**Rate and equilibrium topic test solutions**

**SECTION A: Multiple-choice questions (1 mark each)**

**Question 1**

*Answer:* C

*Explanation:*

 Catalysts increase the rate of both forward and reverse reactions equally. They do not change the position of equilibrium but they do increase the rate of the reactions.

**Question 2**

*Answer:* A

*Explanation:*

Hydrochloric acid is colourless so there will not be any colour change.

**Question 3**

*Answer:* B

*Explanation:*

From the masses used, it would have been expected that the time required to produce a gas sample in experiment 3 would be lower. A possible explanation is that the particle size of the calcium carbonate in experiment 3 was larger, lowering the surface area hence the rate.

**Question 4**

*Answer:* A

*Explanation:*

The reaction is 4NH3(g) + 5O2(g) ⇄4NO(g) + 6H2O(g)

As the products will be on the numerator and the coefficients in the equation will provide the indices.

**Question 5**

*Answer:* B

*Explanation:*

 If the concentration fraction is calculated it is 2.5. This is lower than the value of *K*. The reaction has to move forward to increase the amounts of products.

**Question 6**

*Answer:* D

*Explanation:*

 Options A, B and C are wrong because they do not take into account that the reaction is reversible. However, it is correct that the amount of SO3 formed will equal the amount of SO2 reacting as they have the same coefficient in the balanced equation.

**Question 7**

*Answer:* A

*Explanation:*

 Units can be determined from the equilibrium expression  = M-1

**Question 8**

*Answer:* B

*Explanation:*

 The reaction has been reversed and halved. Therefore the value of *K* will be  = 0.172

**Question 9**

*Answer:* C

*Explanation:*

 The key to this question is the very low value of *K*. For *K* to be very low, the amounts of products has to be much lower than the amounts of reactants.

**Question 10**

*Answer:* C

*Explanation:*

 Catalysts increase the rate of both forward and reverse reactions equally. They do not change the position of equilibrium but they do increase the rate of the reactions.

**SECTION B: Short-answer questions**

**Question 1** (8 marks)

**a**. **i**. The time for the solution to clear drops as the temperature increases. This indicates the reaction rate is

 increasing with temperature. 2 marks

 **ii**. As the temperature increases many of the particles gain in energy and move faster. This leads to more

 collisions and a higher percentage of successful collisions. 2 marks

**b**. **i**. the independent variable : temperature 2 marks

 **ii**. the dependent variable : time to go colourless

**c**. The CuSO4 acts as a catalyst for this reaction. It increases the reaction rate by providing an alternative

 pathway with a lower activation energy. 2 marks

**Question 2** ( 7 marks)

**a**. CO(g) + Cl2(g) ⇌ COCl2 1 mark

**b**. **i**. *K* =  = 5 M-1 3 marks

 **ii**. No change as the temperature has not changed 1 mark

**c**. At the 10 min mark more COCl2 was injected into an equilibrium mixture. The system opposes this by

 favouring the back reaction.

 2 marks

**Question 3** (8 marks)

**a**. **i.** (0.032)2 = 0.00102

  **ii**.  = 5.59

1 + 1 = 2 marks

**b**. concentration factor =  = 2 The system needs to move backwards to achieve

 equilibrium

2 marks

**c**.  **i**. No, in a reversible reaction, all reactant will not be used up.

 **ii**. amount of Br2 is 0.10 mol, as the mole ratio is 2:1

1 + 1 = 2 marks

**d**. No, despite the mole imbalance, it is a reversible reaction and some reactant will remain.

 1 + 1 = 2 marks

**Question 3** (8 marks)

**a**. **i.** (0.032)2 = 0.00102

  **ii**.  = 5.59

1 + 1 = 2 marks

**b**. concentration factor =  = 2 The system needs to move backwards to achieve

 equilibrium

2 marks

**c**.  **i**. No, in a reversible reaction, all reactant will not be used up.

 **ii**. amount of Br2 is 0.10 mol, as the mole ratio is 2:1

1 + 1 = 2 marks

**d**. No, despite the mole imbalance, it is a reversible reaction and some reactant will remain.

 1 + 1 = 2 marks

**Question 4** (9 marks)

**a**. [NO] =  = 0.18 M [Cl2] = =0.14 M [NOCl] =  = 0.16 M

 *K* =  = 5.64 M-1 4 marks

**b. i**.

  = 5.64 \*

 x2 =  =0.14 \* => x = 0.37 M\*

 **ii**. *n* = *c* × *V* = 0.37 × 20 = 7.49 mol

3 + 1 = 4 marks

**c**. 1/5.64 = 0.177 M 1 mark

**Question 5** (8 marks)

**a**.

 *rate*

  *time*  1 mark

**b**.

 *concentration*

 *Time* 1 mark

**c**. *K* is relatively high as the amount of product is higher than the amount of reactant.

1 mark

**d. i**. *K* = 

 **ii**. *K* = 

1 + 1 = 2 marks

**e. i**. The amount of N2O4 reacting is 1-x. The amount of NO2 = 2(1-x)

 **ii**. *K* =  = 4(1-x)

1. + 2 = 3 marks