

## 1012\_1st Exam\_1020320

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

1) What is the main difference between a Pt catalyst and an enzyme catalyst?

- A) A Pt catalyst is always a homogeneous catalyst.
- B) The enzyme causes a faster reaction.
- C) The Pt catalyst causes a faster reaction.
- D) An enzyme has greater substrate specificity.
- E) A Pt catalyst is an enzyme.

Answer: D

2) 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) the reaction rate is second order in [A]
- C) the reaction rate is zero order in [A]
- D) the reaction rate is first order in [A]
- E) A is not involved in the reaction

Answer: C

3) A factor that decreases the activation energy for a reaction:

- I) decreases the rate constant
- II) increases the rate constant
- III) has no effect on the rate constant
- IV) makes the product yield increase
- V) might be a catalyst

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

Answer: C

4) For the second order reaction  $A \rightarrow \text{products}$ , the following data are obtained:

- [A] = 1.512 M,  $t = 0$  min
- [A] = 1.490 M,  $t = 1.0$  min
- [A] = 1.469 M,  $t = 2.0$  min

What is the concentration of [A] in the experiment after 4.0 min for the reaction?

- A) 1.61 M      B) 1.43 M      C) 1.37 M      D) 1.40 M      E) 1.35 M

Answer: B

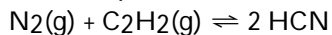
5) In a second order reaction:

- 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  $M^{-2}s^{-1}$  or  $M^{-2}min^{-1}$ .

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

Answer: B

- 6) Given that the equilibrium concentrations of  $[N_2] = 0.035 \text{ M}$ ,  $[C_2H_2] = 0.057 \text{ M}$ , and  $[HCN] = 6.8 \times 10^{-4} \text{ M}$ , find the value of the equilibrium constant expression for the reaction:



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

Answer: B

- 7) What is the  $[HPO_4^{2-}]$  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)  $4.2 \times 10^{-13} \text{ M}$   
 B)  $1.6 \times 10^{-9} \text{ M}$   
 C)  $1.6 \times 10^{-16} \text{ M}$   
 D)  $6.3 \times 10^{-8} \text{ M}$   
 E)  $7.1 \times 10^{-3} \text{ M}$

Answer: D

- 8) 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) 31%                      B) 69%                      C) 37%                      D) 43%                      E) 57%

Answer: A

- 9) For the reaction:  $2NO_2(g) \rightarrow 2NO(g) + O_2(g)$  concentration-time data are:

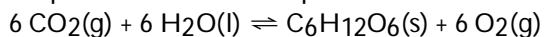
t(s)	$[NO_2]$	$\ln[NO_2]$	$\frac{1}{[NO_2]}$
0.00	2.000	0.300	0.500
0.40	1.467	0.166	0.682
0.80	1.076	0.032	0.929
1.20	0.789	-0.103	1.267
1.60	0.579	-0.237	1.727
2.00	0.424	-0.373	2.358

What is the order of the reaction with respect to  $[NO_2]$ ?

- A) first                      B) third                      C) second                      D) zero                      E) 2 + 2

Answer: A

10) Write the equilibrium constant expression for the following reaction:



A)  $K_c = \frac{[\text{O}_2]^6}{[\text{CO}_2]^6}$

B)  $K_c = \frac{[\text{C}_6\text{H}_{12}\text{O}_6]}{[\text{H}_2\text{O}]^6[\text{CO}_2]^6}$

C)  $K_c = \frac{[\text{CO}_2]^6}{[\text{C}_6\text{H}_{12}\text{O}_6]}$

D)  $K_c = \frac{[\text{CO}_2]^6[\text{H}_2\text{O}]^6}{[\text{O}_2]^6}$

E)  $K_c = \frac{[\text{O}_2]}{[\text{CO}_2]}$

Answer: A

11) Choose the INCORRECT statement.

A) A reversible chemical reaction is one in which equilibrium is never established due to the constant decomposition of the products.

B) When the rate of the reverse reaction equals the rate of the forward reaction, equilibrium has been established.

C) Chemical equilibrium is a dynamic equilibrium.

D) A certain amount of energy, called the activation energy, must be available if a reaction is to take place.

E) Changes in temperature will change the value of an equilibrium constant.

Answer: A

12) What is the pH of a 0.475 M solution of sodium nitrite?  $K_a$  (nitrous acid) =  $7.2 \times 10^{-4}$

A) 5.59

B) 8.58

C) 12.27

D) 8.41

E) 5.42

Answer: D

13) 0.75 mol of  $\text{N}_2$  and 1.20 mol of  $\text{H}_2$  are placed in a 3.0 liter container. When the reaction

$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2 \text{NH}_3(\text{g})$  reaches equilibrium,  $[\text{H}_2] = 0.100 \text{ M}$ . Which of the following is true?

A)  $[\text{NH}_3] = 0.150 \text{ M}$

B)  $[\text{NH}_3] = 0.200$

C)  $[\text{N}_2] = 0.650 \text{ M}$

D)  $[\text{N}_2] = 0.250$

E)  $[\text{NH}_3] = [\text{H}_2] = 0.05 \text{ M}$

Answer: B

14) Equilibrium constant  $K$  is constant except when one varies the:

A) concentration of the products

B) temperature of the reaction

C) concentrations of the reactants

D) partial pressures of the reactants

E)  $K$  always remains constant

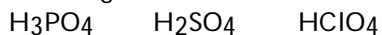
Answer: B

15) Choose the INCORRECT statement.

- A) The rate-determining step is always the first step.
- B) An elementary process is a step in the mechanism.
- C) A bimolecular process is one involving a collision of two molecules.
- D) A unimolecular process is one in which a single molecule dissociates.
- E) A reaction mechanism is a step-by-step detailed description of a chemical reaction.

Answer: A

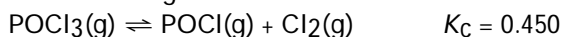
16) List the following acids in order of increasing strength:



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

Answer: D

17) Consider the following reversible reaction:



The following initial amounts of reactants and products were mixed:  $[\text{POCl}_3] = 0.750 \text{ M}$ ,  $[\text{POCl}] = 0.550 \text{ M}$ , and  $[\text{Cl}_2] = 0.150 \text{ M}$ . What is the equilibrium concentration of  $\text{POCl}$ ?

- A) 0.360 M
- B) 0.395 M
- C) 0.155 M
- D) 0.945 M
- E) 0.740 M

Answer: E

18) 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)  $1.54 \times 10^{-4} \text{ M/s}$
- C)  $1.54 \times 10^{-4} \text{ moles/s}$
- D) 0.0154 M/s
- E)  $1.54 \times 10^{-4} \text{ moles}$

Answer: B

19) List the following acids in order of increasing strength:



- A)  $\text{HClO} < \text{HIO} < \text{HBrO}$
- B)  $\text{HClO} < \text{HBrO} < \text{HIO}$
- C)  $\text{HBrO} < \text{HIO} < \text{HClO}$
- D)  $\text{HIO} < \text{HBrO} < \text{HClO}$
- E)  $\text{HIO} < \text{HClO} < \text{HBrO}$

Answer: D

20) If one mole of  $\text{Ba}(\text{OH})_2$  is added to enough water to make 10 liters of solution, the pH of the resulting solution is

- A) 13.0
- B) 1.0
- C) 12.5
- D) 0.7
- E) 13.3

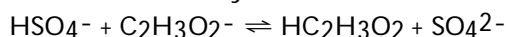
Answer: E

21)  $\text{CO}_2$  acts as an acid in the reaction  $\text{CaO(s)} + \text{CO}_2 \rightleftharpoons \text{CaCO}_3\text{(s)}$  because it \_\_\_\_\_.

- A) reacts with a metal
- B) is a proton donor
- C) is an electron-pair acceptor
- D) turns blue litmus red
- E) is a gas containing a non-metal

Answer: C

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



- A) acids  $\text{SO}_4^{2-}$ ,  $\text{C}_2\text{H}_3\text{O}_2^-$       bases  $\text{HSO}_4^-$ ,  $\text{HC}_2\text{H}_3\text{O}_2$
- B) acids  $\text{SO}_4^{2-}$ ,  $\text{HC}_2\text{H}_3\text{O}_2$       bases  $\text{HSO}_4^-$ ,  $\text{C}_2\text{H}_3\text{O}_2^-$
- C) acids  $\text{HSO}_4^-$ ,  $\text{C}_2\text{H}_3\text{O}_2^-$       bases  $\text{HC}_2\text{H}_3\text{O}_2$ ,  $\text{SO}_4^{2-}$
- D) acids  $\text{HSO}_4^-$ ,  $\text{SO}_4^{2-}$       bases  $\text{HC}_2\text{H}_3\text{O}_2$ ,  $\text{C}_2\text{H}_3\text{O}_2^-$
- E) acids  $\text{HSO}_4^-$ ,  $\text{HC}_2\text{H}_3\text{O}_2$       bases  $\text{SO}_4^{2-}$ ,  $\text{C}_2\text{H}_3\text{O}_2^-$

Answer: E

23) For the following compound, predict whether the solution is acidic, basic or neutral and why:

- A) basic because  $\text{NH}_4\text{Cl}$  is the salt of a weak acid
- B) basic because  $\text{NH}_4\text{Cl}$  is a weak base
- C) acidic because  $\text{NH}_4\text{Cl}$  is a strong acid
- D) acidic because  $\text{NH}_4\text{Cl}$  is the salt of a weak base
- E) neutral because there is no hydrolysis

Answer: D

24) A solution has pOH of -0.47. This means that:

- A) the solution has a pH of 13.53
- B) the solution has an  $[\text{OH}^-] = 0.34 \text{ M}$
- C) The solution has an  $[\text{H}^+] = 2.95 \text{ M}$
- D) the solution has an  $[\text{OH}^-] = 2.95 \text{ M}$
- E) the solution has an  $[\text{OH}^-]$  greater than 10.0 M

Answer: D

25) In the reaction  $\text{BF}_3 + \text{NH}_3 \rightleftharpoons \text{F}_3\text{B:NH}_3$ ,  $\text{BF}_3$  acts as:

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

Answer: D

26) Which of the following situations involves a heterogeneous catalysis?

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

Answer: C

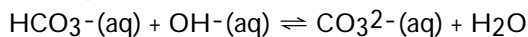
27) Data for the reaction  $A + B \rightarrow C$  are given below. Find the rate constant for this system.

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

Answer: C

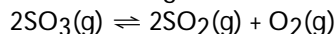
28) In the following reversible reaction the Brønsted acids are \_\_\_\_\_.



- A)  $\text{HCO}_3^-$  and  $\text{H}_2\text{O}$
- B)  $\text{HCO}_3^-$  and  $\text{CO}_3^{2-}$
- C)  $\text{OH}^-$  and  $\text{H}_2\text{O}$
- D)  $\text{OH}^-$  and  $\text{CO}_3^{2-}$
- E)  $\text{H}_2\text{O}$  and  $\text{CO}_3^{2-}$

Answer: A

29) Consider the following reaction at a certain temperature.



When the initial concentration of  $\text{SO}_3(\text{g})$  is 0.128 M, the concentration of oxygen gas at equilibrium is found to be 0.0130 M. Calculate  $K_C$  for this reaction.

- A)  $1.47 \times 10^{-3}$
- B)  $8.45 \times 10^{-4}$
- C)  $7.64 \times 10^{-5}$
- D)  $1.62 \times 10^{-2}$

Answer: B

30) 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 adding  $\text{Fe}(\text{s})$ ?

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

Answer: A

31) In the Arrhenius equation,  $\ln k = -E_a/RT + \ln A$ , the symbol  $A$  denotes:

- A) a constant that represents the frequency of collisions with the proper orientation and other steric conditions favorable for a reaction
- B) the absolute temperature
- C) the initial concentration of A
- D) the activation energy
- E) the rate constant

Answer: A

- 32) 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  $-1.2 \times 10^{-4} \text{ M/s}$ , what is the rate at which  $\text{O}_2$  is being formed?
- A)  $4.8 \times 10^{-4} \text{ M/s}$   
 B)  $2.4 \times 10^{-4} \text{ M/s}$   
 C)  $6.0 \times 10^{-5} \text{ M/s}$   
 D)  $1.2 \times 10^{-4} \text{ M/s}$   
 E)  $3.0 \times 10^{-5} \text{ M/s}$

Answer: C

- 33) 0.375 g of a monoprotic acid ( $M = 245 \text{ g/mol}$ ) is dissolved in water to produce 25.0 mL of a solution with  $\text{pH} = 3.28$ . Determine the ionization constant of the acid.
- A)  $2.3 \times 10^{-2}$       B)  $4.5 \times 10^{-3}$       C)  $4.5 \times 10^{-6}$       D)  $8.56 \times 10^{-3}$       E)  $7.4 \times 10^{-5}$

Answer: C

- 34) For the reaction:  $\text{C}_2\text{H}_4\text{Br}_2 + 3\text{KI} \rightarrow \text{C}_2\text{H}_4 + 2\text{KBr} + \text{KI}_3$

Initial rate data at  $60^\circ\text{C}$  are:

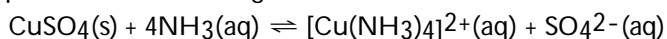
$[\text{C}_2\text{H}_4\text{Br}_2], \text{M}$	$[\text{KI}], \text{M}$	$\Delta[\text{KI}_3]/\Delta t (\text{M min})$
0.500	1.80	0.269
0.500	7.20	1.08
1.50	1.80	0.807

The rate law is \_\_\_\_\_.

- A)  $\text{rate} = k[\text{C}_2\text{H}_4\text{Br}_2]$   
 B)  $\text{rate} = k[\text{KI}]$   
 C)  $\text{rate} = k[\text{KI}][\text{C}_2\text{H}_4\text{Br}_2]^2$   
 D)  $\text{rate} = k[\text{KI}]^2$   
 E)  $\text{rate} = k[\text{KI}][\text{C}_2\text{H}_4\text{Br}_2]$

Answer: E

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



- A)  $\text{NH}_3$   
 B)  $\text{SO}_4^{2-}$   
 C)  $[\text{Cu}(\text{NH}_3)_4]^{2+}(\text{aq})$   
 D)  $\text{Cu}^{2+}$   
 E)  $[\text{Cu}(\text{NH}_3)_4]^{2+}(\text{aq})$  and  $\text{SO}_4^{2-}$

Answer: D

- 36) Which of the following statements is true about the reaction  $2\text{A} \rightarrow \text{B} + \text{C}$  which is first order in A and first order overall?

- A) The rate of formation of C is twice the rate of reaction of A.  
 B) The rate of the reaction will decrease at higher concentrations of B and C.  
 C) The time required for one half of A to react is directly proportional to the quantity of A.  
 D) The rate of formation of B is the same as the rate of reaction of A.  
 E) The initial rate doubles with doubling of initial concentration of A.

Answer: E

- 37) A saturated aqueous solution of calcium hydroxide has a pH of 12.25. What is the  $[\text{Ca}^{2+}]$  of such a solution?  
A)  $5.6 \times 10^{-13}$       B) 0.018      C)  $8.9 \times 10^{-3}$       D)  $2.3 \times 10^{-5}$       E) 0.035

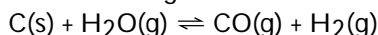
Answer: C

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

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

Answer: D

- 39) 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 M, which of the following is true?

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

Answer: C

- 40) 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. What is the half-life at 310 K?

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

Answer: B

- 41) 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)  $9.24 \times 10^{-3} \text{ min}^{-1}$
- C)  $2.67 \times 10^{-2} \text{ min}^{-1}$
- D)  $52.0 \text{ min}^{-1}$
- E)  $1.54 \times 10^{-4} \text{ min}^{-1}$

Answer: B

- 42) For  $2 \text{NO}_2\text{(g)} \rightleftharpoons \text{N}_2\text{O}_4\text{(g)}$ ,  $K_C = [\text{N}_2\text{O}_4]/[\text{NO}_2]^2$ . At equilibrium there are 0.0270 mol  $\text{N}_2\text{O}_4$  and 0.450 mol  $\text{NO}_2$  in a 50.0-L container. What is  $K_C$ ?

- A) 0.133
- B) 6.81
- C) 0.00267
- D) 6.67
- E) 2.45

Answer: D

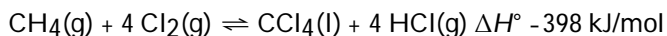


43) In the equilibrium system described by:  $\text{PO}_4^{3-}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{HPO}_4^{2-}(\text{aq}) + \text{OH}^-(\text{aq})$  Brønsted-Lowry theory would designate:

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

Answer: B

44) Consider the reaction:



The equilibrium is displaced to the right if:

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

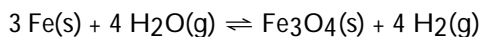
Answer: A

45) What is the pH of a 0.375 M solution of benzoic acid?  $K_a = 6.3 \times 10^{-5}$

- A) 8.9
- B) 11.7
- C) 5.1
- D) 2.3
- E) 0.43

Answer: D

46) For the reaction:

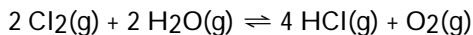


write the expression for  $K_p$ .

- A)  $\frac{[\text{Fe}_3\text{O}_4][\text{H}_2]}{[\text{Fe}][\text{H}_2\text{O}]}$
- B)  $\frac{[\text{Fe}_3\text{O}_4] P(\text{H}_2)}{[\text{Fe}] P(\text{H}_2\text{O})}$
- C)  $\frac{P(\text{H}_2)^4}{P(\text{H}_2\text{O})^4}$
- D)  $\frac{[\text{Fe}_3\text{O}_4][\text{H}_2]^4}{[\text{Fe}][\text{H}_2\text{O}]^4}$
- E)  $\frac{P(\text{H}_2)}{P(\text{H}_2\text{O})}$

Answer: C

47) 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  $25^\circ\text{C}$ .  $R = 0.0831 \text{ bar L / K mol}$



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

Answer: E

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

Answer: A

49) For the reaction  $\text{CO}(\text{g}) + 3 \text{H}_2(\text{g}) \rightleftharpoons \text{H}_2\text{O}(\text{g}) + \text{CH}_4(\text{g})$ ,  $K_c = 190$  at  $1000 \text{ K}$ . If a vessel is filled with these gases such that the initial concentrations are  $[\text{CO}] = 0.036 \text{ M}$ ,  $[\text{H}_2] = 0.045$ ,  $[\text{H}_2\text{O}] = 0.020$ , and  $[\text{CH}_4] = 0.031$ , in which direction will a reaction occur and why?

- A) toward products because  $Q/K_c = 4.1$
- B) toward products because  $Q/K_c = 0.38$
- C) toward reactants because  $Q/K_c = 61$
- D) toward reactants because  $Q/K_c = 0.24$
- E) it is at equilibrium because  $Q/K_c = 1$

Answer: E

50) 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) 12.25
- B) 12.75
- C) 13.00
- D) 12.55
- E) 11.95

Answer: D