AP Chemistry Test (Chapter 12)

Multiple Choice (40%)

1) Which of the following is a kinetic quantity?

A) Enthalpy
B) Internal Energy
C) Gibb's free energy
D) Entropy
E) Rate of reaction

2) Of the following questions, which ones are thermodynamic, rather than kinetic concepts?

I) Can substances react when we put them together?
II) If a reaction happens, how fast will it occur?
III) What is the mechanism by which the reaction occurs?
IV) If substances react, what energy changes occur?

A) I and III
B) II and IV
C) I and IV
D) II and III
E) I, III and IV

3) One of the reactions that is used to produce gaseous hydrogen commercially follows. A proper expression for the rate of this reaction could be __?__.

$$H_2O\,(g) + CO\,(g) \rightarrow H_2\,(g) + CO_2\,(g)$$

A) $\frac{\Delta[CO_2]}{\Delta t}$ B) $\frac{-\Delta[H_2]}{\Delta t}$ C) k D) $\frac{\Delta[CO]}{\Delta t}$ E) $\frac{\Delta[H_2O]}{\Delta t}$

4) Which of the following reactions would be expected to be the slowest?

A) $H^+\,(aq) + CN^-\,(aq) \rightarrow HCN\,(aq)$
B) $3\,H^+\,(aq) + PO_4^{3-}\,(aq) \rightarrow H_3PO_4\,(aq)$
C) $Pb^{2+}\,(aq) + SO_4^{2-}\,(aq) \rightarrow PbSO_4\,(s)$
D) $O\,(g) + O\,(g) \rightarrow O_2\,(g)$
E) $O_2\,(g) + O\,(g) \rightarrow O_3\,(g)$

5) What can be said about the stoichiometric coefficients of a balanced chemical equation for a reaction and the powers to which the concentrations are raised in the rate law expression?

A) There is an exact relationship between the two.
B) The powers can be equal to the number of molecules that are formed.
C) The powers are equal to the number of molecules with effective collisions in the fastest step of the reaction mechanism.
D) Not much can be said except that there is no necessary relationship.
E) The powers equal the coefficients of the equation.

6) Please consider the following gas phase reaction and its experimentally observed rate law. What is the overall order of the reaction?

$$A + B \rightarrow C \qquad \text{rate} = k[A]^2[B]$$

A) 1^{st} B) 2^{nd} C) 3^{rd} D) 0 order

7) Please consider the following gas phase reaction and its experimentally observed rate law. Which one would affect the value of the specific rate constant, k?

$A + B \rightarrow C$ rate = $k[A]^2[B]$

A) Decreasing the temperature
B) Changing the concentration of A
C) Changing the concentration of B
D) Changing the concentration of C
E) Letting the reaction proceed for a long time

8) The units of the rate constant for a second order reaction could be __?__.

A) $M^{-1} \bullet s^{-1}$ B) $M^{-2} \bullet s^{-1}$ C) $M \bullet s^{-1}$ D) s^{-1} E) $M^{2} \bullet s^{-1}$

9) Please consider the following hypothetical reaction found to be first order in X and second order in Y. What are the units of the rate k, the specific rate constant, if the reaction rate is expressed in units of M/s?

$X + 2\ Y \rightarrow$ Products

A) $M \bullet s^{-1}$ B) $M^{-2} \bullet s^{-1}$ C) $M^{-3} \bullet s^{-1}$ D) $M^{2} \bullet s^{-1}$ E) $M^{-1} \bullet s^{-1}$

10) Please consider the following hypothetical reaction and its experimentally determined specific rate constant, k. What overall order is this reaction?

$X + Y \rightarrow$ Products $k = 0.255\ s^{-1}$

A) 0 order
B) 1^{st} order
C) 2^{nd} order
D) 3^{rd} order
E) Cannot be determined

11) Please consider the following hypothetical reaction and its experimentally determined specific rate constant, k. Which rate law expression could be correct?

$X + Y \rightarrow$ Products $k = 0.255\ M^{-3}min^{-1}$

A) rate = $k[X]^3$
B) rate = $k[X]^2[Y]$
C) rate = $k[X][Y]$
D) rate = k
E) rate = $k[X]^3[Y]$

12) Please consider the following gas phase reaction and its experimentally determined rate law expression. If the concentration of A is tripled and the concentration of B is doubled, the reaction rate would be increased by a factor of __?__.

$A + B \rightarrow C$ rate = $k[A]^2[B]$

A) 6 B) 9 C) 12 D) 18 E) 36

13) Which of the following statements is false?

A) In order for a reaction to occur, reactant molecules must collide with each other.
B) According to the collision theory, a three-body collision is less likely than a two-body collision.
C) In reactions that are second order in one reactant and first order in another, the slow step generally involves a three-body collision of these reactants.
D) The transition state is a short-lived, high energy state, intermediate between reactants and products.

14) Which one is the rate law expression for this elementary, gas phase reaction?

$NO_3 + CO \rightarrow NO_2 + CO_2$

A) rate = $k[NO_3]^2$
B) rate = $k[CO]$
C) rate = $k[NO_3]^2[CO]^2$
D) rate = $k[NO_2][CO_2]$
E) rate = $k[NO_3][CO]$

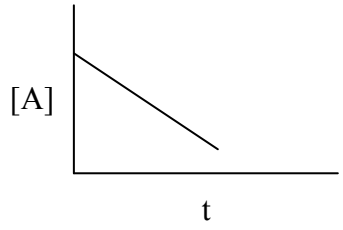
15) We are studying the following reaction. We make a plot of ln[A] vs. time as the reaction proceeds. This plot turns out to be linear with a slope of -0.25. What is the rate law expression for this reaction?

$2\ A \rightarrow 3\ B$

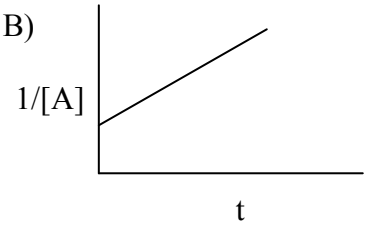
A) rate = 0.25 s^{-1} [A]
B) rate = 0.25 $M^{-1}s^{-1}$ ln[A]
C) rate = 0.25 $M^{-1}s^{-1}$ $[A]^2$
D) rate = -0.25 s^{-1} [A]
E) rate = 0.0625 $M^{-1}s^{-1}$ $[A]^2$

16) Which graph illustrates a 2nd order reaction, A → B

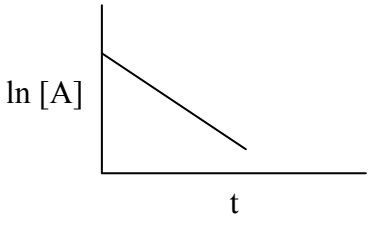
A)



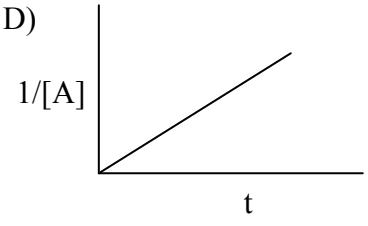
B)



C)



D)



Please use the following information to answer questions 17-20.

Step 1: $A + B \rightarrow C$
Step 2: $C + D \rightarrow E + 2\,M$
Step 3: $D + E + B \rightarrow J$

17) Please write the overall, balanced reaction.

18) Please identify all intermediates.

19) Please identify the products.

20) Please identify the reactants.

Problems (60%) **Please show all your work for any credit!!!**

1) Please write the rate law expression for this reaction, based on the following experimental data.

$NO + O_2 + N_2 \rightarrow$ Products

Experiment	Initial [NO] (M)	Initial [O_2] (M)	Initial [N_2] (M)	Initial Rate of Disappearance of NO (M/min)
1	0.100	0.150	0.250	7.99×10^{-4}
2	0.100	0.450	0.250	2.40×10^{-3}
3	0.100	0.150	0.500	1.60×10^{-3}
4	0.400	0.150	0.500	2.56×10^{-2}

Please use the following experimental data to answer questions 2-3.

$A + B + C \rightarrow$ Products

Experiment	Initial [A] (M)	Initial [B] (M)	Initial [C] (M)	Initial Rate of Reaction (M/s)
1	0.20	0.10	0.30	0.00798
2	0.20	0.30	0.40	0.0426
3	0.20	0.10	0.50	0.0222
4	0.30	0.10	0.60	0.0319

2) Please write the rate law expression for this reaction.

3) What would be the initial rate of reaction if the initial concentration of A was 0.40 M, the initial concentration of B was 0.20 M and the initial concentration of C was 0.10 M?

4) Please write the rate law expression, using the following experimental data.

$$CO_2\ (g) \rightarrow C\ (s) + O_2\ (g)$$

Time (s)	$[CO_2]$ (M)
0.0	0.153
5.00	0.122
10.00	0.102
15.00	0.0872
20.00	0.0762

5) What is the half-life of this reaction? $2\ A \rightarrow A_2$ $k = 2.34\ s^{-1}$

6) Please consider this reaction:

$$2\ NO_2\ (g) \rightarrow 2\ NO\ (g) + O_2\ (g) \qquad \text{rate} = 0.103\ M^{-1}\ s^{-1}[NO_2]^2$$

4.00 mol NO_2 is placed into a 6.00-L flask. What mass of O_2 is present after 1.80 s?

7) Please consider this reaction: $2\ NH_3\ (g) \rightarrow N_2\ (g) + 3\ H_2\ (g)$ $k = 1.21\ M\ s^{-1}$

5.25 mol NH_3 is placed into a 3.00-L flask. How long will the reaction proceed to consume 80.0% of the original NH_3?

8) Please write the rate law for this reaction mechanism.

Step 1:	$H_2 \leftrightarrow 2\ H$	(Fast, equilibrium)
Step 2:	$H + CO \rightarrow HCO$	(Slow)
Step 3:	$H + HCO \rightarrow H_2CO$	(Fast)

Formulas: $\mathbf{t_{1/2} = \frac{[A]_0}{2k}}$ $\mathbf{t_{1/2} = \frac{0.693}{k}}$ $\mathbf{t_{1/2} = \frac{1}{k[A]_0}}$

AP Chemistry Test (Chapter 12) **Name**_____

Multiple Choice (40%)

1)	_____	11)	_____
2)	_____	12)	_____
3)	_____	13)	_____
4)	_____	14)	_____
5)	_____	15)	_____
6)	_____	16)	_____
7)	_____	17)	_____
8)	_____	18)	_____
9)	_____	19)	_____
10)	_____	20)	_____

Problems (70%) **Please show all your work for any credit.**

1) Please use only the front side of each piece of paper.

2) Please number your problems clearly and consecutively.

3) Please staple your problems to the back of this page in numerical order.

4) Please write on the paper in the conventional manner.

5) Please do not make a separate list of answers. Record your answer at the end of the work supporting your answer.

6) Please circle/box your answer to any problems.

AP Chemistry Test (Chapter 12) **Name Key**

Multiple Choice (40%)

1)	E	11)	E
2)	C	12)	D
3)	B	13)	D
4)	B	14)	E
5)	D	15)	A
6)	C	16)	B
7)	A	17)	$A + 2\,B + 2\,D \rightarrow 2\,M + J$
8)	A	18)	C E
9)	B	19)	M J
10)	B	20)	A B D

Problems (60%)

1) rate = 2.13 $M^{-3}min^{-1}$ $[NO]^2[O_2][N_2]$

2) rate = 0.89 $M^{-2}s^{-1}$ $[B][C]^2$

3) 0.0018 M/s

4) rate = 0.329 $M^{-1}s^{-1}$ $[CO_2]^2$

5) 1^{st} order!! 0.296 s

6) 2^{nd} order!! 7.04 g

7) 0^{th} order!! 1.16 s

8) rate = k $[H_2]^{1/2}[CO]$