

## 992\_1st\_Exam\_1000316

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) For the reaction:  $\text{CH}_4(\text{g}) + 2 \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{CO}_2(\text{g}) + 4 \text{H}_2(\text{g})$   $\Delta H^\circ = +190 \text{ kJ}$  when  $\text{CH}_4$  is added:

- A) the temperature increases
- B) the reaction reacts to the left
- C) the reaction reacts to the right
- D) the  $\Delta H^\circ$  increases
- E) there is no change in equilibrium position

Answer: C

2) In the equilibrium system described by:  $\text{PO}_4^{3-}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{HPO}_4^{2-}(\text{aq}) + \text{OH}^-(\text{aq})$  Brønsted-Lowry theory would designate:

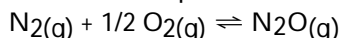
- A)  $\text{PO}_4^{3-}$  and  $\text{H}_2\text{O}$  as the bases
- B)  $\text{HPO}_4^{2-}$  and  $\text{OH}^-$  as the acids
- C)  $\text{PO}_4^{3-}$  as amphiprotic
- D)  $\text{H}_2\text{O}$  and  $\text{OH}^-$  as a conjugate pair
- E)  $\text{HPO}_4^{2-}$  and  $\text{H}_2\text{O}$  as a conjugate pair

Answer: D

3) Given the following:

- I)  $\text{N}_2\text{O}(\text{g}) + 1/2 \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g})$   $K_C = 1.7 \times 10^{-13}$
- II)  $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g})$   $K_C = 4.1 \times 10^{-31}$

Find the value of the equilibrium constant for the following equilibrium reaction:



- A)  $2.6 \times 10^{-22}$
- B)  $2.4 \times 10^{-18}$
- C)  $1.6 \times 10^{-9}$
- D)  $7.0 \times 10^{-44}$
- E)  $4.2 \times 10^{17}$

Answer: B

4) The reaction  $\text{A} + \text{B} \rightarrow \text{C} + \text{D}$  is second order in A and zero order in B. The value of  $k$  is  $0.012 \text{ M}^{-1} \text{ min}^{-1}$ . What is the rate of this reaction when  $[\text{A}] = 0.125 \text{ M}$  and  $[\text{B}] = 0.435 \text{ M}$ ?

- A)  $1.3 \text{ M min}^{-1}$
- B)  $3.4 \times 10^{-3} \text{ M min}^{-1}$
- C)  $5 \times 10^{-4} \text{ M min}^{-1}$
- D)  $1.5 \times 10^{-3} \text{ M min}^{-1}$
- E)  $1.9 \times 10^{-4} \text{ M min}^{-1}$

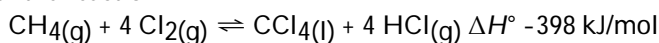
Answer: E

5) For the reaction:  $3 \text{Fe}(\text{s}) + 4 \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{Fe}_3\text{O}_4(\text{s}) + 4 \text{H}_2(\text{g})$  what is the effect on equilibrium of increasing temperature of an exothermic reaction?

- A) The  $K_p$  is doubled.
- B) The reaction shifts to the left.
- C) There is no change.
- D) The  $K_p$  is decreased.
- E) The reaction shifts to the right.

Answer: B

6) Consider the reaction:

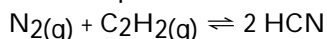


The equilibrium is displaced to the right if:

- A) some hydrogen chloride is added
- B) the temperature is raised
- C) the pressure is lowered
- D) some carbon tetrachloride is removed
- E) some chlorine gas is removed

Answer: D

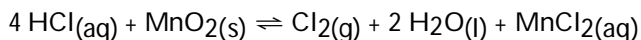
7) Given that the equilibrium concentrations of  $[\text{N}_2] = 0.035 \text{ M}$ ,  $[\text{C}_2\text{H}_2] = 0.057 \text{ M}$ , and  $[\text{HCN}] = 6.8 \times 10^{-4} \text{ M}$ , find the value of the equilibrium constant expression for the reaction:



- A)  $3.4 \times 10^{-1}$       B)  $6.8 \times 10^{-1}$       C) 4300      D) 2.9      E)  $2.3 \times 10^{-4}$

Answer: E

8) Consider the exothermic reaction:



The equilibrium is displaced to the left if:

- A) pressure is lowered
- B)  $\text{H}_2\text{O}(\text{l})$  is added
- C) temperature is lowered
- D) catalyst is added
- E)  $\text{MnO}_2(\text{s})$  is added

Answer: B

9) Activation energy is:

- A) minimum kinetic energy that molecules must bring to their collisions for a chemical reaction to occur
- B) energy at the bottom of the reaction curve
- C) the heat energy in Joules required to break the bonds in one reactant
- D) an energy that a catalyst brings to the system to activate one of the reactants
- E) the kinetic energy of solution stirring that brings the reaction to start

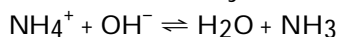
Answer: A

10) Proton acceptor is an abbreviated definition of:

- A) Brønsted-Lowry acid
- B) Brønsted-Lowry base
- C) Lewis base
- D) Lewis acid
- E) Arrhenius acid

Answer: B

11) Choose the Brønsted-Lowry acids and bases in the following equation:



- A) acids  $\text{OH}^-$ ,  $\text{H}_2\text{O}$       bases  $\text{NH}_3$ ,  $\text{NH}_4^+$   
B) acids  $\text{NH}_4^+$ ,  $\text{OH}^-$       bases  $\text{H}_2\text{O}$ ,  $\text{NH}_3$   
C) acids  $\text{NH}_4^+$ ,  $\text{H}_2\text{O}$       bases  $\text{OH}^-$ ,  $\text{NH}_3$   
D) acids  $\text{NH}_4^+$ ,  $\text{OH}^-$       bases  $\text{NH}_4^+$ ,  $\text{H}_2\text{O}$   
E) acids  $\text{NH}_4^+$ ,  $\text{NH}_3$       bases  $\text{OH}^-$ ,  $\text{H}_2\text{O}$

Answer: C

12) Which of the following is the strongest base?

- A)  $\text{NO}_3^-$       B)  $\text{F}^-$       C)  $\text{Cl}^-$       D)  $\text{ClO}_4^-$       E)  $\text{H}_2\text{O}$

Answer: B

13) Which of the following has no effect on the rate of a reaction?

- A) concentrations of reactants  
B) presence of a catalyst  
C) activation energy  
D) value of  $\Delta H^\circ$   
E) temperature of reactants

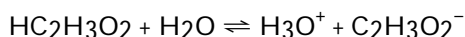
Answer: D

14) Which factor influences the value of the equilibrium constant for a reversible reaction?

- A) removing product  
B) removing reactant  
C) raising the temperature  
D) addition of a catalyst  
E) increase in mixing rate

Answer: C

15) Consider the reaction:



Choose the pair of substances that are both bases in the reaction.

- A)  $\text{HC}_2\text{H}_3\text{O}_2$  and  $\text{C}_2\text{H}_3\text{O}_2^-$   
B)  $\text{H}_3\text{O}^+$  and  $\text{HC}_2\text{H}_3\text{O}_2$   
C)  $\text{H}_2\text{O}$  and  $\text{C}_2\text{H}_3\text{O}_2^-$   
D)  $\text{HC}_2\text{H}_3\text{O}_2$  and  $\text{H}_3\text{O}^+$   
E)  $\text{H}_2\text{O}$  and  $\text{H}_3\text{O}^+$

Answer: C

16) Which of the following are Brønsted-Lowry acid?

- I)  $\text{CH}_3\text{COOH}$
- II)  $[\text{Cu}(\text{H}_2\text{O})_4]^{2+}$
- III)  $\text{H}_2\text{O}$
- IV)  $\text{CH}_3\text{NH}_2$
- V)  $\text{H}_3\text{O}^+$
- A) II, III, and IV)
- B) I, II and III)
- C) I, II, III, and V)
- D) I, II, III) and IV)
- E) II, III) and V)

Answer: C

17) Calculate rate constant  $k$  for a first order reaction with a half-life of 75.0 min.

- A)  $1.33 \times 10^{-2} \text{ min}^{-1}$
- B)  $52.0 \text{ min}^{-1}$
- C)  $1.54 \times 10^{-4} \text{ min}^{-1}$
- D)  $2.67 \times 10^{-2} \text{ min}^{-1}$
- E)  $9.24 \times 10^{-3} \text{ min}^{-1}$

Answer: E

18) Define activation energy.

- A) the difference between the energy of the products and reactants
- B) the minimum total kinetic energy that molecules must bring to their collisions for a chemical reaction to occur
- C) the total kinetic energy of molecules in a system
- D) the total kinetic energy of molecules in collisions
- E) the energy difference between the maximum energy of reaction and the energy of the products

Answer: B

19) The rate of a specific chemical reaction is independent of the concentrations of the reactants. Thus the reaction is:

- A) second order
- B) first order in A
- C) catalyzed
- D) overall zero order
- E) first order in the product

Answer: D

20) The reaction  $2\text{H}_2 + \text{NO} \rightarrow \text{H}_2\text{O} + 1/2\text{N}_2$  is first order in  $\text{H}_2$  and second order in  $\text{NO}$ . The rate law is \_\_\_\_\_.

- A)  $k[\text{H}_2]$
- B)  $k[\text{H}_2][\text{NO}]^2$
- C)  $k[\text{H}_2][\text{NO}]^{-2}$
- D)  $k[\text{H}_2][\text{NO}]$
- E)  $k[\text{H}_2]^2[\text{NO}]$

Answer: B

- 21) For the reaction:  $\text{CH}_4(\text{g}) + 2 \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{CO}_2(\text{g}) + 4 \text{H}_2(\text{g})$   $\Delta H^\circ = +190 \text{ kJ}$  raise the temperature to 1200 K:
- A) the temperature increases
  - B) the reaction reacts to the left
  - C) the reaction reacts to the right
  - D) the  $\Delta H^\circ$  increases
  - E) there is no change in equilibrium position

Answer: C

- 22)  $\text{pOH} = 3.14$  is equivalent to:

- A)  $\text{pH} = 11.$
- B)  $[\text{OH}^-] = 3.14 \times 10^{-7} \text{ M}$
- C)  $[\text{OH}^-] = 7.2 \times 10^{-4} \text{ M}$
- D)  $[\text{H}^+] = 1.4 \times 10^{-10} \text{ M}$
- E)  $[\text{H}^+] = 7.0 \times 10^{-4} \text{ M}$

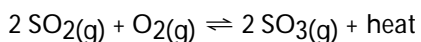
Answer: C

- 23) For the reaction:  $\text{C}_2\text{H}_4\text{Br}_2 + 3 \text{KI} \rightarrow \text{C}_2\text{H}_4 + 2 \text{KBr} + \text{KI}_3$ , when the rate of reaction is  $2.0 \times 10^{-5}$ , what is the rate of disappearance of  $\text{KI}$ ?

- A)  $-0.67 \times 10^{-5}$
- B)  $-1.0 \times 10^{-5}$
- C)  $-4.0 \times 10^{-5}$
- D)  $-6.0 \times 10^{-5}$
- E)  $-2.0 \times 10^{-5}$

Answer: D

- 24) Choose the correct statement about a container in which the chemical equilibrium is established:



- A) A decrease in the volume will decrease the amount of  $\text{SO}_2$  present.
- B) An increase in amount of  $\text{O}_2$  will increase the amount of  $\text{SO}_2$  present.
- C) A decrease in temperature will increase the amount of  $\text{SO}_2$  present.
- D) A decrease in the amount of  $\text{SO}_3$  present will increase the amount of  $\text{SO}_2$  present.
- E) A decrease in amount of  $\text{O}_2$  will decrease the amount of  $\text{SO}_2$  present.

Answer: A

- 25) If the half-life of a reactant is independent of its initial concentration, the reaction order is \_\_\_\_\_.

- A) 0.5
- B) 1
- C) 2
- D) 0
- E) 3

Answer: B

- 26) Choose the INCORRECT answer. The rate of a chemical reaction:

- A) will be very rapid if the activation energy is large
- B) describes the change in concentration of a reactant or product with time
- C) may be increased by certain catalytic agents
- D) is dependent on temperature
- E) usually is increased when the concentration of one of the reactants is increased

Answer: A

- 27) In the reaction  $\text{C}_4\text{H}_9\text{Cl}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{C}_4\text{H}_9\text{OH}(\text{aq}) + \text{HCl}(\text{aq})$  the concentration of the reactant changes from 0.0562 M to 0.0431 M in 85 sec. What is the average rate of decomposition over this interval?
- A) 0.0154 M
  - B)  $1.54 \times 10^{-4}$  M/s
  - C)  $1.54 \times 10^{-4}$  moles/s
  - D)  $1.54 \times 10^{-4}$  moles
  - E) 0.0154 M/s

Answer: B

- 28) In a second order reaction:

- I) the sum of the exponents in the rate law is equal to two.
  - II) at least one of the exponents in the rate law is a two.
  - III) the half-life is not constant.
  - IV) the half-life is constant.
  - V)  $k$  can be expressed as  $\text{M}^{-2}\text{s}^{-1}$  or  $\text{M}^{-2}\text{min}^{-1}$ .
- A) II and III      B) I and IV      C) II and IV      D) I, III, and V      E) I and III

Answer: E

- 29) Choose the strongest acid.

- A)  $\text{HC}_2\text{H}_3\text{O}_2$       B)  $\text{H}_2\text{CO}_3$       C)  $\text{HClO}_4$       D)  $\text{HCN}$       E)  $\text{HF}$

Answer: C

- 30) In the first order reaction  $\text{A} \rightarrow \text{products}$ ,  $[\text{A}] = 0.400$  M initially and 0.250 M after 15.0 min, what will  $[\text{A}]$  be after 175 min?

- A)  $1.67 \times 10^{-3}$  M
- B)  $1.04 \times 10^{-3}$  M
- C)  $3.70 \times 10^{-2}$  M
- D)  $6.024 \times 10^{-3}$  M
- E)  $2.31 \times 10^{-1}$  M

Answer: A

- 31) For the reaction:  $3 \text{Fe}(\text{s}) + 4 \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{Fe}_3\text{O}_4(\text{s}) + 4 \text{H}_2(\text{g})$  what is the effect of removing  $\text{H}_2$ ?

- A) The  $K_p$  is decreased.
- B) The  $K_p$  is doubled.
- C) The reaction shifts to the right.
- D) There is no change.
- E) The reaction shifts to the left.

Answer: C

- 32) Which of the following situations involves a heterogeneous catalysis?

- A) The catalyst, reactants, and products are all different phases of matter.
- B) The catalyst is present in a different phase of matter than are the reactants and products.
- C) The reactants and products are different phases of matter in a catalyzed reaction.
- D) The catalyst changes phases during the reaction.
- E) The catalyst is in two different phases of matter.

Answer: B

- 33) At 25°C, the pH of pure water is:  
A) 0                      B) 14                      C) >0, <7                      D) 7                      E) >7, <14

Answer: D

- 34) Which of the following statements is correct ?  
A) A zero order reaction depends on the concentration of reactants.  
B) The orientation of a collision does not affect the rate constant.  
C) A reaction rate cannot be calculated from the collision frequency alone.  
D) The number of collisions has no effect on the rate constant.  
E) The activated complex is a chemical species that can be isolated and analysed.

Answer: C

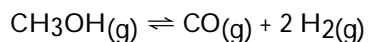
- 35) A catalyst alters the rate of a chemical reaction by:  
A) increasing the number of collisions of molecules  
B) always providing a surface on which molecules react  
C) inducing an alternate pathway for the reaction with generally lower activation energy  
D) changing the frequency of collisions between molecules  
E) changing the products formed in the reaction

Answer: C

- 36) In the Arrhenius equation,  $\ln k = -E_a/RT + \ln A$ , the symbol  $A$  denotes:  
A) the initial concentration of A  
B) a constant that represents the frequency of collisions with the proper orientation and other steric conditions favorable for a reaction  
C) the absolute temperature  
D) the rate constant  
E) the activation energy

Answer: B

- 37) What is the value for  $K_c$  if  $[CO] = 0.025$ ,  $[H_2] = 0.013$  and  $[CH_3OH] = 0.0028$  for the following reaction?



- A) 0.12                      B)  $6.6 \times 10^2$                       C)  $9.1 \times 10^{-7}$                       D) 8.6                      E)  $1.5 \times 10^{-3}$

Answer: E

- 38) If increasing the concentration of A in a chemical reaction causes no increase in the rate of the reaction, then we may say:  
A) A is a catalyst  
B) A is not involved in the reaction  
C) the reaction rate is zero order in A  
D) the reaction rate is zero order in [A]  
E) the reaction rate is first order in [A]

Answer: D

- 39) The reaction has the rate law  $\text{Rate} = k[A][B]^2$ . Which will cause the rate to increase the most?  
A) doubling [A]  
B) tripling [B]  
C) doubling [B]  
D) lowering temperature  
E) quadrupling [A]

Answer: B

- 40) Which of the following statements is INCORRECT ?
- A) In a zero order reaction the rate remains constant throughout the reaction.
  - B) Radioactive decay is a first order reaction.
  - C) Half-life in a first order reaction is constant.
  - D) In gaseous reactions  $[A]$  can be expressed as concentration or as pressure.
  - E) For a first order reaction  $\ln [A]_t/[A]_0 = kt$ .

Answer: E

- 41) For the second order reaction  $A \rightarrow$  products, the following data are obtained:
- $[A] = 3.024 \text{ M}, t = 0 \text{ min}$
  - $[A] = 2.935 \text{ M}, t = 1.0 \text{ min}$
  - $[A] = 2.852 \text{ M}, t = 2.0 \text{ min}$

What is the rate constant,  $k$ ?

- A)  $3.6 \times 10^{-3} \text{ M}^{-1} \text{ min}^{-1}$
- B)  $9.7 \times 10^{-3} \text{ M}^{-1} \text{ min}^{-1}$
- C)  $1.0 \times 10^{-2} \text{ M}^{-1} \text{ min}^{-1}$
- D)  $2.2 \times 10^{-2} \text{ M}^{-1} \text{ min}^{-1}$
- E)  $1.4 \times 10^{-2} \text{ M}^{-1} \text{ min}^{-1}$

Answer: C

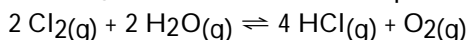
- 42) According to the Arrhenius theory, a neutralization reaction involves:
- A) the dissociation of a strong base into hydroxide ions and a cation.
  - B) the combination of hydrogen ions and hydroxide ions to form water.
  - C) the dissociation of a strong acid to hydrogen ions and an anion.
  - D) the combination of an acid with a base to make only water.
  - E) the addition of water to ammonia to make ammonium hydroxide.

Answer: B

- 43) Define rate law.
- A) An experimentally determined equation that describes how the rate of reaction depends on the concentration of reactants.
  - B) A theoretical equation that describes how the rate of reaction depends on temperature, orientation and number of collisions.
  - C) An experimentally determined equation that describes how the rate of reaction depends on temperature, orientation and number of collisions.
  - D) A theoretical equation that describes how the rate of reaction depends on the concentration of reactants.
  - E) A statement that describes how the ratio of reaction depends on concentration of reactants developed from the balanced equation.

Answer: A

- 44) For the following chemical equilibrium,  $K_p = 4.6 \times 10^{-14}$  at  $25^\circ\text{C}$ , find the value of  $K_c$  for this reaction at  $25^\circ\text{C}$ .

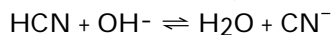


- A)  $K_c = 2.2 \times 10^{-14}$
- B)  $K_c = 1.9 \times 10^{-15}$
- C)  $K_c = 4.6 \times 10^{-14}$
- D)  $K_c = 9.4 \times 10^{-14}$
- E)  $K_c = 1.1 \times 10^{-12}$

Answer: B



45) Choose the Brønsted-Lowry acids and bases in the following equation:



- A) acids  $\text{CN}^-$ ,  $\text{OH}^-$             bases  $\text{HCN}$ ,  $\text{H}_2\text{O}$   
B) acids  $\text{HCN}$ ,  $\text{OH}^-$             bases  $\text{H}_2\text{O}$ ,  $\text{CN}^-$   
C) acids  $\text{HCN}$ ,  $\text{H}_2\text{O}$             bases  $\text{OH}^-$ ,  $\text{CN}^-$   
D) acids  $\text{HCN}$ ,  $\text{CN}^-$             bases  $\text{OH}^-$ ,  $\text{H}_2\text{O}$   
E) acids  $\text{OH}^-$ ,  $\text{H}_2\text{O}$             bases  $\text{CN}^-$ ,  $\text{HCN}$

Answer: C

46) For the reaction:  $2\text{N}_2\text{O}_5(\text{g}) \rightarrow 4\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$  at the time when  $\text{N}_2\text{O}_5$  is being consumed at a rate of  $-1.2 \times 10^{-4}$  M/s, what is the rate at which  $\text{O}_2$  is being formed?

- A)  $6.0 \times 10^{-5}$  M/s  
B)  $2.4 \times 10^{-4}$  M/s  
C)  $1.2 \times 10^{-4}$  M/s  
D)  $4.8 \times 10^{-4}$  M/s  
E)  $3.0 \times 10^{-5}$  M/s

Answer: A

47) If a reaction has a rate equation of  $\text{rate} = k[\text{A}][\text{B}][\text{C}]$  then it is:

- A) overall first order  
B) overall second order  
C) zero order in A  
D) second order in B  
E) overall third order

Answer: E

48) Which statement is INCORRECT ?

- A) An activated complex has higher energy than any molecule contributing to it.  
B) The activated complex will be the highest on the energy profile.  
C) Activation energy is the same for forward and reverse reaction.  
D) In an endothermic reaction, activation energy is usually greater than the enthalpy.  
E) If the forward reaction is endothermic, the reverse will be exothermic.

Answer: C

49) The definition of a neutralization reaction as a reaction in which an acid reacts with a base to produce water and a salt is inherent in:

- A) both the Brønsted-Lowry and the Lewis theories  
B) only the Lewis theory  
C) both the Arrhenius and the Brønsted-Lowry theories  
D) only the Arrhenius theory  
E) only the Brønsted-Lowry theory

Answer: D

50) For the reaction:  $\text{CH}_4(\text{g}) + 2\text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{CO}_2(\text{g}) + 4\text{H}_2(\text{g})$   $\Delta H^\circ = +190 \text{ kJ}$  add  $\text{H}_2(\text{g})$ :

- A) the temperature increases
- B) the reaction reacts to the right
- C) the reaction reacts to the left
- D) the  $\Delta H^\circ$  increases
- E) there is no change in equilibrium position

Answer: C