982_1st_Exam_990324

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

1) For the overall chemical reaction shown below, which one of the following statements can you rightly assume?

$2H_2S_{(g)} + O_{2(g)} \rightarrow 2S_{(s)} + 2H_2O_{(l)}$

A) The reaction is second-order overall.
B) The rate law cannot be determined from the information given.
C) The reaction is third-order overall.
D) The rate law is, rate = $k[H_2S]^2 [O_2]$.
E) The rate law is, rate = $k[H_2S] [O_2]$.

Answer: B

2) The reaction A + 2B →products was found to have the rate law, rate = $k[A] [B]^2$. While holding the concentration of A constant, the concentration of B was increased from x to 3x. Predict by what factor the rate of reaction will increase.

A) 9 B) 30 C) 27 D) 6 E) 3

Answer: A

3) For the hypothetical reaction A + 3B →2C, the rate should be expressed as

A) rate=$\frac{3\triangle[B]}{\triangle t}$ B) rate=$\frac{\triangle[A]}{\triangle t}$ C) rate=$\frac{\triangle[C]}{\triangle t}$ D) rate=$\frac{\triangle[C]}{2\triangle t}$ E) rate=$\frac{\triangle[B]}{3\triangle t}$

Answer: D

4) The units for a first-order rate constant are

A) $1/M^2$ s B) 1/M s C) 1/s D) M/s

Answer: C

5) Nitric oxide reacts with hydrogen to form nitrous oxide, and water. Use the following data to determine the rate law for the reaction.

$2NO + H_2 \rightarrow N_2O + H_2O$

Expt.#	$[NO]_0$	$[H_2]_0$	Initial rate
1	0.021	0.065	1.46 M/min
2	0.021	0.260	1.46 M/min
3	0.042	0.065	5.84 M/min

A) rate = $k[NO]^2[H_2]^2$
B) rate = $k[NO]$
C) rate = $k[NO]^2[H_2]$
D) rate = $k[NO][H_2]$
E) rate = $k[NO]^2$

Answer: E

6) A certain first-order reaction A →B is 25% complete in 42 min at 25 . What is the half-life of the reaction?

A) 84 min B) 42 min C) 21 min D) 120 min E) 101 min

Answer: E

7) The reaction $2NO_{2(g)} \rightarrow 2NO_{(g)} + O_{2(g)}$ is suspected to be second order in NO_2. Which of the following kinetic plots would be the most useful to prove whether or not the reaction is second order?

A) a plot of ln $[NO_2]^{-1}$ vs. t

B) a plot of $[NO_2]^{-1}$ vs. t

C) a plot of ln $[NO_2]$ vs. t

D) a plot of $[NO_2]$ vs. t

E) a plot of $[NO_2]^2$ vs. t

Answer: B

8) For the chemical reaction A →C, a plot of 1/[A] versus time was found to give a straight line with a positive slope. What is the order of reaction?

A) Such a plot cannot reveal the order of the reaction.

B) zero

C) second

D) first

Answer: C

9) For the hypothetical reaction A + 3B →2C, the rate of appearance of C given by ($\triangle[C]/\triangle t$) may also be expressed as

A) $\frac{\triangle[C]}{\triangle t} = \frac{\triangle[A]}{\triangle t}$ B) $\frac{\triangle[C]}{\triangle t} = \frac{-2/3\triangle[B]}{\triangle t}$ C) $\frac{\triangle[C]}{\triangle t} = \frac{-\triangle[B]}{2/3\triangle t}$ D) $\frac{\triangle[C]}{\triangle t} = \frac{-1/2\triangle[A]}{\triangle t}$

Answer: B

10) Which one of the following changes would alter the rate constant (k) for the reaction 2A + B →products?

A) measuring k again after the reaction has run for a while

B) increasing the concentration of A

C) increasing the temperature

D) increasing the concentration of B

Answer: C

11) The Arrhenius equation is $k = A\, e^{-(Ea / RT)}$

The slope of a plot of ln k vs. 1/T is equal to:

A) —Ea/R B) k C) A D) Ea E) —k

Answer: A

12) The rate law for the reaction $2NO_2 + O_3 \rightarrow N_2O_5 + O_2$ is rate = $k[NO_2][O_3]$. Which one of the following mechanisms is consistent with this rate law?

A) $NO_2 + O_3 \rightarrow NO_3 + O_2$ (slow)
$NO_3 + NO_2 \rightarrow N_2O_5$ (fast)

B) $NO_2 + NO_2 \rightarrow N_2O_2 + O_2$ (slow)
$N_2O_2 + O_3 \rightarrow N_2O_5$ (fast)

C) $NO_2 + O_3 \rightarrow NO_5$ (fast)
$NO_5 + NO_5 \rightarrow N_2O_5 + 5/2O_2$ (slow)

D) $NO_2 + NO_2 \rightarrow N_2O_4$ (fast)
$N_2O_4 + O_3 \rightarrow N_2O_5 + O_2$ (slow)

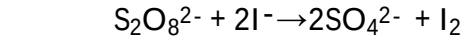
Answer: A

13) Complete this statement: A catalyst

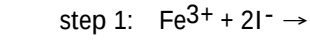
A) increases the concentration of reactants.
B) increases the collision frequency of reactant molecules.
C) increases the activation energy.
D) alters the reaction mechanism.
E) increases the average kinetic energy of the reactants.

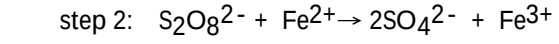
Answer: D

14) Peroxodisulfate ion can oxidize iodide ions to iodine according to the balanced equation



The reaction is catalyzed by certain chemical species. Identify the catalyst in the following mechanism:

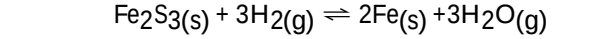
step 1: 

step 2: 

A) Fe^{3+} B) Fe^{2+} C) I^- D) $S_2O_8^{2-}$ E) SO_4^{2-}

Answer: A

15) Which is the correct equilibrium constant expression for the following reaction?



A) $K_c = [Fe]\,[H_2O] / [Fe_2O_3]\,[H_2]$
B) $K_c = [H_2] / [H_2O]$
C) $K_c = [Fe_2O_3]\,[H_2]^3 / [Fe]^2[H_2O]^3$
D) $K_c = [Fe]^2[H_2O]^3 / [Fe_2O_3]\,[H_2]^3$
E) $K_c = [H_2O]^3 / [H_2]^3$

Answer: E

16) The following reactions occur at 500°K. Arrange them in order of increasing tendency to proceed to completion (least → greatest tendency).

1. $2NOCl \leftrightarrow 2NO + Cl_2$ $Kp=1.7 \times 10^{-2}$
2. $2SO_3 \leftrightarrow 2SO_2 + O_2$ $Kp=1.3 \times 10^{-5}$
3. $2NO_2 \leftrightarrow 2NO + O_2$ $Kp=5.9 \times 10^{-5}$

A) 1 < 2 < 3 B) 3 < 1 < 2 C) 2 < 3 < 1 D) 3 < 2 < 1 E) 2 < 1 < 3

Answer: C

17) Consider the two gaseous equilibria

$SO_{2(g)} + \frac{1}{2}O_{2(g)} \rightleftharpoons SO_{3(g)}$ K_1

$2SO_{3(g)} \rightleftharpoons 2SO_{2(g)} + O_{2(g)}$ K_2

The values of the equilibrium constants K_1 and K_2 are related by

A) $K_2 = (K_1)^2$

B) $K_2^2 = K_1$

C) none of the above

D) $K_2 = \frac{1}{K_1^2}$

E) $K_2 = \frac{1}{K_2}$

Answer: D

18) The equilibrium constant for the reaction

$Ni_{(s)} + 4CO_{(g)} \leftrightarrow Ni(CO)_{4(g)}$

is 5.0×10^4 at 25°C. What is the equilibrium constant for the reaction below?

$Ni(CO)_{4(g)} \rightleftharpoons Ni_{(s)} + 4CO_{(g)}$

A) 5.0×10^4 B) 2.0×10^{-5} C) 2.0×10^{-3} D) 5.0×10^{-4} E) 2.5×10^9

Answer: B

19) 1.25 moles of NOCl were placed in a 2.50 L reaction chamber at 427°C. After equilibrium was reached, 1.10 moles of NOCl remained. Calculate the equilibrium constant, Kc, for the reaction:

$2NOCl_{(g)} \leftrightarrow 2NO_{(g)} + Cl_{2(g)}$

A) 3.0×10^{-4} B) 4.1×10^{-3} C) 1.4×10^{-3} D) 5.6×10^{-4} E) 1.8×10^3

Answer: D

20) Kp for the reaction of $SO_{2(g)}$ with O_2 to produce $SO_{3(g)}$ is 3×10^{24} . Calculate Kc for this equilibrium at 25°C.

$2SO_{2(g)} + O_{2(g)} \leftrightarrow 2SO_{3(g)}$

A) 3×10^{24} B) 7×10^{25} C) 5×10^{21} D) 2×10^{20} E) 5×10^{22}

Answer: B

21) For the following reactions the equilibrium constants are defined:

$A+2B \leftrightarrow C \qquad K_1$

$C \leftrightarrow D+E \qquad K_2$

Then for the reaction

$A+2B \leftrightarrow D+E \qquad K_c$

The equilibrium constant must be equal to:

A) $K_c=K_1 - K_2$

B) $K_c=K_2 / K_1$

C) $K_c=(K_1)(K_2)$

D) $K_c=K_1 / K_2$

E) $K_c=K_1+K_2$

Answer: C

22) For the reaction

$PCl_{3(g)} + Cl_{2(g)} \leftrightarrow PCl_{5(g)} \quad K_c = 24.3$

a system is prepared with $[PCl_3] = 0.10$ M; $[Cl_2] = 0.15$ M; $[PCl_5] = 0.60$ M

Which response is correct? The reaction

A) will form PCl_3 and Cl_2 until equilibrium is reached.

B) will form more PCl_5 until equilibrium is reached.

C) is at equilibrium.

D) None of the above.

Answer: A

23) For the following reaction at equilibrium in a reaction vessel, which one of the changes below would cause the Br_2 concentration to increase?

$2NOBr_{(g)} \leftrightarrow 2NO_{(g)}+Br_{2(g)} \quad \triangle H°_{rxn} = 30$ kJ

A) Remove some NOBr.

B) Remove some NO.

C) Compress the gas mixture into a smaller volume.

D) Lower the temperature.

Answer: B

24) For the equilibrium reaction

$2SO_{2(g)} + O_{2(g)} \leftrightarrow 2SO_{3(g)} \qquad \triangle H°_{rxn} = -198$ kJ

which one of the following factors would cause the equilibrium constant to increase?

A) Add a catalyst.

B) Remove O_2 gas.

C) Add SO_2 gas.

D) Decrease the temperature.

E) None of the above.

Answer: D

25) The reaction

$2SO_{3(g)} \leftrightarrow 2SO_{2(g)} + O_{2(g)}$

is endothermic. If the temperature is increased:

A) No change will occure in K_c.

B) K_c will increase.

C) K_c will decrease.

D) The pressure will decrease.

E) More SO_3 will be produced.

Answer: D

26) In which of the following gas-phase equlibria is the yield of products increased by increasing the total pressure on the reaction mixture?

A) $2SO_{3(g)} \leftrightarrow 2SO_{2(g)} + O_{2(g)}$

B) $CO_{(g)} + H_2O_{(g)} \leftrightarrow CO_{2(g)} + H_{2(g)}$

C) $2NO_{(g)} + Cl_{2(g)} \leftrightarrow 2NOCl_{(g)}$

D) $PCl_{5\,(g)} \leftrightarrow PCl_{3(g)} + Cl_{2\,(g)}$

Answer: C

27) The data below were determined for the reaction below.

$S_2O_8^{2-} + 3I^-_{(aq)} \rightarrow 2SO_4^{2-} + I_3^-$

Expt.#	$[S_2O_8^{2-}]$	$[I^-]$	Initial Rate
1	0.038	0.060	1.4×10^{-5} M/s
2	0.076	0.060	2.8×10^{-5} M/s
3	0.076	0.030	1.4×10^{-5} M/s

The rate la for this reaction must be:

A) rate = $k\,[S_2O_8^{2-}]\,[I^-]$

B) rate = $k\,[S_2O_8^{2-}]$

C) rate = $k\,[I^-]$

D) rate = $k\,[S_2O_8^{2-}]^2\,[I^-]^2$

E) rate = $k\,[S_2O_8^{2-}][I^-]^3$

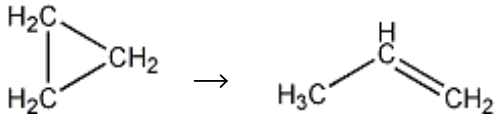
Answer: A

28) A first-order reaction has a rate constant of 3.0×10^{-3}/s. The time requited for the reaction to be 75% complete is:

A) 201 s B) 462 s C) 231 s D) 95.8 s E) 41.7 s

Answer: B

29) The isomerization of cyclopropane to form propene

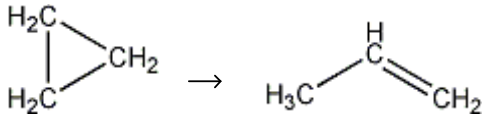


is a first-order reaction. At 760 K, 15% of a sample of cyclopropane changes to propene in 6.8 min. What is the half-life of cyclopropane at 760 K?

A) 2.5 min
B) 230 min
C) 29 min
D) 3.4×10^{-2} min
E) 23 min

Answer: C

30) The isomerization of cyclopropane follows first-order kinetics. At 700 K, the rate constant for this reaction is 6.2×10^{-4}/min. How many minutes are required for 10.0% of a sample of cyclopropane to isomerize to propene?



A) 1120 min
B) 16100 min
C) 170 min
D) 1.43×10^{-3} min
E) 3710 min

Answer: C

31) At 25 °C, the second-order reaction

$$NOCl_{(g)} \rightarrow NO_{(g)} + 1/2\ Cl_{2(g)}$$

is 50% complete after 5.82 hours when the initial concentration of NOCl is 4.46 mol/L. How long will it take for the reaction to be 75% complete?

A) 17.5 h B) 11.6 h C) 23.0 h D) 8.22 h E) 15.5 h

Answer: A

32) When the following reaction is at equilibrium, which choice is always true?

$$2NOCl_{(g)} \leftrightarrow 2NO_{(g)} + Cl_{2(g)}$$

A) $[NO]^2[Cl_2] = [NOCl]^2$
B) $[NO]^2[Cl_2] = K_c[NOCl]^2$
C) $[NOCl] = [NO]$
D) $2[NO] = [Cl_2]$
E) $[NO][Cl_2] = [NOCl]$

Answer: B

33) The thermal decomposition of acetaldehyde is a second-order reaction.
$CH_3CHO \rightarrow CH_4 + CO$
The following data were obtained at 518 °C. The initial pressure of CH_3CHO is 364 mmHg.

time, s	Pressure CH_3CHO, mmHg
42	330
105	290
720	132

Calculate the rate constant for the decomposition of acetaldehyde from the above data.
A) 0.70 mmHg/s
B) 2.2×10^{-3}/mmHg s
C) 2.2×10^{-3}/s
D) 5.2×10^{-5}/mmHg s
E) 6.7×10^{-6}/mmHg s
Answer: E

34) The thermal decomposition of acetaldehyde is a second-order reaction.
$CH_3CHO \rightarrow CH_4 + CO$
The following data were obtained at 518 °C. The initial pressure of CH_3CHO is 364 mmHg.

time, s	Pressure CH_3CHO, mmHg
42	330
105	290
720	132

Based on the data given, what is the half-life of acetaldehyde?
A) 410 s B) 305 s C) 5.4×10^7 s D) 1.5×10^5 s E) 520 s
Answer: A

35) The chemical reaction

$2NO_{(g)} \leftrightarrow N_{2(g)} + O_{2(g)}$, is exothermic, i.e., $\triangle H^\circ rxn = -180$ kJ

which one of the following statements is true?
A) K_p at 1,000K is less than K_p at 2,000K.
B) K_p at 1,000K is larger than K_p at 2,000K.
C) K_p depends on total pressure as well as temperature.
D) The $K_{p's}$ at 1,000K and 2,000K are the same.
Answer: B

36) For what order reaction does the half-life get longer as the initial concentration increases?
A) concentration
B) zero order
C) second ordernone of them because half-life is always independent of the initial
D) first order
Answer: B

37) Which one of the following changes would alter the rate constant (k) for the reaction
$2A + B \rightarrow$ products?

A) increasing the temperature
B) increasing the concentration of B
C) measuring k again after the reaction has run for a while
D) increasing the concentration of A

Answer: A

38) If Ea for a certain biological reaction is 50 kJ/mol, by what factor (how many times) will the rate of this reaction increase when body temperature increases from 37 °C (normal) to 40 °C (fever)?

A) 2.0 times
B) 1.20 times
C) 1.05 times
D) 2.0×10^5 times
E) 1.0002 times

Answer: B

39) The isomerization of methyl isocyanide (CH_3NC)

$CH_3NC \rightarrow CH_3CN$

Follows first-order kinetics. The half-lives were found to be 161 min at 199°C, and 12.5 min at 230°C. Calculate the activation energy for this reaction.

A) 31.4 kJ/mol
B) 6.17×10^{-3} kJ/mol
C) 78.2 kJ/mol
D) 163 kJ/mol
E) 124 kJ/mol

Answer: D

40) The activation energy for the reaction

$C_4H_{10} \rightarrow C_2H_6 + C_2H_4$

has an activation energy (Ea) of 350 kJ/mol, and the Ea of the reverse reaction is 260 kJ/mol. Estimate $\triangle H$, in kJ/mol, for the reaction as written above.

A) +90 kJ/mol B) -90 kJ/mol C) 350 kJ/mol D) +610 kJ/mol E) -610 kJ/mol

Answer: A

41) The activation energy for the reaction $O + O_3 \rightarrow 2O_2$ is 25 kJ/mol, and the enthalpy change is $\triangle H = -388$ kJ/mol. What is the activation energy for the decomposition of O_2 by the reverse reaction?

A) 363 kJ B) 413 kJ C) 25 kJ D) 388 kJ E) 50 kJ

Answer: B

42) An increase in the temperature of the reactants causes an increase in the rate of reaction. The best explanation is: As the temperature increases,

A) the activation energy decreases.
B) the collision frequency increases.
C) the activation energy increases.
D) the concentration of reactants increases.
E) the fraction of collisions with total kinetic energy > Ea increases.

Answer: E

43) The rate law for the reaction

$H_2O_2 + 2H^+ + 2I^- \rightarrow I_2 + 2H_2O$

is rate = $k[H_2O_2][I^-]$. The following mechanism has been suggested.

$H_2O_2 + I^- \rightarrow HOI + OH^-$ slow

$OH^- + H^+ \rightarrow H_2O$ fast

$HOI + H^+ + I^- \rightarrow I_2 + H_2O$ fast

Identify all intermediates included in this mechanism.

A) $H^+$and HOI
B) HOI and OH^-
C) H^+only
D) H^+ and I^-
E) H_2O and OH^-

Answer: B

44) The equilibrium constants (expressed in atm) for the chemical reaction

$N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$

are $Kp = 1.1 \times 10^{-3}$ and 3.6×10^{-3} at 2,200K and 2,500K, respectively. Which one of the following statements is true?

A) K_p is less than K_c by (RT).
B) Higher total pressure shifts the equilibrium to the left.
C) The total pressure at 2,200K is the same as at 2,500K.
D) The partialpressure of $NO_{(g)}$ is less at 2,200K than at 2,500K.
E) The reaction is exothermic, $\triangle H° < 0$.

Answer: D

45) For the reaction $X_2 + Y + Z \rightarrow XY + XZ$

it is found that the rate equation is rate = k $[X_2][Y]$. Why does the concentration of Z have no effect on the rate?

A) Z must react in a step after the rate determining step.
B) Z is an intermediate.
C) The activation energy for Z to react is very high.
D) The fraction of molecules of Z that have very high energies is zero.
E) The concentration of Z is very small and the others are very large.

Answer: A

46) When the concentrations of reactant molecules are increased, the rate of reaction increases. The best explanation is: As the reactant concentration increases;

A) the order of reaction increases.
B) the average kinetic energy of molecules increases.
C) the rate constant increases.
D) the activation energy increases.
E) the frequency of molecular collisions increases.

Answer: E

47) A reaction mechanism usually is

A) obvious if the activation energy is known.
B) obvious if the reaction order is known.
C) difficult to prove.
D) restricted to only one possible explanation.
E) the same as the balanced chemical equation.

Answer: C

48) For the reaction

$BrO_3^- + 5Br^- + 6H^+ \rightarrow 3Br_2 + 3H_2O$

$-\triangle[BrO_3^-] / \triangle t = 1.5 \times 10^{-2}$ M/s at a particular time.

What is $-\triangle [Br^-]/ \triangle t$ at the same instant?

A) 13 M/s
B) 3.0×10^{-3} M/s
C) 7.5×10^{-2} M/s
D) 330 M/s
E) 1.5×10^{-2} M/s

Answer: C

49) The reaction A + 2B →products was found to have the rate law , rate = $k[A][B]^2$. Predict by what factor the rate of reaction will increase when the concentration of A is doubled and the concentration of B is also doubled.

A) 9 B) 2 C) 4 D) 6 E) 8

Answer: E

50) In general, the unit of reaction rate is:

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

Answer: D