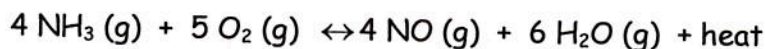


## KINETICS AND EQUILIBRIUM REVIEW PACKET (RC)

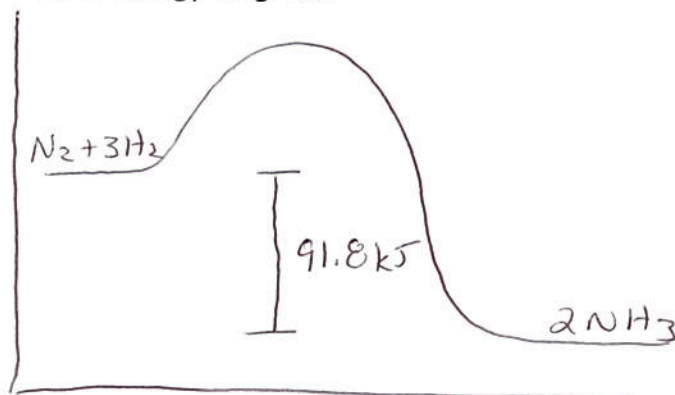
- 1) In which of the following physical states does a given substance have the highest entropy?  
(A) solid  
(B) liquid  
(C) gas  
(D) all of the above
- 2) A reaction that requires free energy  
(A) must be endothermic  
(B) is nonspontaneous  
(C) must decrease in entropy  
(D) is spontaneous.
- 3) The two factors that determine whether a reaction is spontaneous or nonspontaneous are  
(A) entropy and disorder  
(B) entropy and enthalpy change.  
(C) electron configuration and enthalpy change.  
(D) energy and heat of reaction.
- 4) All spontaneous processes  
(A) are exothermic  
(B) are endothermic  
(C) increase in entropy  
(D) release free energy
- 5) In which of these systems is entropy decreasing?  
(A) air escaping a tire  
(B) snow melting  
(C) salt dissolving in water  
(D) vapor condensing to rain
- 6) Which of the following affects the rate of a chemical reaction?  
(A) temperature  
(B) presence of a catalyst  
(C) concentration of reactants  
(D) all of the above
- 7) If a catalyst is used in a reaction the  
(A) activation energy increases  
(B) reaction rate does not change  
(C) reaction rate increases.  
(D) equilibrium shifts.
- 8) Given the reaction at equilibrium:  $A(g) + B(g) + \text{heat} \leftrightarrow C(g) + D(g)$   
The equilibrium will shift to the right when the  
(A) pressure decreases  
(B) temperature increases  
(C)  $[A(g)]$  decreases  
(D)  $[C(g)]$  increases
- 9) A chemical reaction has reached equilibrium when  
(A) the reverse reaction begins  
(B) the forward reaction stops  
(C) the concentrations of reactants and products are equal  
(D) the concentrations of reactants and products are constant

- 10) If a catalyst is added to a system at equilibrium and the temperature and pressure remain constant, there will be no effect on the
- (A) rate of the forward reaction                      (C) activation energy  
 (B) rate of the reverse reaction                      (D) heat of reaction
- 11) Which factors must be equal in a reversible chemical reaction at equilibrium?
- (A) concentrations of reactants and products  
 (B) potential energy of reactants and products  
 (C) activation energy of the forward and reverse reactions  
 (D) rates of the forward and reverse reactions
- 12) A sample of water in a sealed flask at 298 K is in equilibrium with its vapor. This is an example of
- (A) chemical equilibrium                              (C) solution equilibrium  
 (B) phase equilibrium                                    (D) static equilibrium
- 13) Given the reaction at equilibrium:  $\text{NaCl (s)} \leftrightarrow \text{Na}^+ \text{(aq)} + \text{Cl}^- \text{(aq)}$   
 The addition of KCl to this system will cause a shift in the equilibrium to the
- (A) left and the concentration of the  $\text{Na}^+ \text{(aq)}$  ions will increase  
 (B) right and the concentration of the  $\text{Na}^+ \text{(aq)}$  ions will increase  
 (C) left and the concentration of the  $\text{Na}^+ \text{(aq)}$  ions will decrease  
 (D) right and the concentration of the  $\text{Na}^+ \text{(aq)}$  ions will increase
- 14) Two reactant particles collide with proper orientation. The collision will be effective if the particles have
- (A) sufficient potential energy                      (C) high ionization energy  
 (B) high activation energy                            (D) sufficient kinetic energy
- 15) The reaction  $\text{A} + \text{B} \rightarrow \text{C} + \text{D} + 30 \text{ kJ}$  has a forward activation energy of 20 kJ. What is the activation energy of the reverse reaction?
- (A) 50 kJ                      (B) 20 kJ                      (C) 30 kJ                      (D) 10 kJ
- 16) Determine the direction of the equilibrium shift using LeChatilier's principle when each of the following stresses is applied to the chemical equilibrium below.



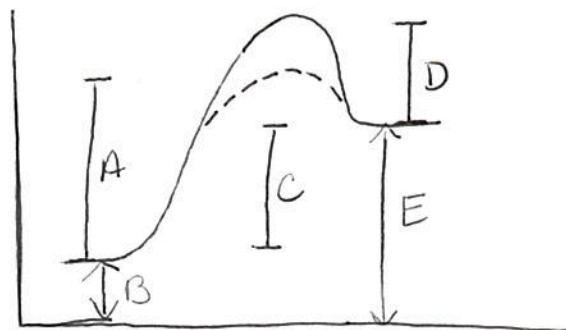
- (A) Increase [NO]                      \_\_\_\_\_
- (B) Decrease heat                      \_\_\_\_\_
- (C) Increase pressure                      \_\_\_\_\_
- (D) Decrease [O<sub>2</sub>]                      \_\_\_\_\_

- 17) Nitrogen gas reacts with hydrogen gas to form ammonia gas according to the following potential energy diagram.



- (A) Is the reaction endothermic or exothermic? Justify.
- (B) If the activation energy of the forward reaction is  $5.0 \text{ kJ}$ , what is the activation energy of the reverse reaction?
- (C) Write the chemical equation for the reaction on the line below. Put the energy on the correct side of the arrow as a reactant or product.
- 18) Entropy is a measure of \_\_\_\_\_ in a system. All systems in nature tend to favor an \_\_\_\_\_ in entropy.
- 19) For a reaction to occur spontaneously at any temperature there must be a(n) \_\_\_\_\_ in enthalpy and a(n) \_\_\_\_\_ in entropy.

20) Using the diagram below, identify the region indicated by each letter.



- (A) \_\_\_\_\_  
 (B) \_\_\_\_\_  
 (C) \_\_\_\_\_  
 (D) \_\_\_\_\_  
 (E) \_\_\_\_\_

**Matching: Match each description to the appropriate term.**

activated complex

reaction rate

LeChatelier's Principle

Spontaneous

entropy

activation energy

inhibitor

chemical equilibrium

21) the number of particles that react in a given time to form products

22) the minimum energy colliding particles must have in order to react

23) when the forward and reverse reactions take place at the same rate

24) a substance that interferes with the action of a catalyst

25) the measure of disorder

26) the arrangement of atoms at the peak of the activation energy barrier

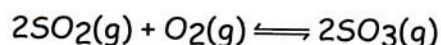
27) if a stress is applied to a system at dynamic equilibrium, the system changes to relieve the stress

Name: \_\_\_\_\_

- 1) Which of the following statements describes characteristics of an endothermic reaction?
- 1) The sign of  $\Delta H$  is positive, and the products have less potential energy than the reactants.
  - 2) The sign of  $\Delta H$  is positive, and the products have more potential energy than the reactants.
  - 3) The sign of  $\Delta H$  is negative, and the products have more potential energy than the reactants.
  - 4) The sign of  $\Delta H$  is negative, and the products have less potential energy than the reactants.
- 2) When  $\text{NH}_4\text{NO}_3$  is dissolved in water, the temperature of the water decreases. When  $\text{NaOH}$  is dissolved in a separate water sample, the temperature of the water increases. Based on these observations, it can be concluded that the dissolving of
- 1) both salts are endothermic
  - 2)  $\text{NH}_4\text{NO}_3$  is exothermic and the dissolving of  $\text{NaOH}$  is endothermic
  - 3) both salts are exothermic
  - 4)  $\text{NH}_4\text{NO}_3$  is endothermic and the dissolving of  $\text{NaOH}$  is exothermic
- 3) Energy is released when the atoms of two elements bond to form a compound. Compared to the total potential energy of the atoms before bonding, the total potential energy of the atoms after bonding is
- 1) lower and the compound formed is unstable
  - 2) higher and the compound formed is unstable
  - 3) higher and the compound formed is stable
  - 4) lower and the compound formed is stable
- 4) At room temperature, which reaction would be expected to have the *fastest* reaction rate?
- |  |   |
|--|---|
| 1) $\text{Pb}^{2+}(\text{aq}) + \text{S}^{2-}(\text{aq}) \longrightarrow \text{PbS}(\text{s})$ | 3) $\text{N}_2(\text{g}) + 2\text{O}_2(\text{g}) \longrightarrow 2\text{NO}_2(\text{g})$    |
| 2) $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{H}_2\text{O}(\ell)$    | 4) $2\text{KClO}_3(\text{s}) \longrightarrow 2\text{KCl}(\text{s}) + 3\text{O}_2(\text{g})$ |
- 5) Based on the *Heats of Reaction at 101.3 kPa and 298 K* chemistry reference table, which equation represents an endothermic reaction?
- |   |   |
|---|---|
| 1) $\text{C}(\text{s}) + \text{O}_2(\text{g}) \longrightarrow \text{CO}_2(\text{g})$  | 3) $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{H}_2\text{O}(\text{g})$ |
| 2) $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \longrightarrow 2\text{HI}(\text{g})$ | 4) $2\text{C}(\text{s}) + 3\text{H}_2(\text{g}) \longrightarrow \text{C}_2\text{H}_6(\text{g})$ |
- 6) What is the heat of formation of 1 mole of  $\text{H}_2\text{O}(\text{g})$ ?
- |                   |                   |
|-------------------|-------------------|
| 1) -571.6 kJ/mole | 3) -285.8 kJ/mole |
| 2) -483.6 kJ/mole | 4) -241.8 kJ/mole |

- 7) As the number of effective collisions of reacting particles increases, the rate of reaction
- 1) remains the same
  - 2) increases
  - 3) decreases
- 8) Which condition will increase the rate of a chemical reaction?
- 1) decreased temperature and decreased concentration of reactants
  - 2) increased temperature and decreased concentration of reactants
  - 3) increased temperature and increased concentration of reactants
  - 4) decreased temperature and increased concentration of reactants

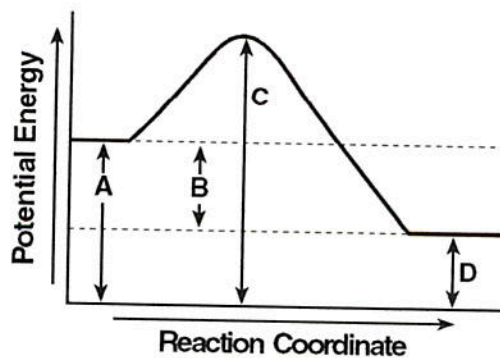
- 9) Given the reaction at equilibrium:



The rate of the forward reaction increases by adding more  $\text{SO}_2$  because the

- 1) temperature will increase
  - 2) reaction will shift to the left
  - 3) number of molecular collisions will increase
  - 4) forward reaction is endothermic
- 10) Raising the temperature speeds up the rate of a chemical reaction by increasing
- 1) the frequency of the collisions, only
  - 2) both the effectiveness and the frequency of the collisions
  - 3) neither the effectiveness nor the frequency of the collisions
  - 4) the effectiveness of the collisions, only
- 11) In the reaction  $2\text{Mg}(\text{s}) + \text{O}_2(\text{g}) \longrightarrow 2\text{MgO}(\text{s})$ , as the surface area of  $\text{Mg}(\text{s})$  increases, the rate of the reaction
- 1) remains the same
  - 2) decreases
  - 3) increases
- 12) A catalyst can increase the rate of a reaction by
- 1) decreasing the potential energy of the products
  - 2) decreasing the activation energy
  - 3) increasing the potential energy of the products
  - 4) increasing the activation energy

- 13) The graph below represents the potential energy changes that occur in a chemical reaction.



- (a) According to the graph, is energy absorbed or released during the reaction?
- (b) Which lettered interval represents the  $\Delta H$  of the reaction?
- (c) Which lettered interval would change by the addition of a catalyst?
- 14) Write out the thermochemical equation for the production of  $C_2H_6$  from its elements.
- 15) How much energy is produced if 1.25 moles of carbon reacts to form  $C_2H_6$ ?