A.P. Chemistry Practice Test: Ch. 12, Kinetics

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

1) Consider the following reaction:

$3A \rightarrow 2B$

The average rate of appearance of B is given by $\Delta[B]/\Delta t$. Comparing the rate of appearance of B and the rate of disappearance of A, we get $\Delta[B]/\Delta t =$ _____ x $(-\Delta[A]/\Delta t)$.

A) –2/3 B) –3/2 C) +2/3 D) +3/2 E) +1

2) A burning splint will burn more vigorously in pure oxygen than in air because

A) nitrogen is a reactant in combustion and its low concentration in pure oxygen catalyzes the combustion.

B) oxygen is a reactant in combustion and the concentration of oxygen is higher in pure oxygen than it is in air.

C) oxygen is a product of combustion.

D) nitrogen is a product of combustion and the system reaches equilibrium at a lower temperature.

E) oxygen is a catalyst for combustion.

3) Of the following, all are valid units for a reaction rate except _____.

A) mol/L B) M/s C) mol/hr D) mol/L–hr E) g/s

*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) | 1 | 10 | 20 | 30 | 40 |
|---|---|---|---|---|---|
| Moles of A | 0.124 | 0.110 | 0.088 | 0.073 | 0.054 |

4) The average rate of disappearance of A between 10 s and 20 s is _____ mol/s.

A) $1.1 \times 10^{-3}$ B) $4.4 \times 10^{-3}$ C) 454 D) $9.90 \times 10^{-3}$ E) $2.2 \times 10^{-3}$

*The peroxydisulfate ion* ($S_2O_8^{2-}$) *reacts with the iodide ion in aqueous solution via the reaction:*

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

*An aqueous solution containing* 0.050 M *of* $S_2O_8^{2-}$ i*on and* 0.072 M *of* $I^-$ *is prepared, and the progress of the reaction followed by measuring* $[I^-]$. *The data obtained is given in the table below.*

| Time (s) | 0 | 400 | 800 | 1200 | 1600 |
|---|---|---|---|---|---|
| $[I^-]$ (M) | 0.072 | 0.057 | 0.046 | 0.037 | 0.029 |

5) The concentration of $S_2O_8^{2-}$ remaining at 800 s is _____ M.

A) 0.015 B) 0.041 C) 0.076 D) $4.00 \times 10^{-3}$ E) 0.046

6) Of the units below, _____ are appropriate for a first–order reaction rate constant.

A) L $mol^{-1}$ $s^{-1}$ B) $s^{-1}$ C) $M^{-1}$ $s^{-1}$ D) mol/L E) M $s^{-1}$

7) If the rate law for the reaction

$$2A + 3B \rightarrow \text{products}$$

is first order in A and second order in B, then the rate law is rate = _____.

A) $k[A]^2[B]^3$ B) $k[A]^2[B]^2$ C) $k[A][B]$ D) $k[A]^2[B]$ E) $k[A][B]^2$

8) The kinetics of the reaction below were studied and it was determined that the reaction rate increased by a factor of 9 when the concentration of B was tripled. The reaction is _____ order in B.

$$A + B \rightarrow P$$

A) zero B) first C) second D) third E) one-half

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

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

| 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 |

9) What is the order of the reaction with respect to $ClO_2$?

A) 4 B) 1 C) 0 D) 2 E) 3

10) What is the order of the reaction with respect to $OH^-$?

A) 0 B) 1 C) 2 D) 3 E) 4

11) What is the overall order of the reaction?

A) 0 B) 1 C) 4 D) 3 E) 2

12) What is the magnitude of the rate constant for the reaction?

A) 115 B) $1.15 \times 10^4$ C) 713 D) 4.6 E) 230

13) For a first-order reaction, a plot of _____ versus _____ is linear.

A) $\ln [A]_t$, t B) $\frac{1}{[A]_t}$, t C) In $[A]_t$, $\frac{1}{t}$ D) $[A]_t$, t E) t, $\frac{1}{[A]_t}$

14) The rate law for a reaction is

$$\text{rate} = k\,[A][B]^2$$

Which one of the following statements is false?

A) If [B] is doubled, the reaction rate will increase by a factor of 4.
B) The reaction is second order in B.
C) The reaction is first order in A.
D) *k* is the reaction rate constant
E) The reaction is second order overall.

15) The half–life of a first–order reaction _____.

A) is constant
B) is the time necessary for the reactant concentration to drop to half its original value
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.

16) The reaction

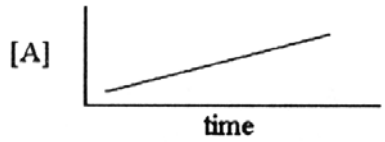
$$CH_3\text{–}N{\equiv}C \rightarrow CH_3\text{–}C{\equiv}N$$

is a first–order reaction. At 230.3°C, $k = 6.29 \times 10^{-4}\ s^{-1}$. If $[CH_3\text{–}N{\equiv}C]$ is $1.00 \times 10^{-3}$ initially, $[CH_3\text{–}N{\equiv}C]$ is _____ after $1.000 \times 10^{3}$ s.

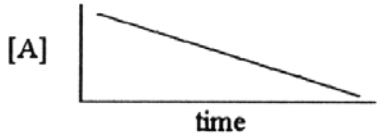
A) $4.27 \times 10^{-3}$ B) $2.34 \times 10^{-4}$ C) $5.33 \times 10^{-4}$ D) $1.88 \times 10^{-3}$ E) $1.00 \times 10^{-6}$

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

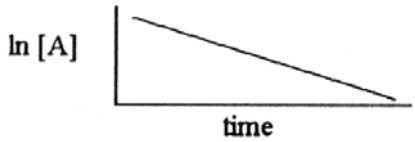
A)



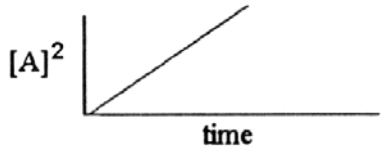

B)



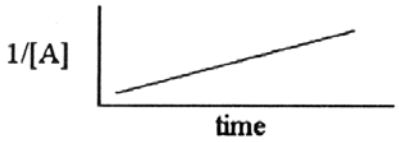

C)




D)




E)



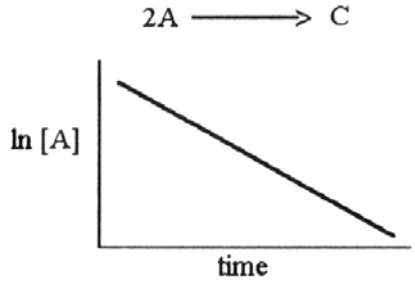

18) A first-order reaction has a rate constant of 0.33 $min^{-1}$. It takes _____ min for the reactant concentration to decrease from 0.13 M to 0.088 M.

A) 1.2 B) 1.4 C) 0.13 D) 0.85 E) 0.51

19) The rate constant for a second-order reaction is 0.13 $M^{-1}s^{-1}$. If the initial concentration of reactant is 0.26 mol/L, it takes _____ s for the concentration to decrease to 0.13 mol/L.

A) 1.0 B) $4.4 \times 10^{-3}$ C) 0.017 D) 0.50 E) 30

20) The graph shown below depicts the relationship between concentration and time for the following chemical reaction.




The slope of this line is equal to _____.

A) –k B) –1/k C) k D) $\ln[A]_o$ E) 1/k

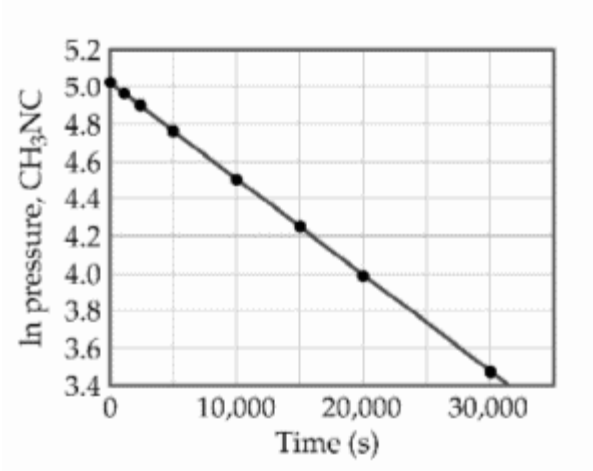
21) The rate constant of a first–order process that has a half–life of 225 s is _____ $s^{-1}$.

A) $3.08 \times 10^{-3}$ B) 12.5 C) 1.25 D) $4.44 \times 10^{-3}$ E) 0.693

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

$$CH_3NC\ (g) \rightarrow CH_33CN\ (g)$$

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




The rate constant for the reaction is _____ $s^{-1}$.

A) $-5.2 \times 10^{-5}$ B) $+1.9 \times 10^{4}$ C) +6.2 D) $-1.9 \times 10^{4}$ E) $+5.2 \times 10^{-5}$

23) 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) $k\dfrac{[N_2O_5]^2}{[NO_2]^4\,[O_2]}$ B) $k[N_2O_5]^2$ C) $k[N_2O_5]$ D) $2k[N_2O_5]$ E) $k\dfrac{[NO_2]^4\,[O_2]}{[N_2O_5]^2}$

24) The rate of a reaction depends on _____.

A) collision frequency

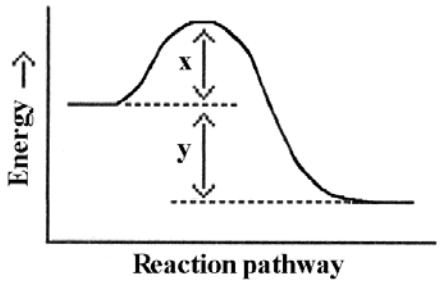
B) collision orientation

C) collision energy

D) all of the above

E) none of the above

25) 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) y – x E) x – y

26) In the energy profile of a reaction, the species that exists at the maximum on the curve is called the _____.

A) product

B) enthalpy of reaction

C) atomic state

D) activated complex

E) activation energy

27) In the Arrhenius equation,

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

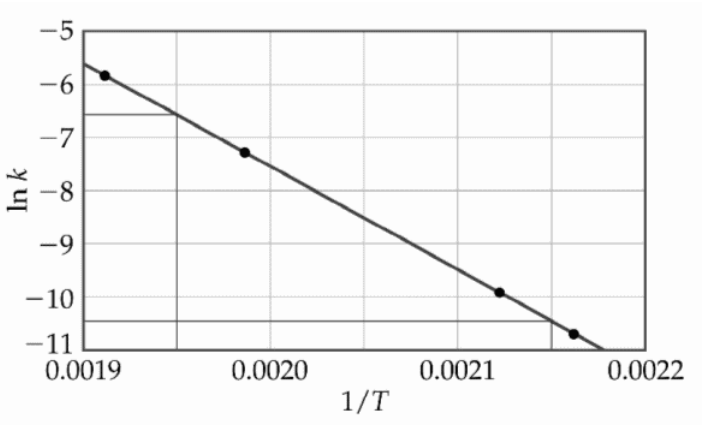
_____ is the frequency factor.

A) k B) A C) e D) R E) $E_a$

28) 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) $4.4 \times 10^{-7}$ B) $1.9 \times 10^{4}$ C) $1.6 \times 10^{5}$ D) 160 E) $4.4 \times 10^{-4}$

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

$A + B \rightarrow C + D$ (slow)
$B + D \rightarrow X$ (fast)

The intermediate reactant in the reaction is _____.

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

30) 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) 4, $k[NO_3][CO][NO_2][CO_2]$

B) 2, $k[NO_3][CO]/[NO_2][CO_2]$

C) 4, $k[NO_2][CO_2]/[NO_3][CO]$

D) 2, $k[NO_2][CO_2]$

E) 2, $k[NO_3][CO]$

31) Of the following, _____ will lower the activation energy for a reaction.

A) increasing the concentrations of reactants

B) adding a catalyst for the reaction

C) raising the temperature of the reaction

D) removing products as the reaction proceeds

E) increasing the pressure

32) The rate law of the overall reaction

$$A + B \rightarrow C$$

is rate $= k[A]^2$. Which of the following will <u>not</u> increase the rate of the reaction?

A) increasing the concentration of reactant A
B) increasing the temperature of the reaction
C) increasing the concentration of reactant B
D) adding a catalyst for the reaction
E) All of these will increase the rate.

33) A particular first-order reaction has a rate constant of $1.35 \times 10^2\ s^{-1}$ at 25°C. What is the magnitude of k at 75°C if $E_a = 85.6$ kJ/mol?

A) 670 B) $3.47 \times 10^4$ C) $3.85 \times 10^6$ D) $1.93 \times 10^4$ E) $1.36 \times 10^2$

Answer Key
Testname: CH_12_PRAC_TEST_KINETICS.TST

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

1) C
ID: chem9b 14.1–1

2) B
ID: chem9b 14.1–2

3) A
ID: chem9b 14.1–3

4) E
ID: chem9b 14.1–9

5) B
ID: chem9b 14.1–19

6) B
ID: chem9b 14.1–24

7) E
ID: chem9b 14.1–26

8) C
ID: chem9b 14.1–28

9) D
ID: chem9b 14.1–37

10) B
ID: chem9b 14.1–38

11) D
ID: chem9b 14.1–39

12) E
ID: chem9b 14.1–40

13) A
ID: chem9b 14.1–41

14) E
ID: chem9b 14.1–42

15) E
ID: chem9b 14.1–45

16) C
ID: chem9b 14.1–47

17) E
ID: chem9b 14.1–49

18) A
ID: chem9b 14.1–50

19) E
ID: chem9b 14.1–52

20) A
ID: chem9b 14.1–54

21) A
ID: chem9b 14.1–60

22) B
ID: chem9b 14.1–65

23) C
ID: chem9b 14.1–67

24) D
ID: chem9b 14.1–69

25) A
ID: chem9b 14.1–70

26) D
ID: chem9b 14.1–71

27) B
ID: chem9b 14.1–72

28) D
ID: chem9b 14.1–74

29) D
ID: chem9b 14.1–75

30) E
ID: chem9b 14.1–77

31) B
ID: chem9b 14.1–80

32) C
ID: chem9b 14.1–81

33) D
ID: chem9b 14.2–12

# AP Chem Practice Test: Ch. 12, Kinetics

PAGE ONE

(1) rate of disappearance of A > rate of appearance of B.
For every 3 As which react, 2 Bs appear.
Let's put the rates in mol L$^{-1}$ s$^{-1}$:

$$\frac{2\ \text{mol B}}{\text{L s}} = \boxed{\text{"x"}\ \frac{\text{mol A}}{\text{mol B}}} \cdot \frac{3\ \text{mol A}}{\text{L s}}$$

$x = \frac{2}{3}$ (C)

$\frac{\Delta[B]}{\Delta t}$ is $\frac{2}{3}$ the rate of [A]'s disappearance

(2) B, collisions increase with higher concentration.

(3) A, rate involves time

(4) $\text{rate} = -\frac{\Delta[A]}{\Delta t} = -\frac{(.088 - .110)\ \text{mol}}{10\ \text{s}} = \frac{-(-0.022)}{10} = \frac{0.0022\ \text{mol}}{\text{s}}$

(E) $2.2 \times 10^{-3}\ \text{mol s}^{-1}$

(5)

$$S_2O_8^{2-} + 3I^- \rightarrow 2SO_4^{2-} + I_3^-$$

| time (s) | | |
|---|---|---|
| 0 | .050 | .072 |
| 800 (s) | ? M | .046 |

$.046 - .072 = \Delta[I] = -0.026\ M$

$$\frac{-0.026\ \text{mol } I^-}{\text{L } I^-} \times \frac{1\ \text{mol } S_2O_8^{2-}}{3\ \text{mol } I^-} = \frac{-0.00867\ \text{mol } S_2O_8^{2-}}{\text{L } S_2O_8^{2-}}$$

$[S_2O_8^{2-}] = \underset{0.050\ M}{\text{initial}} - \underset{0.00867\ M}{\text{change}} = \underset{0.041\ M}{\text{Final}}$ (B)

PAGE TWO

(6) example: rate = k[A] ⟹ generic 1st order rate law

$$\frac{mol}{L\,s} = k\left[\frac{mol}{L}\right]$$

$$\frac{\frac{mol}{L\,s}}{\frac{mol}{L}} = k$$

$$\frac{mol}{\cancel{L}\,s} \times \frac{\cancel{L}}{mol} = k \longrightarrow s^{-1} = k$$

k will have units of reciprocal time

(B)

(7) $rate = k[A]^1[B]^2$ (E)

(8) $\frac{\text{conc [B] \#2}}{\text{conc [B] \#1}} = 3 \Longrightarrow 3^x = 9 \rightarrow x = 2$

$\frac{\text{rate \#2}}{\text{rate \#1}} = 9$

(C)

(9) use exps #1 & #2: $\frac{.06}{.02} = 3$ ; $\frac{.0248}{.00276} \approx 9$

(D) thus, tripling $[CeO_2]$ causes rate to increase by 9.

$3^x = 9 \Rightarrow x = 2 \Rightarrow$ 2nd order wrt $[CeO_2]$

(10) use exps #2 & #3: $\frac{.09}{.03} = 3$ ; $\frac{.00826}{.00276} = 3$

(B) $3^x = 3 \Rightarrow$ 1st order wrt $[OH^-]$

(11) $rate = k[CeO_2]^2[OH^-]$ order = 3

(12) I chose to use expt #1: $0.0248\,\frac{M}{s} = k[0.060\,M]^2[.030\,M]$

$k = 230\ M^{-2}s^{-1}$

(13) $\ln[A]$ vs $t$ (A)

(14) E (3rd order)

(15) E 1ST order half life: $t_{1/2} = \frac{0.693}{k}$

(16) $[CH_3-N\equiv C]_0 = 1.00\times10^{-3}$

rxn is 1st order, so

$$\ln[CH_3-N\equiv C] = -(6.29\times10^{-4}\,s^{-1})(1000\,s) + \ln[1.00\times10^{-3}]$$

$$\ln[CH_3-N\equiv C] = -6.29\times10^{-1} + -6.90776$$

$$\ln[CH_3-N\equiv C] = -7.537$$

$$[CH_3-N\equiv C] = 5.33\times10^{-4}\,M$$

(17) (E) $\frac{1}{[A]}$ vs $t$

(18) $\ln[A] = -kt + \ln[A]_0$

$\ln[.088] = (-0.33\,min^{-1})(t) + \ln[0.13]$

$-0.390 = -0.33\,min^{-1}\,t$

$1.18\,min = t$

$1.2\,min = t$ (A)

(19) $k = 0.13\,M^{-1}s^{-1}$, $[A]_0 = 0.26\,M$, $t = ?$, $[A] = 0.13\,M$

$$\frac{1}{[A]} = kt + \frac{1}{[A]_0}$$

$$\frac{1}{0.13\,M} = (0.13\,M^{-1}s^{-1})(t) + \frac{1}{0.26\,M} \Rightarrow \frac{1}{.13} - \frac{1}{.26} = (.13)(t)$$

$29.6\,s = t$ (E)

NOTE: could have used half life formula here

(20) $\ln[A] = -kt + \ln[A]_0$

$y = mx + b$

$m = -k$ (A)

(21) $t_{1/2} = \frac{0.693}{k} \Rightarrow k = \frac{0.693}{t_{1/2}} = \frac{0.693}{225\,s} = 0.00308\,s^{-1}$

$= 3.08 \times 10^{-3}\,s^{-1}$

(A)

(22) $\ln[A] = -kt + \ln[A]_0$

$y = mx + b$

$\frac{\text{rise}}{\text{run}} = \text{slope} = \frac{3.5 - 5}{30{,}000 - 0}$

$m = -0.00005$

(E) $m = -k = -0.00005$

$k = 0.00005$

$k = 5 \times 10^{-5}$

I am pretty sure that the answer key is wrong, and this answer is correct.

(23) $\text{rate} = k[N_2O_5]$

(C)

(24) D

(25) X (A)

(26) D activated complex (or transition state)

(27) "A" is the frequency factor, which is choice (B) here

(28) $\ln k = \left(\frac{-Ea}{R}\right)\left(\frac{1}{T}\right) + \ln A$

$y = m \quad x + b$

unitless quantity

$$\text{slope} = m = \frac{\text{rise}}{\text{run}} = \frac{-10.5 - (-5.5)}{.00215 - .00190} = \frac{-5}{.00025\,K^{-1}} = -20{,}000\,K$$

$$m = \frac{-Ea}{R} = -20000$$

$$Ea = (-20000\,\cancel{K})(-8.3145\,\frac{J}{mol\,\cancel{K}})$$

$$= 166290\,\frac{J}{mol} = 166\ kJ/mol$$

(D) is closest answer

(29) D

(30) 2; $\text{rate} = k[NO_3][CO]$ (E)

(31) B

(32) C

| T | k ($s^{-1}$) |
|---|---|
| 25°C | $1.35 \times 10^2$ |
| 75°C | ? |

(33) (D)

$$\ln\frac{K_2}{K_1} = \frac{Ea}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$\ln\left(\frac{k_2}{1.35\times10^2\,s^{-1}}\right) = \frac{85600\,\frac{J}{mol}}{8.3145\,\frac{J}{K\,mol}}\left(\frac{1}{298K} - \frac{1}{348K}\right)$$

$$= 10295\,K\,(.000482141\,K^{-1})$$

$$\ln k_2 = 4.964 + (\ln 1.35\times10^2) = 9.869$$

$k_2 = \ln^{-1} 9.869$

$k_2 = 19320$

$k_2 = 1.93\times10^4\ s^{-1}$