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Chemistry II-AP

Kinetics Practice Test

Solution Set

1. B When a catalyst is added to a reaction system, the potential energy of the activated complex:

 A) increases and the heat of the reaction increases; B) decreases and the heat of the reaction remains the same; C) remains the same and the heat of the reaction decreases;

 D) decreases and the heat of the reaction increases; E) remains the same and the heat

 of the reaction increases.

2. **C** All of the following apply to the reaction A(g) + B(g)  --> C(g) as it is carried out at constant

 temperature in a rigid container EXCEPT:

 A) the total pressure decreases; B) the rate of the reaction decreases;

 C) the entropy of the reaction decreases; D) the number of molecules of C decreases;

 E) the frequency of collisions between molecules A and B decreases.

3. **A** All of the following **decrease** the rate of a gas phase reaction EXCEPT:

 A) adding an inert gas; B) removing a catalyst;

 C) increasing the volume of the system; D) lowering the temperature of the system;

 E) decreasing the concentration of one of the gaseous reactants.

4. **D** Which describes the role of the match in the ignition of the liquid propane used to fuel a torch or gas grill?

 A) The match flame decreases the energy of activation for the slowest step.

 B) The match flame increases the concentration of the volatile reactant.

 C) The match flame provides the heat of vaporization for the volatile element.

 D) The match flame supplies the energy of activation for the combustion reaction.

 E) The match flame provides a more favorable activated complex for the combustion reaction.

Consider a radioactive isotope that has a decay rate constant, ***k***, of **4.68 x 10-3 min-1 .**

5. **148 min.** What is the half-life of this substance, in minutes?

 **0.693 /** **4.68 x 10-3 min-1 = 148.07 min**

6. **1.74 mg** If a **0.200-milligram** sample of this isotope remains after **7.70 hours**, what was the mass of the **original sample**?

 **ln( X / 0.200 mg)** = (**4.68 x 10-3 min-1)(7.70 hr)(60 min / hr)**

  **X = 1.737 mg**

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 5 Br-1(aq) + BrO3(aq) -1 + 6 H+1(aq) 3 Br2(liq) + 3 H2O(liq)

In a study of the kinetics of the reaction represented above, the following data were obtained at 298 K.

 Initial [Br-1] Initial [BrO3-1] Initial [H+1] Rate of disappearance

 Exp.# (mol L-1) (mol L-1) (mol L-1) of [BrO3-1] (mol L-1sec-1)

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 1 0.00100 0.00500 0.100 2.50 x 10-4

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 2 0.00200 0.00500 0.100 5.00 x 10-4

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 3 0.00100 0.00750 0.100 3.75 x 10-4

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 4 0.00100 0.01500 0.200 3.00 x 10-3

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 5 0.00400 0.0500 ?? 8.00 x 10-2

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 From the data given above, determine the order of the reaction for each reactant listed below.

 Show or state your reasoning clearly.

7. Br-1

 **1st order – comparing trials #1 & #2 – conc. of bromide doubles & rate doubles**

8. BrO3 -1

 **1st order – comparing trials #1 & #3 – conc. of bromate increases by 1.5 & rate does the same**

9. H+1

 **2nd order – comparing trials #3 & #4 – rate increases by a factor of 8**

 **Bromate doubles and we already know that it is 1st order**

 **Hydrogen also doubles, so it causes the extra quadrupling of the rate.**

10. Write the rate law expression for the overall reaction.

 **Rate = k [Br-1][BrO3-1] [H+1]2**

11. Determine the value of the specific rate constant, k, for the reaction. Include the correct units.

 **Using trial #1 data: 2.50 x 10-4 = k[0.00100][0.00500][0.100]2**

 **k = 5000 M-3-sec-1**

12. **20.0 M**  What is the [H+1] in experiment #5?

 **8.00 x 10-2 = 5000 M-3-sec-1[0.00400][0.0500][ H+1]2**

 **[H+1]2 = 400 M2 🡺 [H+1] = 20.0 M (not realistic!)**

13. **2.50 x 10-3**  What is the rate of disappearance of the [Br-1] in experiment #2?

 **Simply based on the stoichiometry of the reaction…(a 5 : 1 ratio)**

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14. **3rd**  If a reaction A --> P has a specific rate constant, k, with a value of 7.2 x 10-5 M-2 hr-1, what is the overall order of the reaction?

15. **1st**  A student runs a set of trials to determine the initial rate

of a reaction for the following reaction: R 🡪 Products

 By plotting **the log [R] versus time**, she finds that a straight-line graph is produced.

 What is the **order** of this reaction?

16. **enzyme**  What is the term for a biological catalyst? (Hint: it belongs to the group of organic substances known as proteins.)

17. **3rd**  The reaction below is known to be a single-step reaction. What is the overall order?

 2 A(g) + B(g) 🡪 R(g) + 2 Z(g)

-4-

Use the following graph to answer the next set of questions.

 A-C

 450

 400

 Reactants

 350

energy

(in kJ) 300

 250

 Products

 200

 Reaction Pathway Reactants --> Products

18. Indicate whether this reaction is exothermic or endothermic. Justify your answer.

 **Exothermic – energy of products is less than energy of reactants**

19. Determine the heat of the reaction H.

 H = **-150 kJ** (be sure to include the proper sign)

20. **25 kJ** What is the activation energy for the catalyzed forward reaction?

21. **100 kJ** What is the activation energy for the forward reaction (non-catalyzed)?

22. **250 kJ** What is the activation energy for the reverse reaction (non-catalyzed)?

23. **10.0 M/hr** If the rate of formation of Products in this reaction at 60oC was 1.25 M/hour, what would be the approximate rate for this same reaction at 90oC?

 **1.25 x 2 x 2 x2 = 10.0**

Use the following information to answer the next few questions.

 3 A(g) + B(g) + 3 C(g) 🡪 2 G(liq) + 4 H(g) H = **-**135.0 kcal at 35.0oC

 Pd

 **Initial Concentrations Initial Rate of Reaction**

**Trial #**  **[A] [B] [C] (formation of H in M/min)**

 **1 0.150 0.150 0.150 25.00**

 **2 0.150 0.450 0.150 25.00**

 **3 0.300 0.300 0.150 200.00**

 **4 0.300 0.600 0.450 1800.00**

 **5 0.050 0.050 0.050 0.103**

 **6 0.350 0.500 0.500 ??**

24. **3rd**  What is the order with respect to A?

 **(eliminate B, A doubles (trials #2🡪3), rate inc. 8 times**

25.  **zero** What is the order with respect to B?

26. **2nd**  What is the order with respect to C?

 **(eliminate B, C triples (trials #3🡪4), rate inc. 9 times**

# Still using the same reaction, but at **different conditions**,

# the reaction was known to occur in 5 steps.

 Step #1: 2A + Pd ------------------> R moderate

 Step #2 R + A --------------> Pd + Q fast

#  Step #3 Q + 2 C --------------> G + Z moderate

 Step #4 C + Z -----------> G + H + K slow

 Step #5 K + B + C --------> 3 H moderate

27. **#4** Which step is the rate-determining step? **[“slow” step]**

28. **6th**  What is the overall order of the reaction based on this mechanism?

 **Rate\* = k\*[C][Z] 🡺 Z = Q + 2 C 🡺 Q = R + A 🡺 R = 2 A**

 **Rate = k[C]3[A]3**

29. **E** Which of the following represent an intermediate(s)?

 A) R & Q; B) Pd; C) Pd, R, Q, & Z; D) R, Q, & Z; E) R, Q, K, & Z;

 F) none of these represent an intermediate.

30. **30.5 kJ/mol** What is the activation energy (in kJ/mol) for a reaction if the specific rate constant is known to be 2.35 x 104 sec-1 at 20oC and 6.29 x 104 sec-1 at 45oC?

$ln(\frac{k\_{1}}{k\_{2}})= \frac{E\_{A}}{R}(\frac{1}{T\_{2}}- \frac{1}{T\_{1}})$ **=> EA = 30.5 kJ/mol**