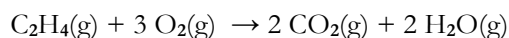


CHEM-1212
Spring 2016
First Examination
Form A

Multiple Choice - Choose the BEST Answer

1. Consider the combustion of ethylene below:



The concentration of C_2H_4 decreases at the rate of 0.036 M/s over a given time period. What is the rate of formation of CO_2 over the same period of time?

- A) 0.072 M/s
- B) 0.036 M/s
- C) -0.072 M/s
- D) -0.018 M/s
- E) 0.018 M/s

2. Consider the following reaction:



The initial rate of reaction is measured at several different concentrations of the reactants with the following results:

$[\text{ClO}_2] \text{ (M)}$	$[\text{OH}^-] \text{ (M)}$	Initial Rate (M/s)
0.060	0.030	0.0248
0.020	0.030	0.00276
0.020	0.090	0.00828

From the data above, which of the following is the correct rate law and the rate constant for the reaction?

- A) Rate = $57 \text{ M}^{-1}\text{s}^{-1}[\text{ClO}_2][\text{OH}^-]$
- B) Rate = $3.0 \text{ M}^{-1/2}\text{s}^{-1}[\text{ClO}_2][\text{OH}^-]^{1/2}$
- C) Rate = $310 \text{ M}^{-3}\text{s}^{-1}[\text{ClO}_2][\text{OH}^-]^2$
- D) Rate = $230 \text{ M}^{-2}\text{s}^{-1}[\text{ClO}_2]^2[\text{OH}^-]$
- E) Rate = $91 \text{ M}^{-2}\text{s}^{-1}[\text{ClO}_2][\text{OH}^-]^2$

3. Molecular Iodine, $\text{I}_2(\text{g})$ dissociates into iodine atoms at 625 K with a first-order rate constant of 0.271 s^{-1} . If you start with 0.50 M I_2 at this temperature, how much will remain after 5.12 s?

- A) 0.12 M
- B) 0.23 M
- C) 2.1 M
- D) 0.30 M
- E) 3.4 M

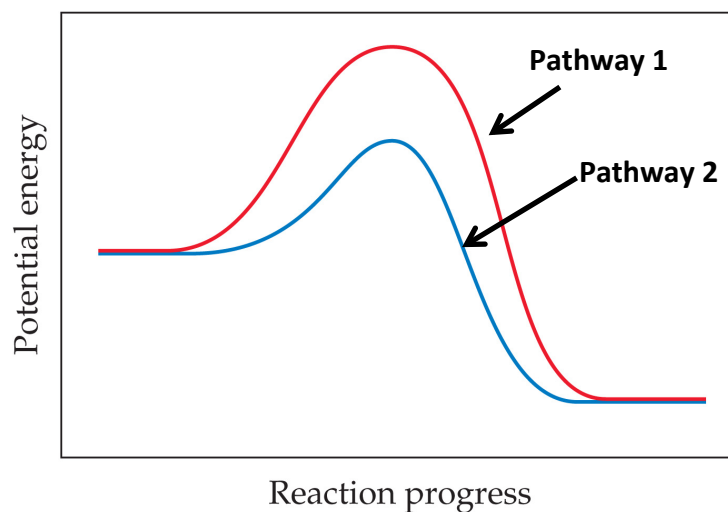
Multiple Choice - Choose the BEST Answer

4. The following reaction has a rate law of: $\text{Rate} = k[\text{B}]^2$



If the concentration of [A] is doubled, what is the effect on the rate of the reaction?

- A) The rate quadruples.
 - B) **The rate doesn't change.**
 - C) The rate doubles
 - D) The rate goes up by a factor of six.
 - E) The rate decreases.
5. The following graph shows two different reaction pathways for the same overall reaction at the same temperature. Which of the following statements is true?

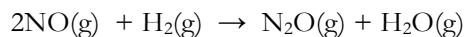


- A) The rate is faster for pathway 1 than for pathway 2.
 - B) For both paths, the rate of the reverse reaction is faster than the rate of the forward reaction.
 - C) **The energy difference between reactants and products is the same for both paths.**
 - D) For both paths, the reaction is endothermic.
 - E) Pathway 1 could be the catalyzed version of pathway 2.
6. Which of the following scenarios would increase f , the fraction of molecules that collide with sufficient energy for a given reaction to occur?
- A) Decrease the temperature of the molecules
 - B) Decrease the activation energy by adding a catalyst to the system.
 - C) Increase the temperature of the system.
 - D) **Both B and C.**
 - E) None of the above; f is a constant for a given reaction.

Multiple Choice - Choose the BEST Answer

7. The elementary step: $\text{NO(g)} + \text{NO(g)} \rightarrow \text{N}_2\text{O}_2\text{(g)}$

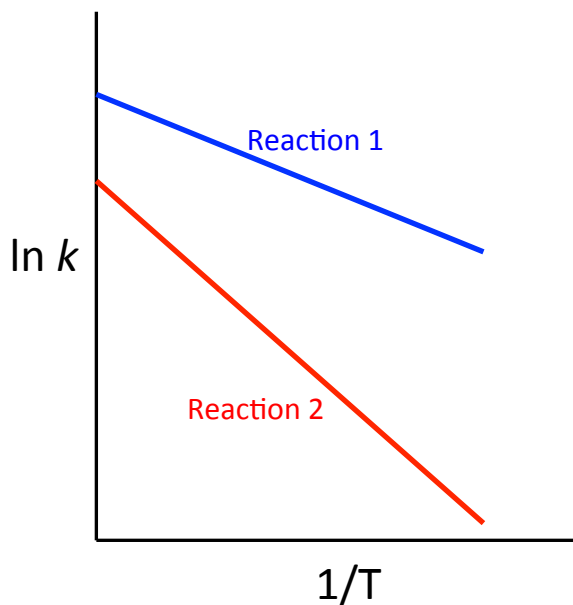
is the first of two steps in a proposed mechanism. The overall reaction is below:



Which of the following statements are true about the reaction?

- A) The elementary step shown above is bimolecular.
- B) The rate law for the elementary step shown above is: $\text{Rate} = k[\text{NO}]^2$
- C) There is at least one intermediate in the mechanism.
- D) One of the two steps in the mechanism is considered the slow step.
- E) All of the above.

8. The graph below shows plots of $\ln k$ versus $1/T$ for two different reactions. Which of the following conclusions can you make based upon the graph below?



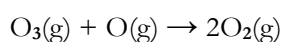
- A) Reaction 1 has a larger pre-exponential factor, A, and a larger activation energy than reaction 2.
- B) Reaction 2 has a larger pre-exponential factor, A, and a larger activation energy than reaction 1.
- C) Reaction 1 has a larger pre-exponential factor, A, and a smaller activation energy than reaction 2.
- D) Reaction 2 has a larger pre-exponential factor, A, and a smaller activation energy than reaction 1.
- E) None of the above statements are correct.

Multiple Choice - Choose the BEST Answer

9. An enzyme is a catalyst for a biological reaction. Which of the following are true?

- A) The enzyme's active site is a small region with a very specific set of conditions.
- B) Enzymes have very large, complex structures.
- C) Enzymes tend to catalyze only very specific reactions of a given molecule.
- D) The enzyme and substrate are held together by intermolecular forces.
- E) All of the above are true.

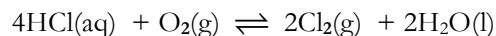
10. You decide to decrease the rate of the following *overall reaction* occurring in the stratosphere:



Which of the following is(are) feasible changes?

- A) Decrease the rate of the slowest elementary step.
- B) Increase the rate of the fastest elementary step.
- C) Capture and decrease the concentration of the catalyst.
- D) A and C only
- E) A, B and C.

11. Which of the following is the appropriate equilibrium constant expression?



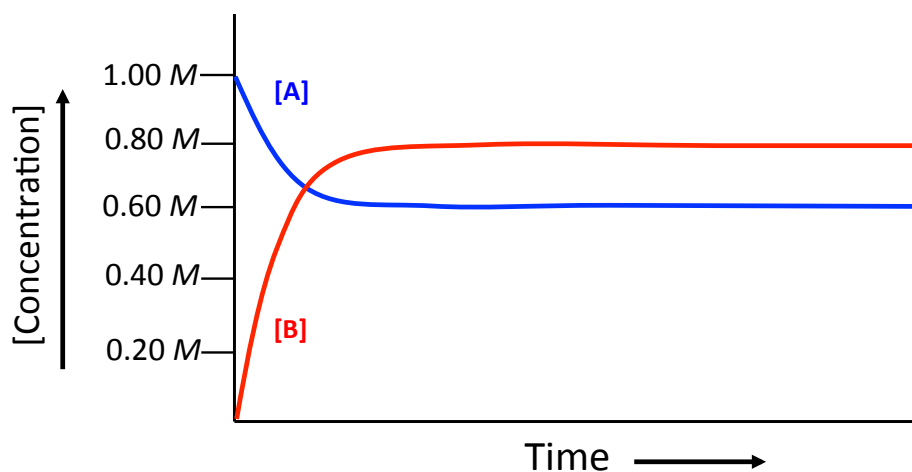
- A) $K_c = \frac{[\text{HCl}][\text{O}_2]}{[\text{Cl}_2][\text{H}_2\text{O}]}$
- B) $K_c = \frac{[\text{Cl}_2][\text{H}_2\text{O}]}{[\text{HCl}][\text{O}_2]}$
- C) $K_c = \frac{[\text{Cl}_2]^2[\text{H}_2\text{O}]^2}{[\text{HCl}]^4[\text{O}_2]}$
- D) $K_c = \frac{[\text{Cl}_2]^2}{[\text{O}_2]}$
- E) $K_c = \frac{[\text{Cl}_2]^2}{[\text{HCl}]^4[\text{O}_2]}$

Multiple Choice - Choose the BEST Answer

12. Which of the following statements is(are) true about dynamic equilibrium?

- A) Once a system reaches equilibrium, the concentrations of the mixture of reactants and products no longer change with time.
- B) A system can achieve chemical equilibrium by the forward or the reverse direction.
- C) Equilibrium is achieved with the opposing reactions proceeding at equal rates.
- D) Once a system reaches equilibrium, the reactants and products do not stop reacting.
- E) All of the above statements are true about dynamic equilibrium.

13. Consider the reaction: $A(g) \rightleftharpoons 2 B(g)$. The graph below shows the concentration of A and B as a function of time at constant temperature. What is the equilibrium constant for this reaction at this temperature?



- A) $K_c = 1.0$
- B) $K_c = 1.1$
- C) $K_c = 1.3$
- D) $K_c = 0.75$
- E) $K_c = 0.90$

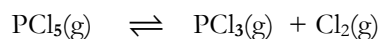
14. Consider the reaction, $4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$ $\Delta H = -904.4 \text{ kJ/mol rxn}$
Which of the following will increase the yield of NO at equilibrium?

- I. Increase the concentration of NH_3 .
- II. Decrease the volume of the container in which the reaction occurs.
- III. Increase the partial pressure of H_2O .

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

Multiple Choice - Choose the BEST Answer

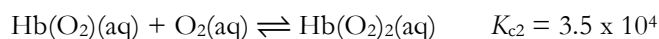
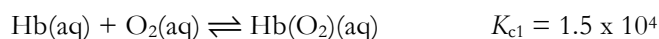
15. A system is described by the following reaction:



The system is at equilibrium, at a given temperature and when $[\text{PCl}_5] = 0.83M$, $[\text{PCl}_3] = 0.15M$, $[\text{Cl}_2] = 0.32M$ and $K_c = 0.0578$. An additional 0.12 mols of $\text{Cl}_2(\text{g})$ is added to the 1.0 L system at the same temperature. What is the concentration, in molarity, of Cl_2 when the system returns to equilibrium?

- A) 0.41 M
- B) 0.016 M
- C) 0.44 M
- D) 0.30 M
- E) The $[\text{Cl}_2]$ will still equal 0.32M. That is the concentration of Cl_2 at equilibrium.

16. The following K_c values were attained at 25°C:

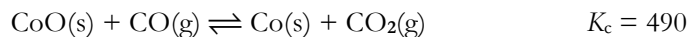
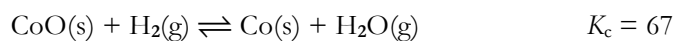


As seen above, each hemoglobin protein can bind up to four oxygen atoms at a time. How does the binding at a site on a hemoglobin affect the binding of each the subsequent O_2 ?

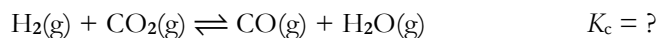
- A) It increases the tendency for O_2 to bind at other sites on the hemoglobin.
- B) It decreases the concentration of O_2 in the muscles.
- C) There is no change in hemoglobin's ability to bind oxygen.
- D) There is a reduction in the tendency for the hemoglobin to bind oxygen.
- E) With the information given above, a conclusion between the binding of oxygen to the subsequent binding sites can not be determined.

Multiple Choice - Choose the BEST Answer

17. The following equilibria were attained at 823 K:

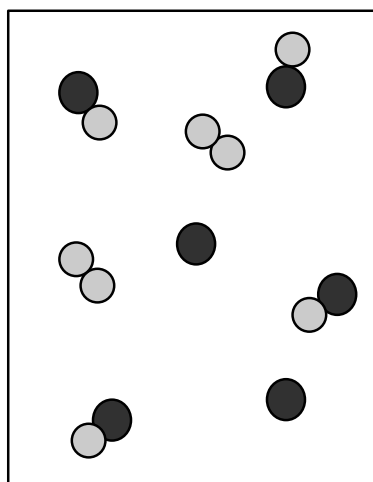


Based on these equilibria, calculate the equilibrium constant for:

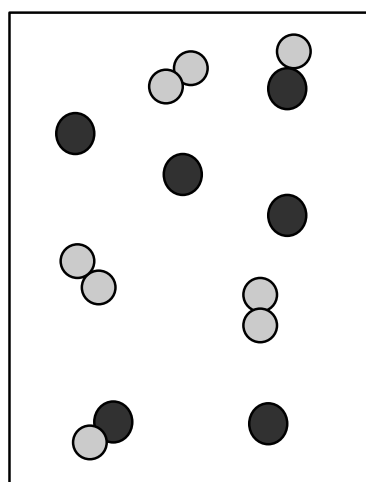


- A) $K_c = 32000$
- B) $K_c = 0.14$
- C) $K_c = 3.0 \times 10^{-5}$
- D) $K_c = 7.3$
- E) $K_c = 423$

18. The following diagrams represent equilibrium mixtures for the reaction shown below. What conclusion(s) can be made about the reaction?



300 K

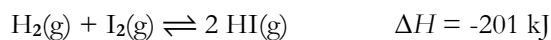


350 K

- A) The reaction is endothermic.
- B) The reaction is exothermic.
- C) The statement made above in the question is incorrect. These images cannot correlate to the same system at equilibrium.
- D) The equilibrium constant for the reaction on the left is equal to 1.
- E) None of the above conclusions can be made with the information given.

Multiple Choice - Choose the BEST Answer

19. Which of the following statement(s) is(are) true about the reaction below at 300 K?



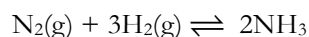
$$k_f = 8.5 \times 10^6 \text{ M}^{-1}\text{s}^{-1}$$

$$k_r = 2.5 \times 10^{-28} \text{ M}^{-1}\text{s}^{-1}$$

- I. At equilibrium, the forward reaction proceeds faster than the reverse reaction.
- II. The reaction as written is strongly product favored at equilibrium.
- III. Changing the temperature would change the rate constants for the forward and reverse reaction.

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

20. A reaction vessel is prepared by adding 98 atm NH_3 , 45 atm, N_2 and 55 atm of H_2 . The reaction:



is allowed to reach equilibrium at 450°C ; $K_p = 4.51 \times 10^{-5}$. Which of the following statements is true about the system?

- A) The rate of the reverse reaction (as written) will be greater than the rate of the forward reaction (as written) until equilibrium is established.
- B) The amount of N_2 (g) will decrease compared to the initial amount, because $Q > K$.
- C) The amount of NH_3 (g) will increase compared to the initial amount, because $Q > K$.
- D) The rate of the forward reaction (as written) will be greater than the rate of the reverse reaction (as written) until equilibrium is established.
- E) The reaction would not shift one direction or the other. The reaction will proceed with the rate of the forward equaling the rate of the reverse reaction

21. Which form of the exam do you have?

- A) A
- B) B