

Name _____

Topic 6 Review - Kinetics and Equilibrium

_____ 1. In a chemical reaction, the difference between the potential energy of the products and the potential energy of the reactants is the

- 1) free energy
- 2) heat of reaction
- 3) activation energy
- 4) heat of fusion

_____ 2. For a chemical reaction, ΔH is equal to

- 1) $H_{\text{products}} \times H_{\text{reactants}}$
- 2) $H_{\text{products}} / H_{\text{reactants}}$
- 3) $H_{\text{products}} - H_{\text{reactants}}$
- 4) $H_{\text{products}} + H_{\text{reactants}}$

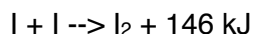
_____ 3. Which of the following statements describes characteristics of an endothermic reaction?

- 1) The sign of ΔH is positive, and the products have more potential energy than the reactants
- 2) The sign of ΔH is positive, and the products have less potential energy than the reactants
- 3) The sign of ΔH is negative and the products have less potential energy than the reactants
- 4) The sign of ΔH is negative and the products have more potential energy than the reactants

_____ 4. When NH_4NO_3 is dissolved in water, the temperature of the water decreases. When NaOH is dissolved in a separate sample, the temperature of the water increases. Based on these observations, it can be concluded that the dissolving of

- 1) both salts are exothermic
- 2) NH_4NO_3 is endothermic and the dissolving of NaOH is exothermic
- 3) both salts is endothermic
- 4) NH_4NO_3 is exothermic and the dissolving of NaOH is endothermic

_____ 5. Given the equation:



This equation shows that the formation of an iodine molecule is an

- 1) endothermic process in which energy is released
- 2) exothermic process in which energy is absorbed
- 3) endothermic process in which energy is absorbed
- 4) exothermic process in which energy is released

_____ 6. Based on Table I in your Chemistry Reference Table, the most energy that would be released when oxygen reacts completely with 1.0 mole of

- 1) CH_4
- 2) CH_3OH
- 3) $\text{C}_6\text{H}_{12}\text{O}_6$
- 4) CO

_____ 7. As a chemical bond forms between two hydrogen atoms, the potential energy

- 1) increases
- 2) decreases
- 3) remains the same

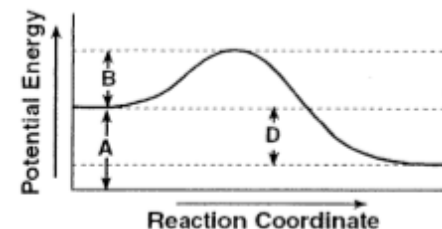
_____ 8. According to Reference Table I in the Chemistry Reference Table, the dissolving of which salt is accompanied by the release of energy?

- 1) NH_4Cl
- 2) LiBr
- 3) KNO_3
- 4) NaCl

_____ 9. Activation energy is required to initiate

- 1) both exothermic and endothermic reactions
- 2) exothermic reactions, only
- 3) endothermic reactions, only
- 4) neither exothermic nor endothermic reactions

_____ 10. The graph below is a potential energy diagram of a compound which is formed from its elements.

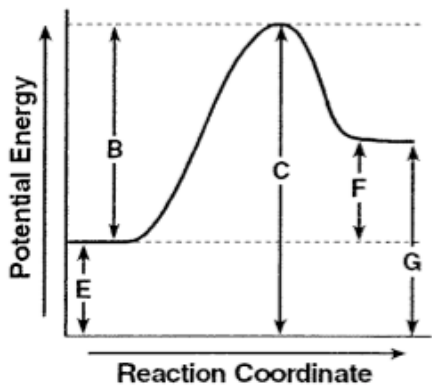


_____ 11. In order for a chemical reaction to occur, there must *always* be

- 1) an effective collision between reacting particles
- 2) reacting particles with a high kinetic energy
- 3) a bond that breaks in a reactant particle
- 4) reacting particles with a high charge

Questions 12 and 13 refer to the following:

The diagram below represents a potential energy diagram of a chemical reaction.

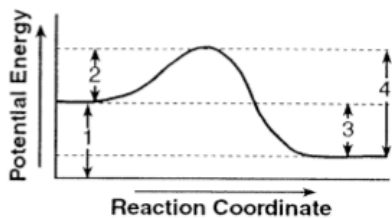


12. What interval represents the heat of reaction (ΔH)?

- 1) F 2) G 3) C 4) E

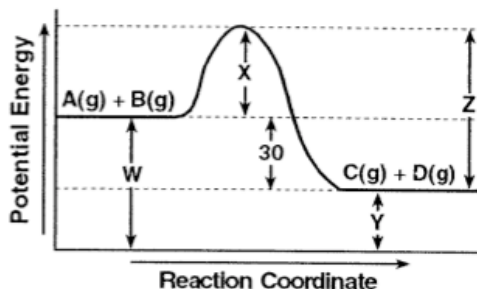
13. Interval B represents the

- 1) activated complex
2) potential energy of the reactants
3) activation energy
4) potential energy of the products



14. The activation energy for the reverse reaction is represented by

- 1) 1 2) 2 3) 3 4) 4



15. The potential energy of the activated complex is equal to the sum of

- 1) $X + W$ 2) $X + W + Z$
3) $X + Y + W$ 4) $X + Y$

16. As the number of effective collision between the reactant particles in a chemical reaction decreases, the rate of reaction

- 1) increases 2) decreases
3) remains the same

17. Two reactant particles collide with proper orientation. The collision will be effective if the particle have

- 1) sufficient potential energy
2) sufficient kinetic energy
3) high ionization energy
4) high activation energy

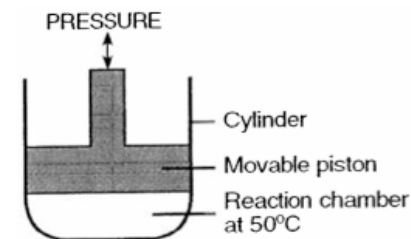
18. Which condition will increase the rate of a chemical reaction?

- 1) increased temperature and increased concentration of reactants
2) decreased temperature and increased concentration of reactants
3) increased temperature and decreased concentration of reactants
4) decreased temperature and decreased concentration of reactants

19. Given the reaction at equilibrium:
 $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$
Increasing the concentration of $N_{2(g)}$ will increase the forward reaction rate due to

- 1) an increase in the activation energy
2) a decrease in the number of effective collisions
3) an increase in the number of effective collisions
4) a decrease in the activation energy

20. The reaction $A_{(g)} + B_{(g)} \rightleftharpoons C_{(g)}$ is occurring in the apparatus shown below



The rate of reaction can be decreased by increasing the

- 1) volume of the reaction chamber
2) concentration of the reactant $A_{(g)}$
3) pressure on the reactants
4) temperature of the reactants

21. In a gaseous system, temperature remaining constant, an increasing pressure will

- 1) decrease the activation energy
2) increase the activation energy
3) decrease the reaction rate
4) increase the reaction rate

22. Given the reaction at equilibrium:
 $2\text{CO}_{(g)} + \text{O}_{2(g)} \rightarrow 2\text{CO}_{2(g)} + 566.0 \text{ kJ}$
 As the temperature increases, the rate of the forward reaction

- 1) decreases
- 2) increases
- 3) remains the same

23. Which of the following will occur if a catalyst is added to a reaction mixture?

- 1) Only the rate of reverse reaction will be increased
- 2) The energy change (ΔH) of the reaction will be decreased
- 3) The activation energy will be changed
- 4) Only the rate of the forward reaction will be increased

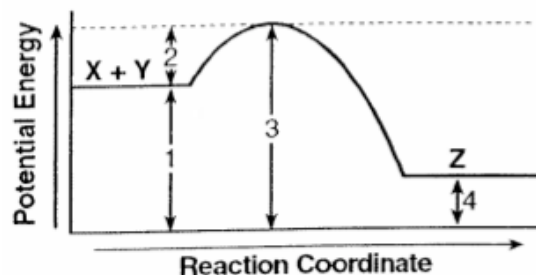
24. What change would most likely increase the rate of a chemical reaction?

- 1) decreasing a reactant's concentration
- 2) decreasing a reactant's surface area
- 3) cooling the reaction mixture
- 4) adding a positive catalyst to the reaction mixture

25. The addition of a catalyst to a system at equilibrium will increase the rate of

- 1) the forward reaction, only
- 2) neither the forward nor the reverse reaction
- 3) the reverse reaction, only
- 4) both the forward and the reverse reaction

26. The potential energy diagram below shows the reaction $X + Y \leftrightarrow Z$



When a catalyst is added to the reaction, it will change the value of

- 1) 2 and 3
- 2) 3 and 4
- 3) 1 and 3
- 4) 1 and 2

27. Which series of physical change represents an entropy increase during each change?

- 1) solid \rightarrow liquid \rightarrow gas
- 2) solid \rightarrow gas \rightarrow liquid
- 3) gas \rightarrow liquid \rightarrow solid
- 4) liquid \rightarrow gas \rightarrow solid

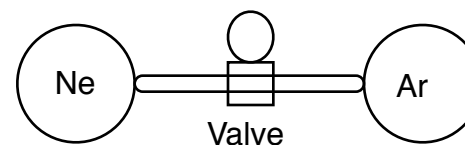
28. A 1-gram sample of a substance has the *greatest* entropy when it is in the

- 1) solid state
- 2) gaseous state
- 3) liquid state
- 4) crystalline state

29. Which reaction results in an increase in entropy?

- 1) $2\text{CO}_{(g)} + \text{O}_{2(g)} \rightarrow 2\text{CO}_{2(g)}$
- 2) $2\text{H}_2\text{O}_{(l)} \rightarrow 2\text{H}_2(g) + \text{O}_2(g)$
- 3) $\text{N}_{2(g)} + 3\text{H}_{2(g)} \rightarrow 2\text{NH}_{3(g)}$
- 4) $2\text{H}_{2(g)} + \text{O}_{2(g)} \rightarrow 2\text{H}_2\text{O}_{(l)}$

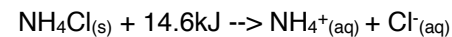
30. The diagram below shows a system of gases with the valve closed.



As the valve is opened, the entropy of the gaseous system

- 1) increases
- 2) decreases
- 3) remain the same

31. As products are formed in the reaction



the entropy of the system

- 1) increases and heat is released
- 2) decreases and heat is absorbed
- 3) increases and heat is absorbed
- 4) decreases and heat is released

32. Which tendency favors a spontaneous reaction?

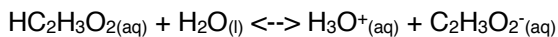
- 1) increasing enthalpy and increasing entropy
- 2) increasing enthalpy and decreasing entropy
- 3) decreasing enthalpy and decreasing entropy
- 4) decreasing enthalpy and increasing entropy

33. According to Reference Table I, the synthesis of which compound is endothermic

- 1) $\text{C}_2\text{H}_4(g)$
- 2) $\text{C}_2\text{H}_6(g)$
- 3) $\text{NH}_3(g)$
- 4) $\text{Al}_2\text{O}_3(s)$

- _____ 34. What factors must be equal in a reversible chemical reaction at equilibrium?
- 1) the activation energies of the forward and reverse reaction
 - 2) the rates of reaction of the forward and reverse reactions
 - 3) the concentrations of the reactants and products
 - 4) the potential energies of the reactants and products

_____ 35. Given the reaction:



What the reaction reaches a state of equilibrium, the concentrations of the reactants

- 1) begin decreasing
- 2) become constant
- 3) are less than the concentration of the products
- 4) are equal to the concentration of the products

_____ 36. Under what conditions are gases most soluble in water?

- 1) low pressure and low temperature
- 2) low pressure and high temperature
- 3) high pressure and low temperature
- 4) high pressure and high temperature

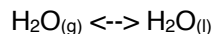
_____ 37. A sample of water in a sealed flask at 298 K is in equilibrium with its vapor. This is an example of

- 1) static equilibrium
- 2) phase equilibrium
- 3) chemical equilibrium
- 4) solution equilibrium

_____ 38. Solution equilibrium *always* exists is a solution that is

- 1) dilute
- 2) saturated
- 3) unsaturated
- 4) concentrated

_____ 39. Given the phase equilibrium in a closed container:



Compared to the rate of gas formation, the rate of liquid formation is

- 1) the same
- 2) slower
- 3) faster

_____ 40. Which of the following statements is true for a saturated solution?

- 1) It must be a dilute solution
- 2) The rate of dissolving equals the rate of crystallizing
- 3) Neither dissolving nor crystallizing is occurring
- 4) It must be a concentrated solution.

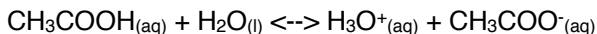
_____ 41. Given the reaction at equilibrium:



As the concentration of Ag^+ ions is increased at a constant temperature, the concentration of Cl^- ions

- 1) increases
- 2) decreases
- 3) remains the same

_____ 42. Given the reaction at equilibrium:



The addition of what ion will cause a decrease in the concentration of $\text{CH}_3\text{COO}^-(\text{aq})$?

- 1) OH^-
- 2) Cl^-
- 3) H_3O^+
- 4) Na^+

_____ 43. Given the reaction at equilibrium:



What change will increase the concentration of $\text{SO}_3(\text{g})$?

- 1) increasing the temperature
- 2) decreasing the pressure
- 3) decreasing the concentration of SO_2
- 4) increasing the concentration of $\text{O}_2(\text{g})$

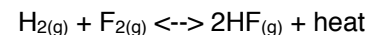
_____ 44. Given the reaction:



This reaction goes to completion (does not enter equilibrium) because one of the products formed is

- 1) a precipitate
- 2) a soluble base
- 3) an insoluble base
- 4) a gas

_____ 45. Given the system at equilibrium:



Which change will *not* shift the point of equilibrium?

- 1) changing the concentration of $\text{H}_2(\text{g})$
- 2) changing the pressure
- 3) changing the concentration of $\text{HF}(\text{g})$
- 4) changing the temperature

_____ 46. The table below recording the production of 50mL of CO_2 in the reaction of HCl with NaHCO_3 . Five trials were performed under different conditions shown.

Trial	Particle Size of NaHCO_3	Concentration of HCl	Temperature ($^{\circ}\text{C}$) of HCl
A	small	1 M	20
B	large	1 M	20
C	large	1 M	40
D	small	2 M	40
E	large	2 M	40

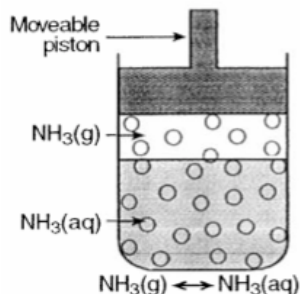
What trial would produce the fastest reaction?

- 1) A
- 2) B
- 3) C
- 4) D

Constructed Response Questions

Questions 1 and 2 refer to the following

The diagram below represents a closed system in which an equilibrium exists between dissolved and undissolved gas.



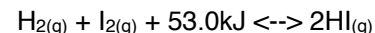
1. What effect will an increase in pressure on the system have on the equilibrium. [Explain your answer.]

2. What effect will increasing the temperature of the system have on the equilibrium? [Explain your answer.]

3. Given the reaction at equilibrium: $2\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \leftrightarrow 2\text{N}_2\text{O}(\text{g})$

Will increasing the pressure on the system favor the forward or the reverse reaction? [Explain why.]

4. Given the following equilibrium reaction at STP:

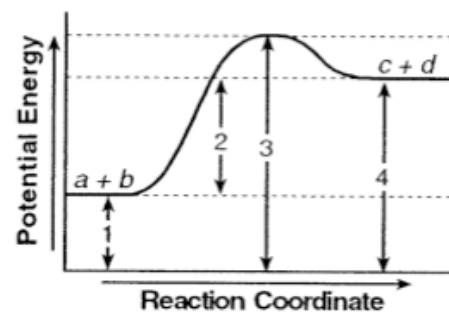


States *two* stresses that could be applied to this system that would cause this equilibrium to shift to the right. Explain why each stress would cause a shift in the equilibrium.

i.

ii.

5. The potential energy diagram shown below represents the reaction:



(a) Does this potential energy diagram represent an exothermic or an endothermic reaction? [Explain why.]

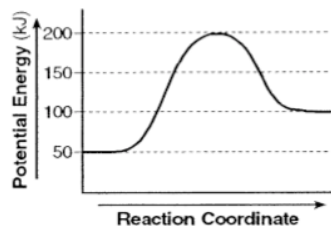
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(b) Which numbered interval represents the heat of reaction? _____

(c) What effect would the addition of a catalyst have on the rate of this chemical reaction?

(d) What effect would the addition of a catalyst have on the heat of reaction? [Explain your answer.]

6. The potential energy diagram of a chemical reaction is shown below.

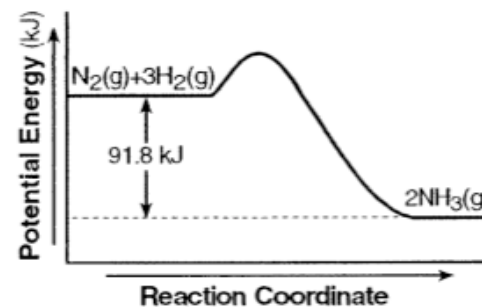


(a) Does this potential energy diagram represent an endothermic or exothermic reaction? [Explain why.]

(b) What is the minimum amount of energy needed to initiate the forward reaction (in kJ) _____

(c) What is the value for ΔH (in kJ)? _____

7. Nitrogen gas reacts with hydrogen gas to form ammonia gas according to the potential energy diagram below.



(a) Does this potential energy diagram represent an exothermic or an endothermic reaction? [Explain why.]

(b) According to the diagram, is the potential energy of the products greater than, less than, or equal to the potential energy of the reactants?

(c) If the activation energy for the forward reaction is 5.0 kJ, what is the activation energy of the reverse reaction? _____

(d) Write the chemical equation for the reaction on the line below. Put the energy term on the correct side of the arrow.

_____ ----> _____

8. Hydrochloric acid and magnesium metal react according to the following chemical equation:



The reaction is complete when all of the magnesium has reacted and no more bubbling of hydrogen gas is observed.

In the laboratory a student performed a controlled experiment to determine the effect of three factors on the rate of reaction. The results of the investigation are reported in the data table below.

Experimental Factor	Rate of Reaction
Increasing temperature of reactants	increased
Increasing concentration of HCl	increased
Cutting magnesium metal into smaller pieces	increased

Any factor which causes an increase in the number of collisions between reactant particles will cause an increase in the rate of reaction. Explain why each experimental factor below causes an increase in the number of collisions:

- (1) increasing temperature
- (2) increasing concentration of acid
- (3) breaking magnesium metal into smaller pieces