CHEMISTRY 202	Name __________**KEY**__________
Hour Exam III	
November 30, 2023	Signature ________________________
Dr. D. DeCoste	
	T.A. ___________________________

This exam contains 23 questions on 12 numbered pages. Check now to make sure you have a complete exam. You have two hours to complete the exam. Determine the best answer to the first 20 questions and enter these on the special answer sheet. Also, circle your responses in this exam booklet. **Show all of your work and provide complete answers to questions 21, 22, and 23.**

1-20	(60 pts.)	__________
21	(15 pts.)	__________
22	(15 pts.)	__________
23	(30 pts.)	__________
Total	(120 pts)	__________

Useful Information:

Table 15.6

Summary of the Kinetics for Reactions of the Type *a*A ⟶ Products That Are Zero, First, or Second Order in [A]

	Order		
	Zero	First	Second
Rate law	Rate = k	Rate = k[A]	Rate = $k[A]^2$
Integrated rate law	$[A] = -kt + [A]_0$	$\ln[A] = -kt + \ln[A]_0$	$\frac{1}{[A]} = kt + \frac{1}{[A]_0}$
Plot needed to give a straight line	[A] versus t	ln[A] versus t	$\frac{1}{[A]}$ versus t
Relationship of rate constant to the slope of the straight line	Slope = $-k$	Slope = $-k$	Slope = k
Half-life	$t_{1/2} = \frac{[A]_0}{2k}$	$t_{1/2} = \frac{0.693}{k}$	$t_{1/2} = \frac{1}{k[A]_0}$

PV = nRT

R = 8.314 J/Kmol = 0.08206 Latm/molK

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

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

1. How many of the following have the **same magnitudes**?

- The ionization energy of element X and the electron affinity of element X.
- The ionization energy of the ion X^{2+} and the electron affinity of the ion X^{+}.
- The ionization energy of the ion X^{2-} and the electron affinity of the ion X^{3-}.
- The ionization energy of element X and the electron affinity of the ion X^{-}.

a) 0 b) 1 c) 2 d) 3 e) 4

2. How many of the following pairs consist of atoms having the **same electronegativity value**?

- Se and Pb
- As and O
- C and N
- P and Te
- F and Ne

a) 1 b) 2 c) 3 d) 4 e) 5

3. Consider the following reaction: $C_2H_4(g) + X_2(g) \rightarrow CH_2XCH_2X(g)$. You know that the change in enthalpy for this reaction at a temperature such that all substances are gases is –92 kJ/mol. Using the bond energies (Table 13.6), determine the **identity of X**.

a) O b) F c) Cl d) Br e) I

4. For which of the following would using bond energies to estimate $\Delta H°_f$ result in the **smallest percent error**?

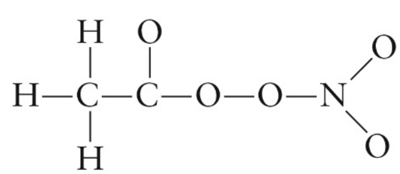
a) $NH_3(g)$ b) $CH_4(g)$ c) $H_2O(g)$ d) $CH_3OH(g)$ e) $HCl(g)$

5. How many of the following molecules are polar?

$SeCl_2$ CO_2 $XeCl_2$ SO_2 OF_2

a) 1 b) 2 c) 3 d) 4 e) 5

6. Consider the following incomplete Lewis structure. When complete, how many lone pairs of electrons will be present? Do all of the atoms have a formal charge of zero?



a) There will be 10 lone pairs of electrons but not all atoms can have a formal charge of zero.
b) There will be 10 lone pairs of electrons and all atoms can have a formal charge of zero.
c) There will be 11 lone pairs of electrons but not all atoms can have a formal charge of zero.
d) There will be 11 lone pairs of electrons and all atoms can have a formal charge of zero.
e) The number of lone pairs and formal charge depends on the resonance structure.

7. How many of the following statements are **false**? Remember that not necessarily true means false!

I. Any molecule exhibiting only London dispersion forces has a lower boiling point than any molecule exhibiting hydrogen-bonding.
II. Molecules with both a tetrahedral geometry and tetrahedral shape are nonpolar.
III. The molecules CF_4 and SF_4 have different geometries and different shapes.
IV. For a given substance, the magnitude of the value of ΔH_{fusion} is generally greater than the magnitude of the value of $\Delta H_{\text{vaporization}}$.

a) 0 b) 1 c) 2 d) 3 e) 4

8. How many of the following polyatomic ions – carbonate, nitrate, sulfate, and phosphate – **must** be drawn with equivalent resonance structures?

a) 0 b) 1 c) 2 d) 3 e) 4

9. Which of the following has the **highest boiling point**?

a) CH_3OCH_3 b) CH_3OH c) $CH_3CH_2CH_3$ d) HCl e) CH_3CH_2OH

10. Which of the following statements is **true** concerning the behavior of real gases?

a) The observed pressure of a gas is lower than expected ideally, and the volume of the container is less than the volume available to the gas.
b) The observed pressure of a gas is lower than expected ideally, and the volume of the container is greater than the volume available to the gas.
c) The observed pressure of a gas is greater than expected ideally, and the volume of the container is greater than the volume available to the gas.
d) The observed pressure of a gas is greater than expected ideally, and the volume of the container is less than the volume available to the gas.

11. Consider two reactions: Reaction I can be represented as $aA \rightarrow Products$ and is zero-order in A, and Reaction II can be represented as $bB \rightarrow Products$ and is second-order in B. Reaction II has a rate constant with a value two-times that of Reaction I. Consider beginning the separate reactions with concentrations of A and B both at 1.000*M* and letting them proceed until the concentration of each is 0.125*M*. How do the times of the reactions compare?

a) The time for [B] to equal 0.125*M* is four (4) times as great as the time for [A] to equal 0.125*M*.
b) The time for [B] to equal 0.125*M* is two (2) times as great as the time for [A] to equal 0.125*M*.
c) The time for [A] and [B] to equal 0.125*M* is the same.
d) The time for [A] to equal 0.125*M* is two (2) times as great as the time for [B] to equal 0.125*M*.
e) The time for [A] to equal 0.125*M* is four (4) times as great as the time for [B] to equal 0.125*M*.

12-13. Consider the following two generic reactions:

$$aA \rightarrow bB \qquad \text{rate} = -\frac{d[A]}{dt} = k_1 = 5.50 \text{ x } 10^{-2}\ M/min \text{ at } 25°C$$

$$cC \rightarrow dD \qquad \text{rate} = -\frac{d[C]}{dt} = k_2[C]^2\ (k_2 = 6.23 \text{ x } 10^{-3}\ \text{Lmol}^{-1}\text{min}^{-1} \text{ at } 25°C)$$

In a particular experiment, A and C are placed in separate containers (at 25°C) under conditions such that $[A]_0 = [C]_0 = 3.14M$. You allow the reactions to progress until [A] = [C].

12. Determine the time required such that [A] = [C].

a) 3 minutes b) 4 minutes c) 5 minutes d) 6 minutes e) [A] will never equal [C].

13. Determine the concentration of A and C when they are equal.

a) 0.116*M* b) 2.77*M* c) 2.81*M* d) 2.87*M* e) [A] will never equal [C].

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14. We want to study the kinetics of the decomposition of a compound into its elements in their standard states. We decide to do so by monitoring the total pressure of the system over time. For which of the following compounds will this approach **not** work?

a) HF(*g*)
b) NH_3(*g*)
c) H_2O(g)
d) We can use total pressure to determine the kinetics of the decomposition for all of the compounds in a-c above.
e) We cannot use total pressure to determine kinetic data because we need the partial pressure of the compound being studied.

15. Consider the following proposed mechanism for the decomposition of dinitrogen pentoxide (N_2O_5) to produce nitrogen dioxide and oxygen gases:

$$N_2O_5(g) \rightleftharpoons NO_3(g) + NO_2(g)$$
$$NO_3(g) + NO_2(g) \rightarrow NO(g) + O_2(g) + NO_2(g)$$
$$N_2O_5(g) + NO(g) \rightarrow 3NO_2(g)$$

To apply the steady-state approximation which of the following equations should be used? Note, the subscripts for the rate constants represent what we discussed in lecture and videos.

a) $k_1[N_2O_5] = k_2[NO_3][NO_2]$
b) $k_2[NO_3][NO_2] = k_{-2}[NO][O_2][NO_2]$
c) $k_1[N_2O_5] + k_2[NO_3][NO_2] = k_3[N_2O_5][NO] + k_{-1}[NO_3][NO_2]$
d) $k_1[N_2O_5] = k_{-1}[NO_3][NO_2] + k_2[NO_3][NO_2]$
e) Two of the above (a-d) should be used.

16. Catalysts can be specific for a certain reaction. Suppose you invent a catalyst to target a reaction you've been studying. The catalyzed reaction (which has an activation energy of 49 kJ/mol) occurred after about 10 seconds at 25°C. When uncatalyzed, the reaction has an activation energy of 75 kJ/mol. About how long does the uncatalyzed reaction take at 25°C? Assume the catalyzed and uncatalyzed reactions have the same form and orders, and the pre-exponential factor, *A*, is the same for both.

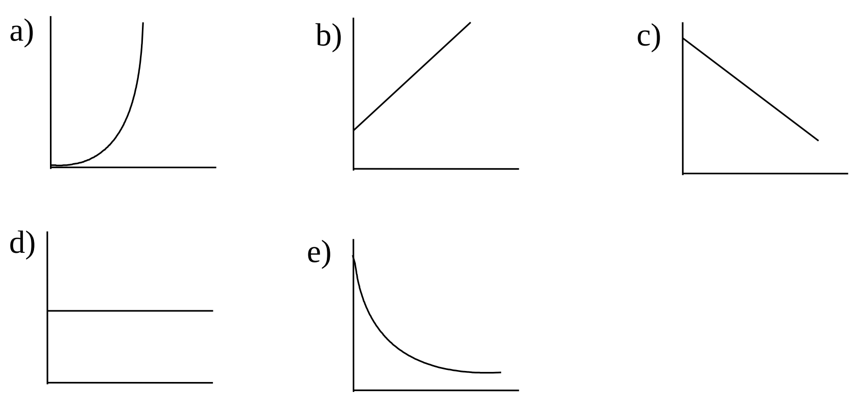
a) About 15-20 seconds.
b) About 45 minutes.
c) About 12 hours.
d) About 4 days.
e) About 2 weeks.

17. How many of the following will change both the value of the equilibrium constant, *K*, and the value of the rate constant, *k*, for a given reaction?

- Adding a catalyst.
- Changing the concentrations of the reactants and/or products.
- Changing the temperature.
- Carrying out the reaction in a closed container.

a) 0 b) 1 c) 2 d) 3 e) 4

18-20. Choose the best graph for the plots described below. A graph may be used once, more than once, or not at all.



18. Length of half-life (y) vs. time (x) for reaction type $aA \rightarrow Products$ which is second-order in A. b

19. Rate of reaction (y) vs. [A] (y) for reaction type $aA \rightarrow Products$ which is zero-order in A. d

20. 1/[A] (y) vs. time (x) for reaction type $aA \rightarrow Products$ which is second-order in A. b