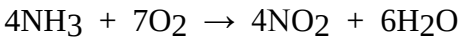
Chapter 14 Chemical Kinetics

Multiple-Choice Questions

1) A burning splint will burn more vigorously in pure oxygen than in air because
A) oxygen is a reactant in combustion and concentration of oxygen is higher in pure oxygen than is in air.
B) oxygen is a catalyst for combustion.
C) oxygen is a product of combustion.
D) nitrogen is a product of combustion and the system reaches equilibrium at a lower temperature.
E) nitrogen is a reactant in combustion and its low concentration in pure oxygen catalyzes the combustion.

2) Of the following, all are valid units for a reaction rate except _____.
A) mol/L
B) M/s
C) mol/hr
D) g/s
E) mol/L-hr

3) Which one of the following is <u>not</u> a valid expression for the rate of the reaction below?

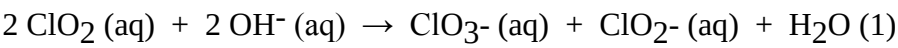


$$4NH_3 + 7O_2 \rightarrow 4NO_2 + 6H_2O$$

A) $-\frac{1}{7}\frac{\Delta\ O_2}{\Delta t}$
B) $\frac{1}{4}\frac{\Delta\ NO_2}{\Delta t}$
C) $\frac{1}{6}\frac{\Delta\ H_2O}{\Delta t}$
D) $-\frac{1}{4}\frac{\Delta\ NH_3}{\Delta t}$
E) All of the above are valid expressions of the reaction rate.

4) Of the units below, _____ are appropriate for a first-order reaction rate constant.
A) $M\ s^{-1}$
B) s^{-1}
C) mol/L
D) $M^{-1}\ s^{-1}$
E) $L\ mol^{-1}\ s^{-1}$

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



$$2\ ClO_2\ (aq) + 2\ OH^-\ (aq) \rightarrow ClO_3^-\ (aq) + ClO_2^-\ (aq) + H_2O\ (1)$$

Experiment Number	$[ClO_2]$ (M)	$[OH^-]$ (M)	Initial Rate (M/s)
1	0.060	0.030	0.0248
2	0.020	0.030	0.00276
3	0.020	0.090	0.00828

5) What is the order of the reaction with respect to ClO_2?
A) 1
B) 0
C) 2
D) 3
E) 4

6) What is the order of the reaction with respect to OH^-?
A) 0
B) 1
C) 2
D) 3
E) 4

7) What is the overall order of the reaction?
A) 4
B) 0
C) 1
D) 2
E) 3

8) What is the magnitude of the rate constant for the reaction?
A) 1.15×10^4
B) 4.6
C) 230
D) 115
E) 713

9) Under constant conditions, the half-life of a first-order reaction _____.
A) is the time necessary for the reactant concentration to drop to half its original value
B) is constant
C) can be calculated from the reaction rate constant
D) does not depend on the initial reactant concentration
E) All of the above are correct.

10) The reaction

$$2NO_2 \rightarrow 2NO + O_2$$

follows second-order kinetics. At 300°C, $[NO_2]$ drops from 0.0100 M to 0.00650 M in 100.0 s. The rate

constant for the reaction is _____ $M^{-1}s^{-1}$.
A) 0.096
B) 0.65
C) 0.81
D) 1.2
E) 0.54

11) The reaction

$$CH_3\text{-}N{\equiv}C \rightarrow CH_3\text{-}C{\equiv}N$$

is a first-order reaction. At 230.3 °C, k = $6.29 \times 10^{-4} s^{-1}$. If $[CH_3{\square}N{\square}C]$ is 1.00×10^{-3} initially, $[CH_3{\square}N{\square}C]$ is _____ after 1.000×10^3 s.
A) 5.33×10^{-4}
B) 2.34×10^{-4}
C) 1.88×10^{-3}
D) 4.27×10^{-3}
E) 1.00×10^{-6}

12) A compound decomposes by a first-order process. If 17.0% of the compound decomposes in 60.0 minutes, the half-life of the compound is _____.
A) 141 minutes
B) 181 minutes
C) 198 minutes
D) 223 minutes
E) 325 minutes

The reaction A → B *is first order in* [A]. *Consider the following data.*

time (s)	[A] (M)
0.0	1.60
10.0	0.40
20.0	0.10

13) The rate constant for this reaction is _____ s^{-1}.
A) 0.013
B) 0.030
C) 0.14
D) 3.0
E) 3.1×10^{-3}

14) The half-life of this reaction is _____ s.
A) 0.97
B) 7.1
C) 5.0

D) 3.0
E) 0.14

The reaction A $\rightarrow$ B *is first order in* [A]. *Consider the following data.*

Time (s)	0.0	5.0	10.0	15.0	20.0
[A] (M)	0.20	0.14	0.10	0.071	0.050

15) The rate constant for this reaction is _____ s^{-1}.
A) 6.9×10^{-2}
B) 3.0×10^{-2}
C) 14
D) 0.46
E) 4.0×10^{2}

16) The concentration of A is _____ M after 40.0 s.
A) 1.3×10^{-2}
B) 1.2
C) 0.17
D) 3.5×10^{-4}
E) 0.025

17) The rate constant of a first-order process that has a half-life of 3.50 min is _____ s^{-1}.
A) 0.693
B) 1.65×10^{-2}
C) 1.98
D) .198
E) 3.30×10^{-3}

18) The decomposition of N_2O_5 in solution in carbon tetrachloride proceeds via the reaction

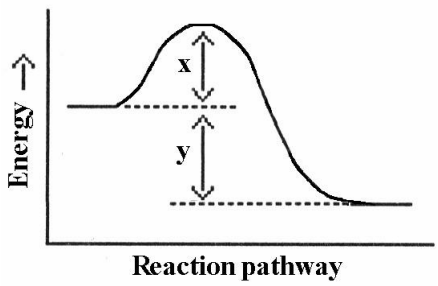
$$2N_2O_5\ (soln) \rightarrow 4NO_2\ (soln) + O_2\ (soln)$$

The reaction is first order and has a rate constant of $4.82 \times 10^{-3}\ s^{-1}$ at 64°C. The rate law for the reaction is rate = _____.
A) $k[N_2O_5]^2$
B) $k\dfrac{[NO_2]^4[O_2]}{[N_2O_5]^2}$
C) $k[N_2O_5]$
D) $k\dfrac{[N_2O_5]^2}{[NO_2]^4[O_2]}$
E) $2k[N_2O_5]$

19) As the temperature of a reaction is increased, the rate of the reaction increases because the _____.
A) reactant molecules collide less frequently
B) reactant molecules collide more frequently and with greater energy per collision
C) activation energy is lowered
D) reactant molecules collide less frequently and with greater energy per collision
E) reactant molecules collide more frequently with less energy per collision

20) The rate of a reaction depends on _____.
A) collision frequency
B) collision energy
C) collision orientation
D) all of the above
E) none of the above

21) Which energy difference in the energy profile below corresponds to the activation energy for the forward reaction?



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

22) In the energy profile of a reaction, the species that exists at the maximum on the curve is called the _____.
A) product
B) activated complex
C) activation energy
D) enthalpy of reaction
E) atomic state

23) In the Arrhenius equation,

$$k = Ae^{-Ea/RT}$$

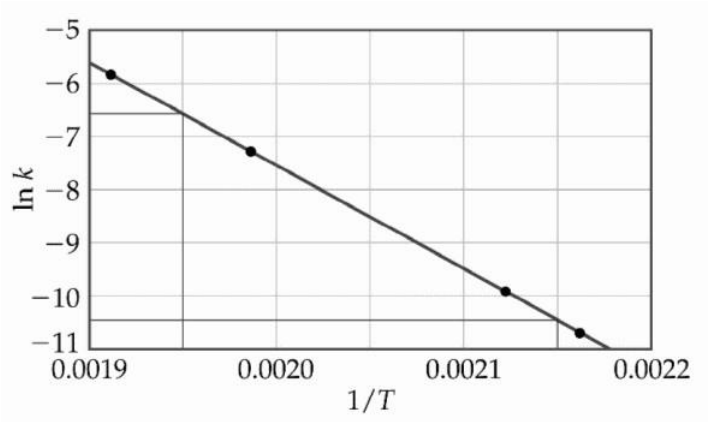
_____ is the frequency factor.
A) k
B) A
C) e

D) E_a
E) R

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

$$CH_3NC\ (g) \rightarrow CH_3CN\ (g)$$

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



The energy of activation of this reaction is _____ kJ/mol.
A) 160
B) 1.6×10^5
C) 4.4×10^{-7}
D) 4.4×10^{-4}
E) 1.9×10^4

25) The mechanism for formation of the product X is:

$$A + B \rightarrow C + D \quad \text{(slow)}$$
$$B + D \rightarrow X \quad \text{(fast)}$$

The intermediate reactant in the reaction is _____.
A) A
B) B
C) C
D) D
E) X

26) For the elementary reaction

$$NO_3 + CO \rightarrow NO_2 + CO_2$$

the molecularity of the reaction is _____, and the rate law is rate = _____.
A) 2, $k[NO_3][CO]$
B) 4, $k[NO_3][CO][NO_2][CO_2]$
C) 2, $k[NO_2][CO_2]$
D) 2, $k[NO_3][CO]/[NO_2][CO_2]$
E) 4, $k[NO_2][CO_2]/[NO_3][CO]$

27) A possible mechanism for the overall reaction

$$Br_2\,(g) + 2NO\,(g) \rightarrow 2NOBr\,(g)$$

is

$$NO\,(g) + Br_2\,(g) \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} NOBr_2\,(g) \qquad \text{(fast)}$$

$$NOBr_2\,(g) + NO\,(g) \xrightarrow{k_2} 2NOBr \qquad \text{(slow)}$$

The rate law for formation of NOBr based on this mechanism is rate = _____.
A) $k_1[NO]1/2$
B) $k_1[Br_2]1/2$
C) $(k_2k_1/k^{-1})[NO]^2[Br_2]$
D) $(k_1/k^{-1})^2[NO]^2$
E) $(k_2k_1/k^{-1})[NO]^2[Br_2]^2$