

## 1042\_1st Exam\_1050330(A)

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

- 1) For the reaction:  $2\text{N}_2\text{O}_5(\text{g}) \rightarrow 4\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$  the rate law is:

$$\frac{\Delta[\text{O}_2]}{\Delta t} = k[\text{N}_2\text{O}_5]$$

At 300 K, the half-life is  $2.50 \times 10^4$  seconds and the activation energy is 103.3 kJ/mol  $\text{O}_2$ . 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  $\text{NO}_2$  is being formed?

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

Answer: B

- 2) The reaction has the rate law  $\text{Rate} = k[\text{A}][\text{B}]^2$ . Which will cause the rate to increase the most?

- A) doubling [A]
- B) quadrupling [A]
- C) tripling [B]
- D) doubling [B]
- E) lowering temperature

Answer: C

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

Answer: D

- 4) Data for the reaction  $\text{A} + \text{B} \rightarrow \text{C}$  are given below. Find the rate constant for this system.

Experiment	[A], M	[B], M	Initial rate, M/s
1	0.030	0.060	$2.5 \times 10^{-5}$
2	0.030	0.020	$2.5 \times 10^{-5}$
3	0.060	0.060	$10.0 \times 10^{-5}$

- A)  $2.8 \times 10^{-2} \text{ M}^2\text{s}^{-1}$
- B)  $1.7 \times 10^{-3} \text{ M}^{-1}\text{s}^{-1}$
- C)  $2.8 \times 10^{-2} \text{ Ms}^{-1}$
- D)  $2.8 \times 10^{-2} \text{ M}^{-1}\text{s}^{-1}$
- E)  $1.7 \times 10^{-3} \text{ Ms}^{-1}$

Answer: D

- 5) In the first order, reaction  $A \rightarrow \text{products}$ ,  $[A] = 0.400 \text{ M}$  initially and  $0.250 \text{ M}$  after  $15.0 \text{ min}$ , what will  $[A]$  be after  $175 \text{ min}$ ?
- A)  $1.04 \times 10^{-3} \text{ M}$
  - B)  $2.31 \times 10^{-1} \text{ M}$
  - C)  $1.67 \times 10^{-3} \text{ M}$
  - D)  $3.70 \times 10^{-2} \text{ M}$
  - E)  $6.024 \times 10^{-3} \text{ M}$

Answer: C

- 6) For the reaction  $A \rightarrow \text{products}$ , the following data are obtained:
- $[A] = 1.512 \text{ M}$ ,  $t = 0 \text{ min}$
  - $[A] = 1.490 \text{ M}$ ,  $t = 1.0 \text{ min}$
  - $[A] = 1.469 \text{ M}$ ,  $t = 2.0 \text{ min}$

What is the rate constant,  $k$ , for the reaction?

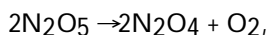
- A)  $1.4 \times 10^{-2} \text{ M}^{-1} \text{ min}^{-1}$
- B)  $2.2 \times 10^{-2} \text{ M}^{-1} \text{ min}^{-1}$
- C)  $9.7 \times 10^{-3} \text{ M}^{-1} \text{ min}^{-1}$
- D)  $1.0 \times 10^{-2} \text{ M}^{-1} \text{ min}^{-1}$
- E)  $3.6 \times 10^{-3} \text{ M}^{-1} \text{ min}^{-1}$

Answer: C

- 7) A variable that has NO effect on reaction rate is:
- A) energy of activation
  - B) concentration
  - C) catalyst
  - D) temperature
  - E) none of these

Answer: E

- 8) What is the rate constant at  $305 \text{ K}$  for the reaction:



if  $k = 3.46 \times 10^{-5} \text{ s}^{-1}$  at  $298 \text{ K}$  and  $E_a = 106 \text{ kJ/mol}$ ?

- A)  $2.4 \times 10^{-5} \text{ s}^{-1}$
- B)  $1.2 \times 10^{-5} \text{ s}^{-1}$
- C)  $4.8 \times 10^{-5} \text{ s}^{-1}$
- D)  $9.2 \times 10^{-5} \text{ s}^{-1}$
- E)  $6.0 \times 10^{-5} \text{ s}^{-1}$

Answer: D

- 9) For the reaction:  $2\text{N}_2\text{O}_5(\text{g}) \rightarrow 4\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$  the rate law is:

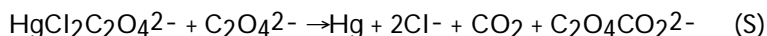
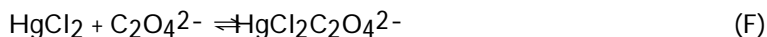
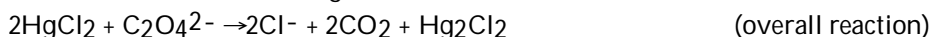
$$\frac{\Delta[\text{O}_2]}{\Delta t} = k[\text{N}_2\text{O}_5]$$

At  $300 \text{ K}$ , the half-life is  $2.50 \times 10^4$  seconds and the activation energy is  $103.3 \text{ kJ/mol O}_2$ . What is the half-life at  $310 \text{ K}$ ?

- A)  $6.57 \times 10^3 \text{ s}$
- B)  $2.49 \times 10^4 \text{ s}$
- C)  $9.51 \times 10^6 \text{ s}$
- D)  $1.87 \times 10^{-1} \text{ s}$
- E)  $9.51 \times 10^4 \text{ s}$

Answer: A

10) What is the rate law for the following reaction and mechanism?



- A) Rate =  $k[\text{HgCl}_2][\text{C}_2\text{O}_4^{2-}]$
- B) Rate =  $k[\text{HgCl}_2]^2[\text{C}_2\text{O}_4^{2-}]$
- C) Rate =  $k[\text{HgCl}_2]^2[\text{C}_2\text{O}_4^{2-}]^2$
- D) Rate =  $k[\text{HgCl}_2]$
- E) Rate =  $k[\text{HgCl}_2][\text{C}_2\text{O}_4^{2-}]^2$

Answer: E

11) The first order reaction  $\text{A} \rightarrow \text{products}$  has  $t_{1/2} = 150$  sec. What percent of the sample remains unreacted after 300 sec?

- A) 100%
- B) 50%
- C) 0.0%
- D) 25%
- E) 12.5%

Answer: D

12) If the half-life of a reaction depends on the concentration of the reactant, then the reaction cannot be \_\_\_\_\_ order.

- A) third
- B) zero
- C) second
- D) first
- E) none of these

Answer: D

13) The rate constant for a first-order reaction is  $k = 0.00073 \text{ s}^{-1}$ . Determine the percent of reactant that has decomposed after 500 s.

- A) 69%
- B) 43%
- C) 31%
- D) 57%
- E) 37%

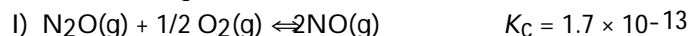
Answer: C

14) For which of the following reactions does  $K_p = K_c$ ?

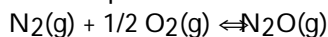
- A)  $3\text{Fe(s)} + 4\text{H}_2\text{O(g)} \rightleftharpoons \text{Fe}_3\text{O}_4\text{(s)} + 4\text{H}_2\text{(g)}$
- B)  $\text{C(s)} + \text{H}_2\text{O(g)} \rightleftharpoons \text{CO(g)} + \text{H}_2\text{(g)}$
- C)  $\text{H}_2\text{(g)} + \text{I}_2\text{(s)} \rightleftharpoons 2\text{HI(g)}$
- D)  $2\text{SO}_2\text{(g)} + \text{O}_2\text{(g)} \rightleftharpoons 2\text{SO}_3\text{(g)}$

Answer: A

15) Given the following:



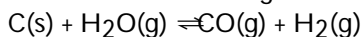
Find the value of the equilibrium constant for the following equilibrium reaction:



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

Answer: B

16) Consider the following reaction.



At equilibrium at a certain temperature,  $[\text{H}_2\text{O(g)}] = 0.12 \text{ M}$ , and  $[\text{CO(g)}] = [\text{H}_2\text{(g)}] = 1.2 \text{ M}$ . If suddenly these concentrations are increased by  $0.50 \text{ M}$ , which of the following is true?

- A) Since  $K_C$  does not change, nothing happens.      B) more products are formed  
C)  $K_C = 4.66$       D) more  $\text{H}_2\text{O(g)}$  will be formed

Answer: B

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

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

Answer: C, D

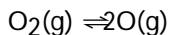
18) For the reaction;  $\text{N}_2\text{(g)} + 3 \text{ H}_2\text{(g)} \rightleftharpoons 2 \text{ NH}_3\text{(g)}$ , the equilibrium amount of  $\text{NH}_3$  will be increased by:

I. increasing the pressure    II. adding  $\text{H}_2$     III. removing  $\text{N}_2$     IV. decreasing the pressure

- A) III only      B) II, III      C) I, II      D) I, III      E) II, IV

Answer: C

19) For the following reaction

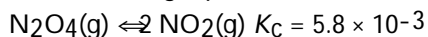


what conditions favor production of oxygen atoms?

- A) low temperature and high pressure      B) high temperature and high pressure  
C) high temperature and low pressure      D) low temperature and low pressure

Answer: C

20) Consider the following equation:



If the initial concentration of  $\text{N}_2\text{O}_4\text{(g)} = 0.040 \text{ M}$  and the initial concentration of  $\text{NO}_2\text{(g)}$  is  $0 \text{ M}$ , what is the equilibrium concentration of  $\text{N}_2\text{O}_4\text{(g)}$ ?

- A)  $2.3 \times 10^{-6} \text{ M}$   
B)  $3.3 \times 10^{-2} \text{ M}$   
C)  $1.9 \times 10^{-2} \text{ M}$   
D)  $1.7 \times 10^{-2} \text{ M}$   
E)  $2.6 \times 10^{-2} \text{ M}$

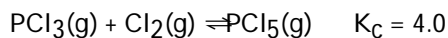
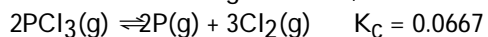
Answer: B

21) For the reaction  $2 \text{ NO(g)} \rightleftharpoons \text{N}_2\text{O}_4\text{(g)}$   $K_P$  equals:

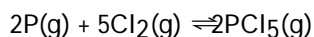
- A)  $K_C(\text{RT})$       B)  $\text{RT}/K_C$       C)  $K_C$       D)  $K_C/\text{RT}$       E)  $K_C(\text{RT})^2$

Answer: D

22) Given the following reactions,



calculate  $K_C$  for the reaction below.



A) 23

B) 240

C) 1.1

D) 60

Answer: B

23) For a reaction, the reaction quotient,  $Q_C > K$ , the reaction:

A) shifts to the left

B) shifts to the right

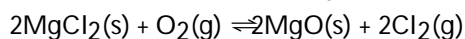
C) is exothermic

D) is at equilibrium

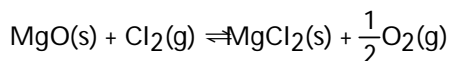
E) is endothermic

Answer: A

24) At a certain temperature,  $K_C = 0.0500$  and  $\Delta H = +39.6$  kJ for the reaction below.



Calculate  $K_C$  for the reaction



and indicate whether the value will be larger or smaller at a lower temperature.

A) 4.47, larger

B) 0.224, smaller

C) 0.224, larger

D) 400, smaller

Answer: A

25) For the reaction:  $2\text{NO}_2(\text{g}) \rightleftharpoons \text{NO}(\text{g}) + \text{O}_2(\text{g})$ , the partial pressure of  $\text{O}_2(\text{g})$  at equilibrium is 0.3500 atm.  $P_{\text{total}} = 1.0866$  atm. What is  $K_P$  for this reaction?

A) 2.86

B) 128

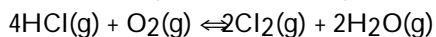
C) 0.350

D) 182

E) 66.9

Answer: B

26) A mixture, containing 0.0750 M  $\text{HCl}(\text{g})$  and 0.0330 M  $\text{O}_2(\text{g})$  is allowed to come to equilibrium at 480 °C.



At equilibrium  $[\text{Cl}_2] = 0.030$  M. What is the value of  $K_C$ ?

A) 890

B) 0.13

C) 1.3

D) 480

E)  $1.1 \times 10^{-3}$

Answer: A

27) Which of the following is the strongest base?

A)  $\text{Cl}^-$

B)  $\text{H}_2\text{O}$

C)  $\text{NO}_3^-$

D)  $\text{ClO}_4^-$

E)  $\text{F}^-$

Answer: E

28) Choose the INCORRECT statement. The term pH:

A)  $= -\log [\text{H}_3\text{O}^+]$

B)  $= -\ln [\text{H}^+]$

C) is more convenient than exponential notation

D) refers to the "potential" of hydrogen ion

E)  $= 14 - \text{pOH}$

Answer: B

29) 0.272 g of a monoprotic solid acid (mw = 189 g/mol) is dissolved in water to produce 25.0 mL of a solution with pH = 4.93. Determine the ionization constant of the acid.

- A)  $2.8 \times 10^{-7}$       B)  $4.1 \times 10^{-8}$       C)  $2.4 \times 10^{-9}$       D)  $1.4 \times 10^{-10}$       E)  $2.1 \times 10^{-4}$

Answer: C

30) For which of the following polyprotic acids is the first ionization step approximately 100%?

- A)  $\text{H}_2\text{CO}_3$       B)  $\text{H}_2\text{S}$       C)  $\text{H}_3\text{PO}_4$       D)  $\text{H}_2\text{SO}_3$       E)  $\text{H}_2\text{SO}_4$

Answer: E

31) What is the  $[\text{HPO}_4^{2-}]$  of a solution labeled "0.10 M Phosphoric Acid"?

$$[K_{a1} = 7.1 \times 10^{-3}; K_{a2} = 6.3 \times 10^{-8}; K_{a3} = 4.2 \times 10^{-13}]$$

- A)  $1.6 \times 10^{-9}$       B)  $4.2 \times 10^{-13}$       C)  $1.6 \times 10^{-16}$       D)  $6.3 \times 10^{-8}$       E)  $7.1 \times 10^{-3}$

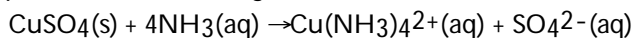
Answer: D

32) The pH of a solution of  $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$  is approximately 7. The best explanation is:

- A) Aqueous ammonia and acetic acid have approximately equal ionization constants.  
B) Ammonium acetate is a weak electrolyte.  
C) The salt is a product of a strong acid and a strong base.  
D) This salt does not react with water.  
E) All salts of weak acids and weak bases are neutral.

Answer: A

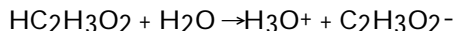
33) Which species in the following reaction acts as a Lewis acid?



- A)  $\text{Cu}(\text{NH}_3)_4^{2+}$   
B)  $\text{Cu}^{2+}$   
C)  $\text{SO}_4^{2-}$   
D)  $\text{NH}_3$   
E) All are acids.

Answer: B

34) Consider the reaction:



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

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

Answer: A

35) A saturated aqueous solution of calcium hydroxide is approximately 0.13% calcium hydroxide, by mass, and has a density of  $1.02 \text{ g ml}^{-1}$ . What is the pH of such a solution?

- A) 11.95      B) 12.25      C) 12.75      D) 13.00      E) 12.55

Answer: E

- 36) Hypochlorous acid (HOCl) has an ionization constant of  $3.2 \times 10^{-8}$ . What is its percent ionization in 1.0 M and 0.10 M solutions, respectively?
- A) 0.57% and 0.18%
  - B) 0.32% in both
  - C) 0.032% and 0.0032%
  - D) 0.57% in both
  - E) 0.018% and 0.057%

Answer: E

- 37) For the following compound, predict whether the solution is acidic, basic or neutral and why:  $\text{NaC}_2\text{H}_3\text{O}_2$ .
- A) basic because it is a weak base
  - B) acidic because it is a strong acid
  - C) neutral because there is no hydrolysis
  - D) basic because it is the salt of a weak acid
  - E) acidic because it is the salt of a weak base

Answer: D

- 38) What is the pH of a 0.052 M solution of sodium acetate?  $K_a = 1.8 \times 10^{-5}$
- A) 5.3
  - B) 10.0
  - C) 3.0
  - D) 8.7
  - E) 11.0

Answer: D

- 39) List the following acids in order of increasing strength:

- HBrO      HIO      HClO
- A) HIO < HClO < HBrO
  - B) HBrO < HIO < HClO
  - C) HClO < HIO < HBrO
  - D) HClO < HBrO < HIO
  - E) HIO < HBrO < HClO

Answer: E

- 40) Which indication of relative acid strengths is INCORRECT?

- A)  $\text{HCl} > \text{HF}$
- B)  $\text{H}_2\text{SO}_3 > \text{HNO}_3$
- C)  $\text{HClO}_2 > \text{HClO}$
- D)  $\text{CH}_3\text{CO}_2\text{H} > \text{CH}_3\text{CH}_2\text{OH}$
- E)  $\text{H}_2\text{SO}_4 > \text{H}_2\text{SO}_3$

Answer: B