

CHEMISTRY 102**EXAM 2 FORM B****SECTION 501****FALL 2008****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).
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PART 1

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

- (a) M/s (b) M (c) 1/s (d) 1/M-s (e) 1/M²-s

3&4. For a certain reaction, the activation energy for the forward reaction is 65 kJ and the internal energy change which equals the enthalpy change is -35 kJ. The activation energy for the reverse reaction is _____. (It may be useful to draw the potential energy diagram.)

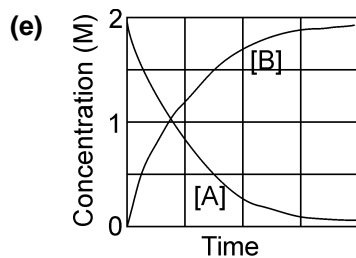
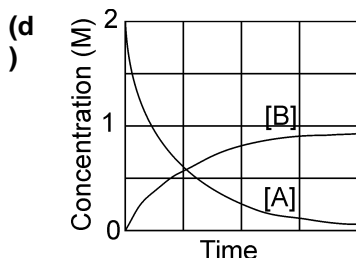
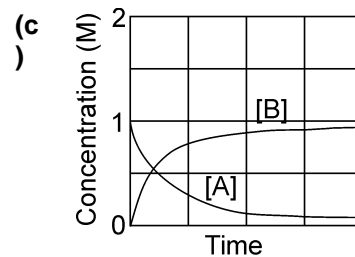
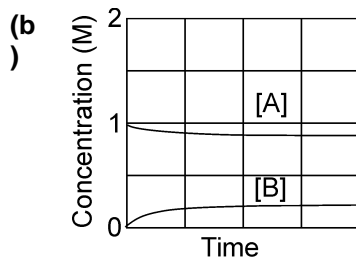
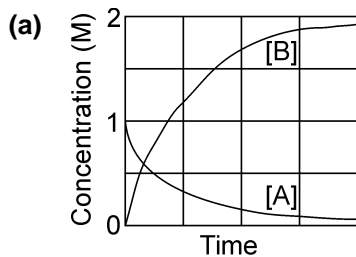
- (a) +30 kJ (b) -30 kJ (c) +100 kJ
(d) -100 kJ (e) +65 kJ

5&6. Which of the following statements concerning chemical kinetics is TRUE?

- (a) Catalysts do not participate in a reaction.
(b) Activation energy for a forward reaction will change with increasing temperature.
(c) An increase in temperature will change the appearance of a potential energy diagram.
(d) The rate of a reaction increases with increasing temperature.

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

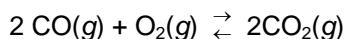
7&8. Which set of curves represents the changes in concentration of A and B with time for a reaction: $A(g) \rightleftharpoons 2B(g)$ in which K is much greater than 1. Assume that initially only A is in the container at 1 M concentration.



9&10. For a reaction where ΔH is +255 kJ/mol rxn and $\Delta S = +52$ 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.

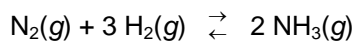
11&12. Consider the gas-phase equilibrium system represented by the equation:



given that the conversion of "left-hand" species (the reactants) to "right-hand" species (the products) as written, is exothermic, which of the following changes will INCREASE the equilibrium mass of CO?

- (a) decreasing the volume of the system at constant temperature
- (b) removing CO_2 gas from the system as it is formed
- (c) decreasing the temperature
- (d) adding a catalyst
- (e) removing more oxygen gas

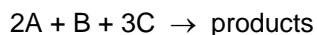
13&14. In a 1.0 liter container there are 0.62 mole N_2 , 0.50 mole H_2 and 0.24 mole NH_3 in the system at equilibrium.



What is the value of K_c for this reaction?

- (a) 0.74 (b) 2.7 (c) 1.3 (d) 0.60 (e) 0.37

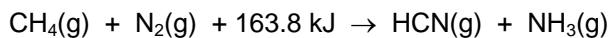
15&16. Rate data were collected for the following reaction at a particular temperature. What is the correct rate law expression?



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

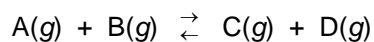
- (a) Rate = $k[A][B][C]$ (b) Rate = $k[B]^2[C]$ (c) Rate = $k[A][C]^2$
 (d) Rate = $k[A]^2[C]$ (e) Rate = $k[A]^2$

17&18. Consider the reaction below at 25°C for which $\Delta G^\circ = +159 \text{ kJ/mol rxn}$. Calculate ΔS° at 25°C.



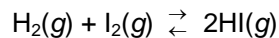
- (a) +1.54 J/K (b) +444 J/K (c) +67.8 J/K (d) +109 J/K (e) +16.1 J/K

19&20. The equilibrium constant for the following gas phase reaction is 144 at a 200°C. If 0.400 mol of both C and D are placed in a 2.00 liter container at that temperature, what will the concentration of A be at that same temperature?



- (a) 0.0020 M (b) 0.075 M (c) 0.13 M (d) 0.067 M (e) 0.015 M

21&22. At 400°C, K_c for the following reaction is 49.



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

$$[\text{H}_2] = 0.10 \text{ M}$$

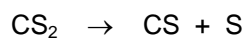
$$[\text{I}_2] = 0.010 \text{ M}$$

$$[\text{HI}] = 0.3 \text{ M.}$$

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

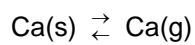
- (a) $Q_c = K_c$
- (b) $Q_c > K_c$; more H_2 and I_2 will be produced
- (c) $Q_c > K_c$; more HI will be produced
- (d) $Q_c < K_c$; more H_2 and I_2 will be produced
- (e) $Q_c < K_c$; more HI will be produced

23&24. The decomposition reaction of carbon disulfide, CS_2 , to carbon monosulfide, CS , and sulfur is first order with a half-life of 16.3 days at 2000°C. How long will it take for 2.00 grams of a 10.0 gram sample to be converted to products?



- (a) 18.1 days (b) 23.7 days (c) 7.55 days (d) 5.25 days (e) 39.0 days

- 25&26.** Estimate the sublimation temperature of the metal, calcium (in °C) using thermodynamic data taken from Appendix K given below:



	ΔH_f° (kJ/mol)	S° (J/mol·K)	ΔG_f° (kJ/mol)
Ca(g)	192.6	154.8	158.9
Ca(s)	0	41.6	0

- (a) 933°C (b) 1428°C (c) 1531°C (d) 1194°C (e) 1650°C

- 27&28.** If the activation energy for a reaction was determined to be 125 kJ/mol rxn, how much faster would the reaction occur at 200°C than it would at 100°C?

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

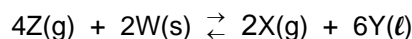
- (a) 5000 (b) 8.0 (c) 0.040 (d) 46 (e) 3100

PART 2

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

(5 pts) **29.** (a) Write the K_c expression for the reaction: $X(g) + 3Y(\ell) \rightleftharpoons 2Z(g) + W(s)$

(4 pts) (b) If the K_c for the above reaction is 12.5, what is the value of K'_c for the following reaction:



(6 pts) **30.** Consider the equilibrium: $A(g) + 2Y(s) \rightleftharpoons 2Z(g)$

The reaction as written is strongly endothermic. Predict how the following changes will affect

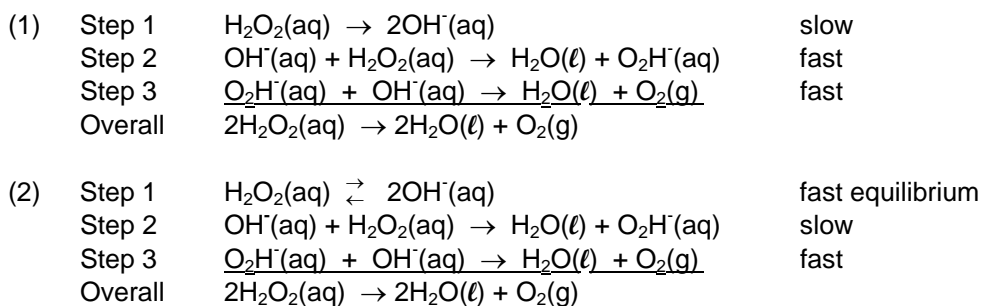
- (i) the moles of A in the container,
- (ii) the value of the equilibrium constant, and
- (iii) the activation energy, E_a , for the forward reaction

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

	moles of A	K	E_a
(a) The temperature is decreased.			
(b) The volume of the container is doubled.			

OVER ⇒

Here are two possible mechanisms for the decomposition of hydrogen peroxide on solid MnO₂. (Ignore the fact that some of the equations are not charge balanced.)



- (7 pts) (c) Write the rate law expression for each of the mechanisms. You must show all your work for Mechanism #2. The answer may have a fractional order.

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

31. Consider the following reaction seen in the demonstrations in class: $2\text{H}_2\text{O}_2(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\ell) + \text{O}_2(\text{g})$. We saw this reaction proceed using KI(aq) and MnO₂(s) in two different demonstrations.

- (2 pts) (a) MnO₂(s) 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 $\Delta H (= \Delta E)$ for the reaction affected?

(1 pt) **32.** Grammar bonus: The one tiny _____ (amoeba or amoebae) was separated from his buddies.

SCRAP PAPER OR COMMENTS ON EXAM

CHEMISTRY 102
EXAM 2 Form B

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