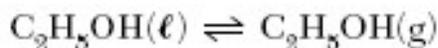


Rate of Reaction & Equilibrium – Cut from Jan 2007 – Jan 2008 Exams

1. Given the equation representing a phase change at equilibrium:



Which statement is true?

- (1) The forward process proceeds faster than the reverse process.
- (2) The reverse process proceeds faster than the forward process.
- (3) The forward and reverse processes proceed at the same rate.
- (4) The forward and reverse processes both stop.

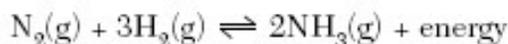
2. A 5.0-gram sample of zinc and a 50.-milliliter sample of hydrochloric acid are used in a chemical reaction. Which combination of these samples has the fastest reaction rate? (1) a zinc strip and 1.0 M HCl(aq)

- (2) a zinc strip and 3.0 M HCl(aq)
- (3) zinc powder and 1.0 M HCl(aq)
- (4) zinc powder and 3.0 M HCl(aq)

3. For a given reaction, adding a catalyst increases the rate of the reaction by

- (1) providing an alternate reaction pathway that has a higher activation energy
- (2) providing an alternate reaction pathway that has a lower activation energy
- (3) using the same reaction pathway and increasing the activation energy
- (4) using the same reaction pathway and decreasing the activation energy

4. Given the equation representing a reaction at equilibrium:



Which change causes the equilibrium to shift to the right?

- (1) decreasing the concentration of $\text{H}_2(\text{g})$

- (2) decreasing the pressure
- (3) increasing the concentration of $\text{N}_2(\text{g})$
- (4) increasing the temperature

5. Given the equation representing a system at equilibrium:



At which temperature does this equilibrium exist at 101.3 kilopascals?

- (1) 0 K
- (2) 0°C
- (3) 32 K
- (4) 273°C

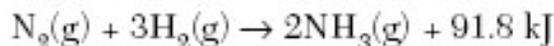
6. Which statement must be true when solution equilibrium occurs?

- (1) The solution is at STP.
- (2) The solution is supersaturated.
- (3) The concentration of the solution remains constant.
- (4) The masses of the dissolved solute and the undissolved solute are equal.

7. Which statement must be true for any chemical reaction at equilibrium?

- (1) The concentration of the products is greater than the concentration of the reactants.
- (2) The concentration of the products is less than the concentration of the reactants.
- (3) The concentration of the products and the concentration of the reactants are equal.
- (4) The concentration of the products and the concentration of the reactants are constant.

8. Given the balanced equation representing a reaction at 101.3 kPa and 298 K:



Which statement is true about this reaction?

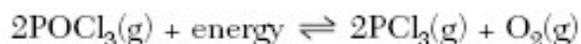
- (1) It is exothermic and ΔH equals -91.8 kJ .

- (2) It is exothermic and ΔH equals +91.8 kJ.
- (3) It is endothermic and ΔH equals -91.8 kJ.
- (4) It is endothermic and ΔH equals +91.8 kJ.

9. Which balanced equation represents a phase

- equilibrium?
- (1) $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$
 - (2) $2\text{NO}_2(\text{g}) \rightleftharpoons \text{N}_2\text{O}_4(\text{g})$
 - (3) $\text{Cl}_2(\text{g}) \rightleftharpoons \text{Cl}_2(\ell)$
 - (4) $3\text{O}_2(\text{g}) \rightleftharpoons 2\text{O}_3(\text{g})$

10. Given the system at equilibrium:



Which changes occur when $\text{O}_2(\text{g})$ is added to this system?

- (1) The equilibrium shifts to the right and the concentration of $\text{PCl}_3(\text{g})$ increases.
- (2) The equilibrium shifts to the right and the concentration of $\text{PCl}_3(\text{g})$ decreases.
- (3) The equilibrium shifts to the left and the concentration of $\text{PCl}_3(\text{g})$ increases.
- (4) The equilibrium shifts to the left and the concentration of $\text{PCl}_3(\text{g})$ decreases.

11. In terms of energy and entropy, systems in nature tend to undergo changes toward (1) higher energy and higher entropy

- (2) higher energy and lower entropy
- (3) lower energy and higher entropy
- (4) lower energy and lower entropy

12. Explain, in terms of collision theory, why the rate of a chemical reaction increases with an increase in temperature. [1]

Base your answers to questions 13 through 15 on the information below.

A beaker contains 100.0 milliliters of a dilute aqueous solution of ethanoic acid at equilibrium. The equation below represents this system.



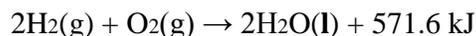
13. Compare the rate of the forward reaction to the rate of the reverse reaction for this system. [1]
14. Describe what happens to the concentration of $\text{H}^+(\text{aq})$ when 10 drops of concentrated $\text{HC}_2\text{H}_3\text{O}_2(\text{aq})$ are added to this system. [1]
15. Draw a structural formula for ethanoic acid. [1]

Base your answer to question 16 on the information below.

“Hand Blasters” is a toy that consists of a set of two ceramic balls, each coated with a mixture of sulfur and potassium chlorate, KClO_3 . When the two balls are struck together, a loud popping noise is produced as sulfur and potassium chlorate react with each other.

16. Identify *one* source of the activation energy for this reaction. [1]

Base your answers to questions 17 through 18 on the reaction represented by the balanced equation below.



One isomer of octane is 2,2,4-trimethylpentane.

20. In the space *in your answer booklet*, draw a structural formula for 2,2,4-trimethylpentane. [1]

21. Explain, in terms of the arrangement of particles, why the entropy of gasoline vapor is greater than the entropy of liquid gasoline. [1]