4 molecules on the left and 2 on the right / to reduce the pressure [1 mark]

Question 8 (2 marks)

8. (2 marks) Hydrogen reacts with iodine to form hydrogen iodide: H₂(g) + I₂(g) ⇌ 2HI(g). Explain why changing the pressure has no effect on the equilibrium yield of hydrogen iodide.

MODEL ANSWER

Changing the pressure has no effect because there are the same number of gas molecules on both sides of the equation (2 molecules on the left and 2 on the right).

MARK SCHEME

- ✓ Same number of gas molecules on both sides [1 mark]
- ✓ (2 molecules on left and 2 on right) so pressure change does not favour either side [1 mark]

Extended Practice

Question 9 (6 marks)

9. (6 marks) Methanol is produced industrially by the reaction of carbon monoxide with hydrogen: CO(g) + 2H₂(g) ⇌ CH₃OH(g). The forward reaction is exothermic. Predict the conditions of temperature and pressure that would give the maximum equilibrium yield of methanol. Explain your choices.

MODEL ANSWER

To get the maximum equilibrium yield of methanol, a low temperature and a high pressure should be used. Temperature: The forward reaction is exothermic. According to Le Chatelier's Principle, decreasing the temperature will cause the equilibrium to shift in the exothermic direction (to the right) to counteract the change and produce heat. Therefore, a low temperature increases the yield of methanol. Pressure: There are 3 molecules of gas on the left side (1 CO + 2 H2) and 1 molecule of gas on the right side. According to Le Chatelier's Principle, increasing the pressure will cause the equilibrium to shift to the side with fewer gas molecules to counteract the change and reduce the pressure. Therefore, a high pressure increases the yield of methanol.

MARK SCHEME

- ✓ Low temperature [1 mark]
- ✓ Because forward reaction is exothermic, so low temp shifts equilibrium to the right [1 mark]
- ✓ To counteract the change / produce heat [1 mark]
- ✓ High pressure [1 mark]
- ✓ Because there are fewer gas molecules on the right (3 on left, 1 on right) [1 mark]
- ✓ So high pressure shifts equilibrium to the right to reduce pressure [1 mark]

Question 10 (4 marks)

10. (4 marks) A student investigates the equilibrium between two different coloured cobalt compounds: [Co(H₂O)₆]²⁺ (pink) + 4Cl⁻ ⇌ [CoCl₄]²⁻ (blue) + 6H₂O. The forward reaction is endothermic. Describe and explain what you would observe if a test tube containing the equilibrium mixture is placed in a beaker of hot water.

MODEL ANSWER

The mixture would turn more blue (or turn from pink to blue). Placing the test tube in hot water increases the temperature. According to Le Chatelier's Principle, the system will respond to counteract the change by favouring the endothermic reaction to absorb heat. Since the forward reaction is endothermic, the equilibrium shifts to the right, producing more of the blue [CoCl4]2- complex.

MARK SCHEME

- ✓ Mixture turns more blue / turns from pink to blue [1 mark]
- ✓ Increasing temperature favours the endothermic reaction [1 mark]
- ✓ To counteract the change / absorb heat [1 mark]
- ✓ Equilibrium shifts to the right, producing more blue product [1 mark]

Question 11 (3 marks)

11. (3 marks) In the industrial production of sulfuric acid, one step is the reversible reaction: 2SO₂(g) + O₂(g) ⇌ 2SO₃(g). The forward reaction is exothermic. The reaction is carried out at a pressure of 1-2 atmospheres and a temperature of 450°C. Evaluate these conditions in terms of equilibrium yield and reaction rate.

MODEL ANSWER

A low temperature would give a higher equilibrium yield because the forward reaction is exothermic, but 450°C is a compromise temperature that is high enough to give a reasonable rate of reaction without reducing the yield too much. A high pressure would give a higher yield (3 molecules to 2), but a low pressure of 1-2 atm is used because the yield is already very high at this pressure, so the cost of building high-pressure equipment is not justified.

MARK SCHEME

- ✓ 450°C is a compromise temperature: gives reasonable rate but lowers yield (as forward reaction is exothermic) [1 mark]
- ✓ High pressure would increase yield (3 molecules to 2) [1 mark]
- ✓ Low pressure (1-2 atm) used because yield is already high enough / saves cost of high-pressure equipment [1 mark]