PRACTICE EXAM

Printed Name:____________________
Student Number: __________________
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CHEMISTRY 1420 FIRST EXAM 100 POINTS

Each multiple choice test question is worth 4 points. Read each question very carefully. There is no partial credit for the multiple choice test questions. The four numerical questions on the exam are worth 10 points each. On the four numerical questions (i.e., non-multiple choice questions) partial credit will be past upon the work shown. **NOTE: TO RECEIVE PARTIAL CREDIT FOR ANY NON-MULTIPLE CHOICE PROBLEM, THE WORK SHOWN MUST BE CONSISTENT WITH THE ANSWER GIVEN!!**

Question 1: Which of the following statements is not true for the reaction of hydrogen gas with nitrogen gas to form ammonia

$$N_{2(gas)} + 3\,H_{2(gas)} \text{ ---------> } 2\,NH_{3(gas)}$$

(a) $-\frac{1}{3}\frac{\Delta[H_2]}{\Delta time} = -\frac{\Delta[N_2]}{\Delta time}$

(b) $-\frac{1}{3}\frac{\Delta[H_2]}{\Delta time} = -\frac{1}{2}\frac{\Delta[NH_3]}{\Delta time}$

(c) $-\frac{\Delta[N_2]}{\Delta time} = \frac{1}{2}\frac{\Delta[NH_3]}{\Delta time}$

(d) $-\frac{1}{3}\frac{\Delta[H_2]}{\Delta time} = \frac{1}{2}\frac{\Delta[NH_3]}{\Delta time}$

(e) One monitor the progress of the chemical reaction by measuring the disappearance of the reactants or the appearance of the products

Question 2: Which of the following statements is true for a reaction that is zero-order with respect to oxygen gas

(a) One could double the rate of reaction by doubling the concentration of oxygen gas

(b) One could double the rate of reaction by halving the concentration of oxygen gas

(c) One could double the rate of reaction by tripling the concentration of oxygen gas

(d) The rate of reaction is independent of the concentration of oxygen gas

(e) None of the above statements are true

Question 3: Which of the following statements is true

(a) Raising the temperature generally increases a reaction rate because it decreases the fraction of molecules that are energetic enough to surmount the activation energy barrier.

(b) Increasing the concentration of a reactant must always increase the reaction rate because there would be more favorable collisions involving that particular reactant

(c) Increasing the concentration of a reactant must always decrease the reaction rate because the additional molecules would prevent other molecules from colliding

(d) Raising the temperature generally increases a reaction rate because it increases the fraction of molecules that are energetic enough to surmount the activation energy barrier.

(e) Changing the temperature has absolutely no effect on the reaction rate

Question 4: Which of the following statements is not true

(a) A catalyst participates in the reaction mechanism

(b) The mechanism for a catalyzed reaction is different from the mechanism of the same reaction without the catalyst

(c) The enthalpy of reaction is the same for the catalyzed versus uncatalyzed chemical reaction.

(d) The rate-determining step in a catalyzed reaction mechanism has a lower activation energy and therefore is faster than the slow step for the uncatalyzed reaction.

(e) The catalyst is not regenerated during the course of the reaction, so it's concentration continually decreases with time.

Question 5: For the rate law expression:

Rate = rate constant $[A]^2$ [B]

(a) The reaction would be an overall second-order reaction

(b) The reaction would be third order with respect to Chemical A

(c) The reaction would be a second-order reaction with respect to Chemical A

(d) The reaction would be a second-order reaction with respect to Chemical B

(e) None of the above statements are true

Question 6: For a first-order radioactive decay, what would be the concentration of the radioactive material after three half-lives

(a) The concentration of radioactive material would be 50.0 % of its original value

(b) The concentration of radioactive material would be 33.3 % of its original value

(c) The concentration of radioactive material would be 25.0 % of its original value

(d) The concentration of radioactive material would be 12.5 % of its original value

(e) Could not be determined without knowing how long the half live was

Question 7: Assuming that the reaction between ozone and an oxygen atom is elementary

$O_{(gas)} + O_{3(gas)} \dashrightarrow 2\ O_{2(gas)}$

one would predict the rate law to be

(a) rate = k [O]

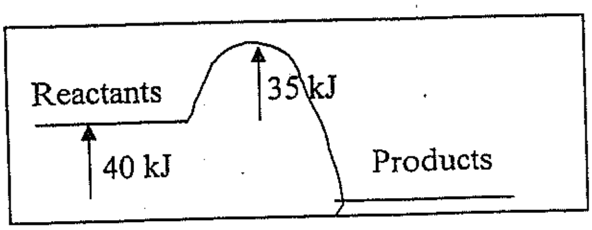
(b) rate = k $[O_3]$

(c) rate = k $[O][O_3]$

(d) rate = k $[O][O_3]/[O_2]^2$

(e) rate = k $[O_2]^2$

Question 8: Given below is an energy versus reaction progress diagram for an elementary reaction



(a) The diagram shows that the enthalpy of reaction is endothermic by 40 kJ and that the energy of activation is 35 kJ

(b) The diagram shows that the enthalpy of reaction is exothermic by -35 kJ and that the energy of activation is 40 kJ

(c) The diagram shows that the enthalpy of reaction is exothermic by -75 kJ and that the energy of activation is 40 kJ

(d) The diagram shows that the enthalpy of reaction is exothermic by -40 kJ and that the energy of activation is 35 kJ

(e) None of the above statements are correct

Question 9: For a zero-order chemical reaction

A -----------> Products

(a) A plot of [A] versus time would be linear and have a positive slope

(b) A plot of 1/[A] versus time would be linear and have negative slope

(c) A plot of 1/[A] versus time would be linear and have a positive slope

(d) A plot of ln [A] versus time would be linear and have a negative slope

(e) A plot of [A] versus time would be linear and have a negative slope

Question 10: Given the following concentrations for the reaction of

$N_{2(gas)} + 3\ H_{2(gas)}$ ---------> $2\ NH_{3(gas)}$

Calculate the average rate of change of hydrogen gas, that is $\Delta[H_2]/\Delta$time

$[H_2]$ = 0.00500 Molar at Time = 0.00 seconds

$[H_2]$ = 0.00450 Molar at Time = 120 seconds

(a) -4.167×10^{-6} M/sec

(b) -1.389×10^{-6} M/sec

(c) -1.2501×10^{-5} M/sec

(d) -8.334×10^{-5} M/min

(e) None of the above answers are correct

Question 11: The energy of activation can be determined by measuring the rate constant at several temperatures. To determine the rate constant one would need to plot the data as:

(a) the ln rate constant on the x-axis and 1/T(in Kelvin) on the y-axis, and the slope of the resulting straight line would be equal to the negative value of the energy of activation divided by R

(b) the ln rate constant on the y-axis and 1/T(in Kelvin) on the x-axis, and the slope of the resulting straight line would be equal to the negative value of the energy of activation divided by R

(c) the rate constant on the x-axis and 1/T(in Kelvin) on the y-axis, and the slope of the resulting straight line would be equal to the negative value of the energy of activation divided by R

(d) the rate constant on the y-axis and 1/T(in Kelvin) on the x-axis, and the slope of the resulting straight line would be equal to the negative value of the energy of activation divided by R

(e) the ln rate constant on the y-axis and the Kelvin temperature on the x-axis, and the slope of the resulting straight line would be equal to the negative value of the energy of activation divided by R

Question 12: For an overall second-order reaction, the units on the rate constant would be

(a) 1/(M sec)

(b) 1/sec

(c) $1/(M^2\ sec)$

(d) $1/(M^2\ sec^2)$

(e) None of the above answers are correct

Question 13:

For the following reaction mechanism:

$ICl_{(gas)} + H_{2(gas)}$ <------> $HI_{(gas)} + HCl_{(gas)}$ fast

$HI_{(gas)} + ICl_{(gas)}$ --------> $HCl_{(gas)} + I_{2(gas)}$ slow

(Note: The double arrow is an equilibrium sign.) The overall reaction is

(a) $HI_{(gas)}$ + ICl(gas) -----> $HCl_{(gas)}$ + $I_{2(gas)}$

(b) 2 $ICl_{(gas)}$ + $H_{2(gas)}$ ---------> 2 $HCl_{(gas)}$ + $I_{2(gas)}$

(c) $ICl_{(gas)}$ + $H_{2(gas)}$ ------> $HCl_{(gas)}$ + $I_{2(gas)}$

(d) $ICl_{(gas)}$ + $H_{2(gas)}$ -------> $HI_{(gas)}$ + $HCl_{(gas)}$

(e) 2 $HI_{(gas)}$ + $ICl_{(gas)}$ + $H_{2(gas)}$ --------> $HCl_{(gas)}$ + $I_{2(gas)}$

Question 14: For the following reaction mechanism:

$ICl_{(gas)}$ + $H_{2(gas)}$ <------> $HI_{(gas)}$ + $HCl_{(gas)}$ fast

$HI_{(gas)}$ + $ICl_{(gas)}$ --------> $HCl_{(gas)}$ + $I_{2(gas)}$ slow

(Note: The double arrow is an equilibrium sign.) The predicted rate of reaction would be

(a) rate = k $[ICl]^2[H_2]/[HCl]$

(b) rate = k $[ICl]^2/[H_2][HCl]$

(c) rate = k $[ICl]\,[H_2]^2/[HCl]$

(d) rate = k $[ICl]\,[H_2]/[HCl]^2$

(e) None of the above answers are correct

Question 15: Which of the following statements would be true for a rate of reaction given by:

Rate of reaction = k $[H_2]^2\,[N_2]$

(a) The rate of reaction would increase by a factor of two if the concentration of hydrogen gas were doubled

(b) The rate of reaction would increase by a factor of eight if both the concentrations of hydrogen gas and nitrogen gas were doubled

(c) Would increase by a factor of four if the concentration of nitrogen gas were doubled

(d) Would increase by a factor of two if the concentration of hydrogen gas were cut in half

(e) Would be independent of the concentration of nitrogen gas

NUMERICAL (NON-MULTIPLE CHOICE) QUESTIONS: Each numerical question is worth 10 points. Remember partial credit is based on the work shown, and to receive partial credit the work must be consistent with the answer shown.

Question 16 (10 points)

Draw an energy versus reaction progress diagram for a reaction whose activiation energy is Ea' = 75 kJ/mole and whose enthalpy of reaction is –25 kJ/mole. Be sure to label the energy difference between the energies of the reactants and the transition state, and between the products and the reactants. What is the difference in energy between the transition state and the products?

Question 17 (10 Points)

For the reaction

$$2\ NO_{(gas)} + 2\ H_{2(gas)} \text{ ------> } N_{2(gas)} + 2\ H_2O_{(gas)}$$

these data were obtained:

[NO] (Mole/L)	[H_2] (Mole/L)	Initial rate (mol/(L sec)
5.00×10^{-3}	2.50×10^{-3}	3.0×10^{-3}
15.00×10^{-3}	2.50×10^{-3}	9.0×10^{-3}
15.00×10^{-3}	5.00×10^{-3}	36.0×10^{-3}

(a) Write the rate law expression for the above reaction (indicate the order of the reaction with respect to NO and with respect to H_2 gas)

(b) Calculate the rate constant – be sure that the units are correct.

Question 18 (10 points)

Experiments show that the reaction of dinitrogen dioxide with fluorine

Overall reaction: $2\ NO_{2(gas)} + F_{2(gas)}$ ---------> $2\ FNO_{2(gas)}$

has the rate law

Initial reaction rate = k $[NO_2][F_2]$

and the reaction is thought to occur in two steps

Step 1: $NO_{2(gas)} + F_{2(gas)}$ --------> $FNO_{2(gas)} + F_{(gas)}$

Step 2: $NO_{2(gas)} + F_{(gas)}$ ----------> $FNO_{2(gas)}$

Which step is rate determining?

Question 19 (10 points)

Using the following the rate constant data at 25 °C and at 50 °C,

T = 25 °C	rate constant = 8×10^{-8} (1/sec)
T = 50 °C	rate constant = 5×10^{-6} (1/sec)

calculate the energy of activation.