NAME _____

CHEMISTRY 102 FALL 2008

EXAM 2 FORM A SECTION 501 DR. KEENEY-KENNICUTT

Directions: (1) Put your name on PART 1 and your name and signature on PART 2 of the exam where indicated.
(2) Sign the Aggie Code on PART 2 of this exam.
(3) Each multiple choice question is actually 2 questions on your scanning sheet. If you are sure of an answer, **put the same answer down for both questions** for 5 pts. If you cannot decide between two answers, put your best answer down for the first (odd) question and the other answer down for the second (even) question. If you get the first one correct you'll get 3 pts; if you get the second one correct you'll get 2 pts. If there is an ambiguous multiple choice question, use the last page to explain your answer.
(4) Do NOT write on the envelope.
(5) When finished, put everything in the envelope and wait to be excused. At the table, take everything out of the envelope. You can pick up the multiple choice part with the answers outside my office after 3pm.
(6) There are a total of 32 questions (18 actual questions).

PART 1

1&2. What are the correct units of the specific rate constant for a reaction that is zero order overall?

(a) M/s (b) M (c) 1/s (d) 1/M·s (e) $1/M^2 \cdot s$

3&4. For a reaction where ΔH is -345 kJ/mol rxn and ΔS = -48 J/K, _____.

(a) the reaction is spontaneous at all temperatures.

(b) the reaction is nonspontaneous at all temperatures

(c) the reaction is spontaneous only at temperatures above a certain value.

(d) the reaction is spontaneous only at temperatures below a certain value.

(e) It is impossible to tell if the reaction is or is not spontaneous.

5&6. For a certain reaction, the activation energy for the forward reaction is 52 kJ and the internal energy change is +22 kJ. The activation energy for the reverse reaction is _____. (It may be useful to draw the potential energy diagram.)

(a) +30 kJ (b) -30 kJ (c) +74 kJ (d) -74 kJ (e) +22 kJ

7&8. Which of the following statements concerning chemical kinetics is TRUE?

(a) Activation energy for a forward reaction will change with increasing temperature.

(b) The rate of a reaction increases with increasing temperature.

(c) To have an effective collision, the reactants only need to collide with a certain minimum amount of energy.

(d) Catalysts do not participate in a reaction.

(e) An increase in temperature will change the appearance of a potential energy diagram.

9&10. Consider the gas-phase equilibrium system represented by the equation:

$$NO_2(g) + O_2(g) \rightleftarrows NO(g) + O_3(g)$$

given that the conversion of "left-hand" species (the reactants) to "right-hand" species (the products) as written, is endothermic, which of the following changes will DECREASE the equilibrium amount of NO?

(a) adding more oxygen gas

(b) decreasing the volume of the container at constant temperature

(c) raising the temperature

(d) adding a catalyst

(e) adding more ozone

11&12. Rate data were collected for the following reaction at a particular temperature. What is the correct rate law expression?

$$3X + Y + 2Z \rightarrow \text{products}$$

Experiment	$[X]_{initial}$	$[Y]_{initial}$	$[Z]_{initial}$	Initial Rate of Reaction
1	0.30 M	0.20 M	0.10 M	6.4×10^{-3} M/s
2	0.30 M	0.20 M	0.30 M	5.76×10^{-2} M/s
3	0.60 M	0.40 M	0.10 M	1.28×10^{-2} M/s
4	0.90 M	0.20 M	0.60 M	2.3×10^{-1} M/s
5	0.80 M	0.40 M	0.10 M	1.28×10^{-2} M/s

(a) Rate = $k[X][Y][Z]$ (b) Rate = $k[Y]^2[Z]$ (c) Rate = $k[Y][Z]^2$

(d) Rate = $k[X]^2[Z]^2$ (e) Rate = $k[Y]^2$

13&14. In a 1.0 liter container there are 0.20 mole N_2, 0.10 mole H_2 and 0.40 mole NH_3 in the system at equilibrium.

$$N_2(g) + 3\ H_2(g) \rightleftarrows 2\ NH_3(g)$$

What is the value of K_c for this reaction?

(a) 0.0012 (b) 20. (c) 0.050 (d) 8.0×10^2 (e) 8.0

15&16. Consider the reaction below at 25°C for which ΔG^o = -159 kJ/mol rxn. Calculate ΔS^o at 25°C.

$$HCN(g) + NH_3(g) \rightarrow CH_4(g) + N_2(g) + 163.8\ kJ$$

(a) -16.1 J/K (b) -67.8 J/K (c) -1.54 J/K (d) -444 J/K (e) -109 J/K

17&18. The equilibrium constant for the following gas phase reaction is 0.25 at a certain temperature. A reaction is carried out in a 2.0 liter container at this temperature starting with 4.0 moles CO_2 and 4.00 moles of H_2. What will be the equilibrium concentration of CO?

$$CO(g) + H_2O(g) \rightleftarrows CO_2(g) + H_2(g)$$

(a) 2.0 M (b) 0.75 M (c) 1.7 M (d) 0.67 M (e) 1.3 M

19&20. Which set of curves represents the changes in concentration of A and B with time for a reaction: $2A(g) \rightleftarrows B(g)$ in which K is much less than 1. Assume that initially only A is in the container at 1 M concentration.

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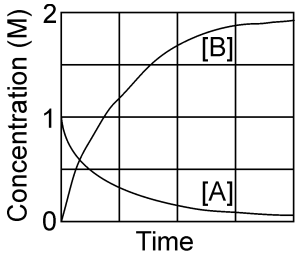
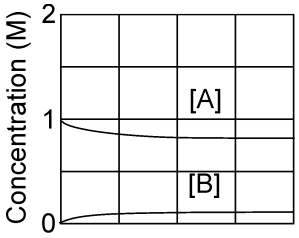
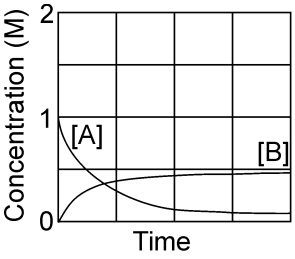
(a)



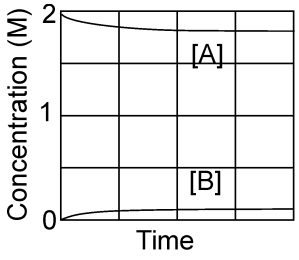
(b)



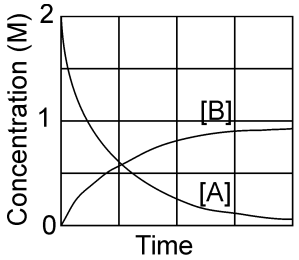
(c)



(d)



(e)



21&22. If the activation energy for a reaction was determined to be 155 kJ/mol rxn, how much faster would the reaction occur at 100°C than it would at 50°C?

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{T_2 - T_1}{T_1 T_2}\right) \quad \text{or} \quad \ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right) \qquad R = 8.314 \text{ J/mol} \cdot \text{K}$$

(a) 0.0012 (b) 8.0 (c) 0.050 (d) 8.0×10^2 (e) 2300

23&24. At 445°C, K_c for the following reaction is 51.

$$H_2(g) + I_2(g) \rightleftarrows 2HI(g)$$

A mixture of H_2, I_2 and HI in a vessel has the following concentrations:

$[H_2] = 1.0$ M
$[I_2] = 0.10$ M
$[HI] = 3.0$ M.

Which one of the following statements concerning the reaction quotient, Q_c, is TRUE for the above system?

(a) $Q_c = K_c$
(b) $Q_c < K_c$; more H_2 and I_2 will be produced
(c) $Q_c < K_c$; more HI will be produced
(d) $Q_c > K_c$; more H_2 and I_2 will be produced
(e) $Q_c > K_c$; more HI will be produced

25&26. The decomposition reaction of carbon disulfide, CS_2, to carbon monosulfide, CS, and sulfur is first order with a half-life of 28.6 days at 1000°C. How long will it take for 6.00 g of a 10.0 g sample of CS2 to be converted to products?

$$CS_2 \rightarrow CS + S$$

(a) 22 days (b) 38 days (c) 19 days (d) 32 days (e) 41 days

27&28. Estimate the sublimation temperature of the metal, sodium (in °C) using thermodynamic data given below taken from Appendix K:

$$Na(s) \rightleftarrows Na(g)$$

	$\Delta H^o_{f\,298}$ (kJ/mol)	S^o (J/mol·K)	$\Delta G^o_{f\,298}$ (kJ/mol)
Na(g)	108.7	153.6	78.11
Na(s)	0	51.0	0

(a) 1044°C (b) 893°C (c) 786°C (d) 911°C (e) 649°C

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Form A

PART 2

Please read and sign: "On my honor, as an Aggie, I have neither given nor received unauthorized aid on this exam." _____

29. Consider the following reaction seen in the demonstrations in class: $2H_2O_2(aq) \rightarrow 2H_2O(\ell) + O_2(g)$. We saw this reaction proceed using KI(aq) and $MnO_2(s)$ in two different demonstrations.

(2 pts) (a) KI(aq) was a _____ catalyst. (begins with h)

(5 pts) (b) Define catalyst. In your paragraph, include the answers to the questions:
* How do you recognize a catalyst in a reaction?
* Does a catalyst affect the mechanism?
* How is the activation energy and the ΔH ($=\Delta E$) for the reaction affected?

Here are two possible mechanisms for the decomposition of hydrogen peroxide.

(1)

Step 1	$H_2O_2(aq) + I^-(aq) \rightarrow IO^-(aq) + H_2O(\ell)$	slow
Step 2	$\underline{IO^-(aq) + H_2O_2(aq) \rightarrow H_2O(\ell) + O_2(g) + I^-(aq)}$	fast
Overall	$2H_2O_2(aq) \rightarrow 2H_2O(\ell) + O_2(g)$	

(2)

Step 1	$H_2O_2(aq) + I^-(aq) \rightleftarrows IO^-(aq) + H_2O(\ell)$	fast equilibrium
Step 2	$\underline{IO^-(aq) + H_2O_2(aq) \rightarrow H_2O(\ell) + O_2(g) + I^-(aq)}$	slow
Overall	$2H_2O_2(aq) \rightarrow 2H_2O(\ell) + O_2(g)$	

(7 pts) (c) Write the rate law expression for each of the mechanisms.
You must show all your work for Mechanism #2.

OVER ⇒

(1 pt) (d) Identify an intermediate: _____

(5 pts) **30.** (a) Write the Kc expression for: $2A(g) + B(s) \rightleftarrows C(\ell) + 3D(g)$

(4 pts) (b) If the K_c for the above reaction is 0.035, what is the value of K'_c for the following reaction:

$$2C(\ell) + 6D(g) \rightleftarrows 4A(g) + 2B(s)$$

(6 pts) **31.** Consider the equilibrium: $2X(g) + 2A(s) \rightleftarrows B(g)$

The reaction as written is strongly exothermic. Predict how the following changes will affect
(i) the moles of B in the container,
(ii) the value of the equilibrium constant, and
(iii) the activation energy, E_a, for the forward reaction

The possible answers are: increase (I), decrease (D), or remain unchanged (U)

	moles of B	**K**	**E_a**
(a) The temperature is decreased.			
(b) The volume of the container is halved.			

(1 pt) **32.** Grammar bonus: Caterpillars are _____ (larva or larvae) of butterflies.

SCRAP PAPER OR COMMENTS ON EXAM

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