

CH142
Sample Exam 1 Questions

Multiple Choice

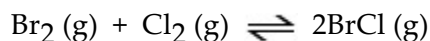
1. Which one of the following will change the value of an equilibrium constant?
 - A) changing temperature
 - B) adding other substances that do not react with any of the species involved in the equilibrium
 - C) varying the initial concentrations of reactants
 - D) varying the initial concentrations of products
 - E) changing the volume of the reaction vessel

2. The equilibrium constant for reaction 1 is K. What is the equilibrium constant for reaction 2?
 - (1) $\text{SO}_2(\text{g}) + (1/2) \text{O}_2(\text{g}) \rightleftharpoons \text{SO}_3(\text{g})$
 - (2) $2\text{SO}_3(\text{g}) \rightleftharpoons 2\text{SO}_2(\text{g}) + \text{O}_2(\text{g})$
 - A) K^2
 - B) $2K$
 - C) $1/2K$
 - D) $1/K^2$
 - E) $-K^2$

3. The equilibrium constant for the gas phase reaction
$$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$$
is $K = 4.34 \times 10^{-3}$ at 300°C . At equilibrium, which is true?
 - A) products predominate
 - B) reactants predominate
 - C) roughly equal amounts of products and reactants are present
 - D) only products are present
 - E) only reactants are present

4. Of the following equilibria, which one will shift left in response to a decrease in volume?
 - A) $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons 2 \text{HCl}(\text{g})$
 - B) $2 \text{SO}_3(\text{g}) \rightleftharpoons 2 \text{SO}_2(\text{g}) + \text{O}_2(\text{g})$
 - C) $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2 \text{NH}_3(\text{g})$
 - D) $4 \text{Fe}(\text{s}) + 3 \text{O}_2(\text{g}) \rightleftharpoons 2 \text{Fe}_2\text{O}_3(\text{s})$
 - E) $2\text{HI}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{I}_2(\text{g})$

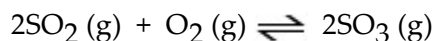
5. At 400 K, the equilibrium constant for the reaction



is $K_p = 7.0$. A closed vessel at 400 K is charged with 1.00 atm of $\text{Br}_2(\text{g})$, 1.00 atm of $\text{Cl}_2(\text{g})$, and 2.00 atm of $\text{BrCl}(\text{g})$. Use Q to determine which of the statements below is true.

- A) The equilibrium partial pressures of Br_2 , Cl_2 , and BrCl will be the same as the initial values.
 - B) The equilibrium partial pressure of Br_2 will be greater than 1.00 atm.
 - C) At equilibrium, the total pressure in the vessel will be less than the initial total pressure.
 - D) The equilibrium partial pressure of $\text{BrCl}(\text{g})$ will be greater than 2.00 atm.
 - E) The reaction will go to completion since there are equal amounts of Br_2 and Cl_2 .
6. What is the effect of a catalyst on an equilibrium?
- A) increase the rate of the forward reaction only
 - B) increase the equilibrium constant so that products are favored
 - C) slow the reverse reaction only
 - D) increase the rate at which equilibrium is achieved without changing the composition of the equilibrium mixture
 - E) shift the equilibrium to the right
7. Which of the following statements is true?
- A) Q does not change with temperature.
 - B) K does not change with temperature, whereas Q is temperature dependent.
 - C) K does not depend on the concentrations or partial pressures of reaction components.
 - D) Q does not depend on the concentrations or partial pressures of reaction components.
 - E) Q is the same as K when a reaction is at equilibrium.

8. The reaction below is exothermic:



Which will result in an increase in the number of moles of $\text{SO}_3(\text{g})$ in the reaction container?

- A) increasing the amount of SO_2
- B) decreasing the pressure
- C) increasing the temperature
- D) removing some oxygen
- E) increasing the volume of the container

9. The rate law of a reaction is $\text{rate} = k[\text{D}][\text{X}]$. What are the units of the rate constant?

- A) $\text{mol L}^{-1}\text{s}^{-1}$
- B) $\text{L mol}^{-1}\text{s}^{-1}$
- C) $\text{mol}^2 \text{L}^{-2}\text{s}^{-1}$
- D) $\text{mol L}^{-1}\text{s}^{-2}$
- E) $\text{L}^2 \text{mol}^{-2}\text{s}^{-1}$

10. The data in the table below were obtained for the reaction:

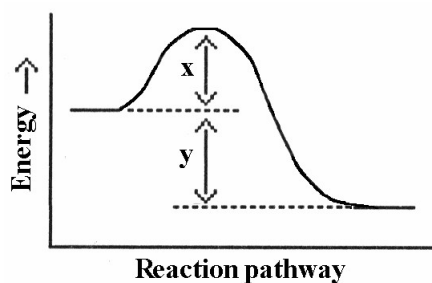


Experiment Number	[A] (M)	[B] (M)	Initial Rate (M/s)
1	0.273	0.763	2.83
2	0.273	1.526	2.83
3	0.819	0.763	25.47

What is the rate law for this reaction?

- A) $\text{rate} = k[\text{A}][\text{B}]$
- B) $\text{rate} = k[\text{P}]$
- C) $\text{rate} = k[\text{A}]^2[\text{B}]$
- D) $\text{rate} = k[\text{A}]^2[\text{B}]^2$
- E) $\text{rate} = k[\text{A}]^2$

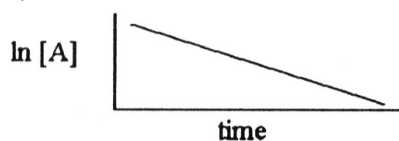
11. Which energy difference in the energy profile below corresponds to the activation energy for the back reaction?



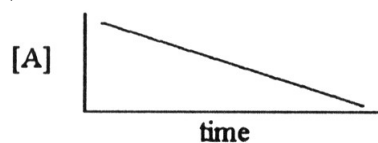
- A) x
- B) y
- C) $x + y$
- D) $x - y$
- E) $y - x$

12. Which one of the following graphs shows the correct relationship between concentration and time for a reaction that is second order in [A]?

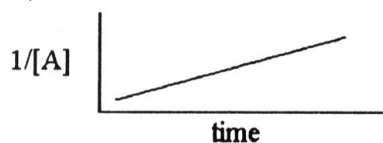
A)



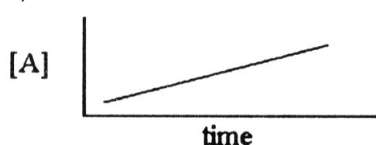
B)



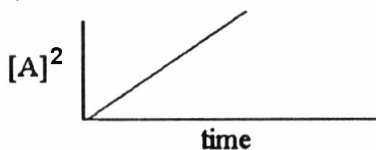
C)



D)



E)



13. What is the rate constant of a first-order process that has a half-life of 3.50 min?

A) 0.693 min^{-1}

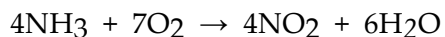
B) $1.65 \times 10^{-2} \text{ min}^{-1}$

C) 1.98 min^{-1}

D) 0.198 min^{-1}

E) $3.30 \times 10^{-3} \text{ min}^{-1}$

14. Which substance in the reaction below either appears or disappears the fastest?



A) NH_3

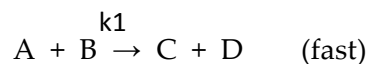
B) O_2

C) NO_2

D) H_2O

E) The rates of appearance/disappearance are the same for all of these.

15. The mechanism for formation of the product X is:



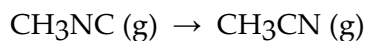
Which is an intermediate in the reaction to make X?

- A) A
- B) B
- C) C
- D) D
- E) X

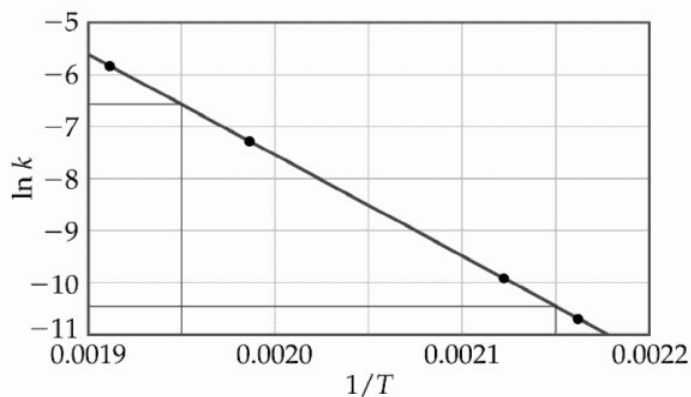
16. For the reaction in the previous question, what is the rate law for formation of product X?

- A) rate = $k_1[A]$
- B) rate = $k_1[A][B]$
- C) rate = $k_1[A][B]^2$
- D) rate = $k_2[B][D]$
- E) rate = $(k_2 + k_1)[A][B]^2[D]$

17. At elevated temperatures, methylisonitrile (CH_3NC) isomerizes to acetonitrile (CH_3CN):



The dependence of the rate constant on temperature is studied and the graph below is prepared from the results.



What is the energy of activation of this reaction in units of kJ/mol?

- A) 160
- B) 1.6×10^5
- C) 4.4×10^{-7}
- D) 4.4×10^{-4}
- E) 1.9×10^4

18. Of the following, which will lower the activation energy for a reaction?

- A) increasing the concentrations of reactants
- B) raising the temperature of the reaction
- C) adding a catalyst for the reaction
- D) removing products as the reaction proceeds
- E) increasing the pressure

19. The rate law for a reaction is

$$\text{rate} = k[A][B]$$

Which one of the following statements is false?

- A) The reaction is first order overall.
- B) The reaction is first order in A.
- C) The reaction is first order in [B].
- D) k is the reaction rate constant
- E) If [A] is doubled, the reaction rate will increase by a factor of 2.

20. Suppose the activation energy of a certain reaction is 250 kJ/mol. If the rate constant at $T_1 = 300 \text{ K}$ is k_1 and the rate constant at $T_2 = 320 \text{ K}$ is k_2 , then the reaction is ___ times faster at 320 K than at 300 K.

- A) 3×10^{-29}
- B) 0.067
- C) 15.0
- D) 267
- E) 525

Short Answer

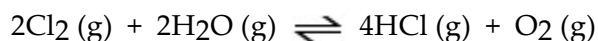
21. A flask is charged with 0.124 mol of A and allowed to react to form B according to the reaction $A(g) \rightarrow B(g)$. The following data are obtained for [A] as the reaction proceeds:

Time (s)	0.00	10.0	20.0	30.0	40.0
Moles of A	0.124	0.110	0.088	0.073	0.054

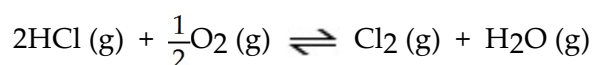
What is the average rate of disappearance of A between 10 s and 20 s?

22. The half-life of a first-order reaction is 13 min. If the initial concentration of reactant is 0.085 M, how long does it take for the reactant to decrease to 0.055 M?

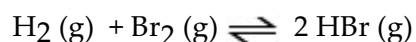
23. The K for the equilibrium below is 7.52×10^{-2} at 480.0 °C.



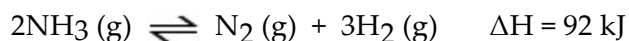
What is the value of K at this temperature for the following reaction?



24. Given the following reaction at equilibrium, if $K_c = 1.90 \times 10^{19}$ at 25.0 °C, what is the value of K_p ?



25. Consider the following reaction at equilibrium:



Which of the following will result in an increase in the moles of H_2 in the reaction container? Assume only that change. Circle all choices.

Removal of NH_3 from the reaction vessel

Decrease in the total pressure

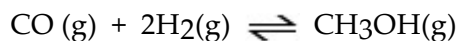
Addition of some N_2 to the reaction vessel

Decrease in the total volume of the reaction vessel

Increase in total pressure by the addition of helium gas

Increase in the temperature

26. Consider the following chemical reaction:



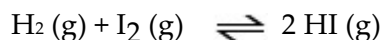
At equilibrium in a particular experiment, the concentrations of CO and H₂ were 0.15 M and 0.36, M respectively. What is the equilibrium concentration of CH₃OH? The value of K for this reaction is 14.5 at the temperature of the experiment.

27. Dinitrogen tetroxide partially decomposes according to the following equilibrium:



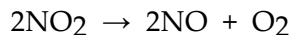
A 1.00-L flask is charged with 0.0400 mol of N₂O₄. At equilibrium at 373 K, 0.0055 mol of N₂O₄ remains. What is the value of K for this reaction?

28. The equilibrium constant K for the reaction below is 55.64.



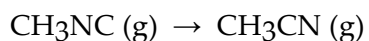
A closed 1 L vessel is charged with 1.00 mol each of H₂ and I₂. At equilibrium, what is the concentration of HI?

29. The reaction

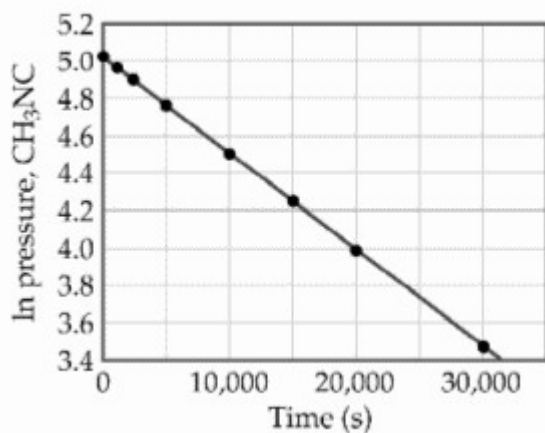


follows second-order kinetics. At 300 °C, [NO₂] drops from 0.0100 M to 0.0065 M in 100.0 s. What is the value of the rate constant?

30. At elevated temperatures, methylisonitrile (CH_3NC) isomerizes to acetonitrile (CH_3CN):

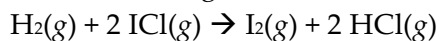


The reaction is first order in methylisonitrile. This graph shows data for the reaction obtained at 198.9°C :



What is the rate constant for the reaction?

31. Given the following data, determine the rate law for the reaction.



<i>Experiment</i>	$[\text{H}_2]$ (torr)	$[\text{ICl}]$ (torr)	<i>Rate</i> (M/s)
1	250	325	1.34
2	250	81	0.331
3	50	325	0.266