

CHEMISTRY 102**FALL 2008****EXAM 2 FORM C****SECTION 502****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 31 questions (17 actual questions).

PART 1

1&2. Which is the correct K_c expression for the equilibrium: $P_4(s) + 6H_2(g) \rightleftharpoons 4PH_3(g)$?

(a) $K_c = \frac{4[PH_3]}{[P_4] + 6[H_2]}$

(b) $K_c = \frac{[PH_3]^4}{[P_4][H_2]^6}$

(c) $K_c = \frac{[P_4][H_2]^6}{[PH_3]^4}$

(d) $K_c = \frac{[PH_3]^4}{[H_2]^6}$

(e) $K_c = \frac{4[PH_3]}{6[H_2]}$

3&4. Consider the conversion of a substance between solid and liquid: solid \rightleftharpoons liquid.

When the two phases are in equilibrium at one atmosphere pressure and at the melting point of the substance,

- (a) $\Delta H = 0$ for the process.
 (b) $\Delta E = 0$ for the process.
 (c) $\Delta S = 0$ for the process.
 (d) $\Delta G = 0$ for the process.
 (e) both (a) and (b)

5&6. Consider this reaction: $X + Y_2 \rightarrow$ products. The experimentally-derived rate law expression is: Rate = $k[X]^3[Y_2]$. If, during a reaction, the concentration of X is doubled and the concentration of Y_2 is halved, the rate of the reaction will _____ by a factor of _____.

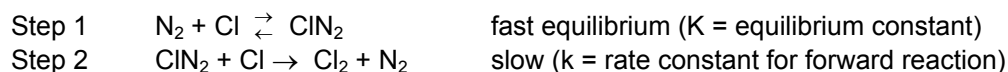
- (a) increase, 2
 (b) decrease, 2
 (c) increase, 4
 (d) decrease, 4
 (e) remain unchanged

7&8. Consider the equilibrium: $2\text{NOCl}(g) \rightleftharpoons 2\text{NO}(g) + \text{Cl}_2(g)$ $K_c = 4.0 \times 10^{-4}$

What is the equilibrium constant for the equilibrium: $\text{NO}(g) + 1/2 \text{Cl}_2(g) \rightleftharpoons \text{NOCl}(g)$?

- (a) 2.5×10^3 (b) 4.0×10^{-4} (c) 5×10^3 (d) 2×10^{-4} (e) 50

9&10. The combination of Cl atoms is catalyzed by $\text{N}_2(g)$. The following mechanism is suggested:



What is the appropriate rate law expression? Watch out for the correct constant combination!

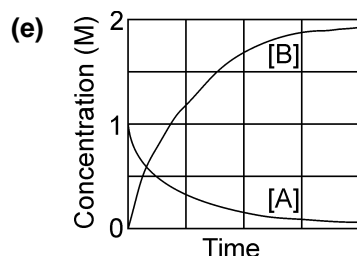
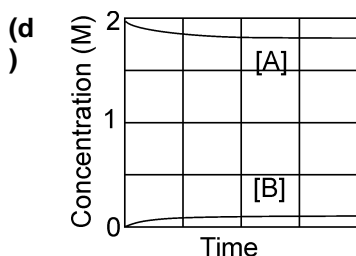
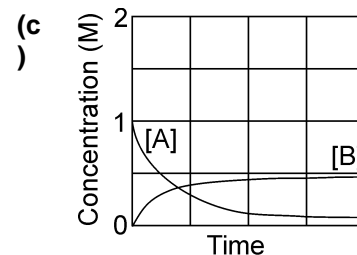
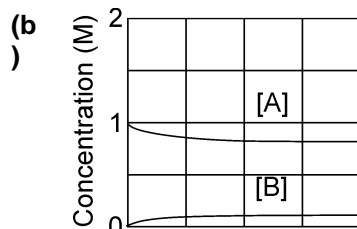
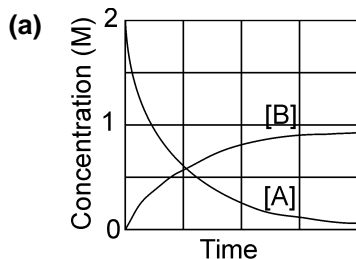
- (a) Rate = $kK[\text{N}_2][\text{Cl}]^2$ (b) $K[\text{Cl}]^2$ (c) Rate = $k[\text{N}_2][\text{Cl}]$
(d) Rate = $K[\text{ClN}_2][\text{Cl}]$ (e) Rate = $kK[\text{Cl}]^2$

11&12. Which of the following statements is/are FALSE concerning the action of catalysts?

- (1) The activation energy of the rate-determining step is raised and the reaction speeds up.
- (2) When added to equilibrium reactions, a catalyst will cause the equilibrium constant to change and the equilibrium to shift.
- (3) Their presence does not change the mechanism of the reaction.

- (a) 1, 3 only (b) 1, 2, 3 (c) 2 only (d) 2, 3 only (e) 1, 2 only

13&14. Which set of curves represents the changes in concentration of A and B with time for a reaction: $2A(g) \rightleftharpoons B(g)$ in which K is much greater than 1. Assume that initially only A is in the container at 1 M concentration.



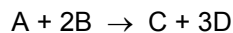
15&16. Consider the following rate law expression for the reaction: $X + 2Y \rightarrow 2Z$

$$\text{Rate} = k[X][Y]$$

The units of the specific rate constant are:

- (a) $M \cdot \text{time}^{-1}$ (b) time^{-1} (c) $M^{-1} \cdot \text{time}^{-1}$ (d) $M^{-2} \cdot \text{time}^{-1}$ (e) $M^{-3} \cdot \text{time}^{-1}$

17&18. Rate data were collected for the following reaction at a particular temperature. What is the correct rate law expression?



Experiment	[A] _{initial}	[B] _{initial}	Initial Rate of Reaction
1	0.10 M	0.40 M	0.0090 M/min
2	0.20 M	0.40 M	0.036 M/min
3	0.10 M	0.20 M	0.0045 M/min

- (a) $\text{Rate} = k[A][B]$ (b) $\text{Rate} = k[A]^2[B]$ (c) $\text{Rate} = k[A][B]^2$
 (d) $\text{Rate} = k[A]^2[B]^2$ (e) $\text{Rate} = k[A]^2$

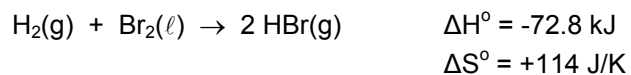
19&20. Consider the following equilibrium reaction:



If the initial concentration of BrF in a closed container is 1.00 M, what will be the concentration of BrF after the system finally reaches equilibrium?

- (a) 0.661 M (b) 0.500 M (c) 0.287 M (d) 0.147 M (e) 0.788 M

21&22. Consider the following reaction and choose the correct statement:



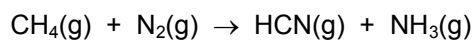
- (a) The reaction is nonspontaneous at all temperatures.
- (b) The reaction is spontaneous at all temperatures.
- (c) The reaction becomes spontaneous as the temperature increases.
- (d) The reaction becomes nonspontaneous as the temperature increases.
- (e) The temperature does not influence the spontaneity of any reaction.

23&24. Consider the equilibrium at a certain temperature: $C \rightleftharpoons 3A + B$

A reaction begins with 4.0 moles of C in a 2.0 L container. When the system reaches equilibrium, there are 2.0 moles of B present. What is the value of the equilibrium constant, K_c ?

- (a) 0.081 (b) 0.11 (c) 6.0 (d) 0.037 (e) 27

25&26. Consider the reaction below at 25°C for which $\Delta G^\circ = -2470$ kJ/mol rxn and $\Delta H^\circ = -2599$ kJ/mol rxn. Calculate ΔS° per mol rxn at 25°C.



- (a) +340 J/K (b) -340 J/K (c) +386 J/K (d) -386 J/K (e) -433 J/K

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27&28. Consider the following gas phase reaction: $2\text{HBr(g)} \rightleftharpoons \text{H}_2\text{(g)} + \text{Br}_2\text{(g)}$. The equilibrium constant at a particular temperature is 9.0. At that temperature the following is measured:

$$[\text{H}_2] = [\text{Br}_2] = 0.500 \text{ M}$$

$$[\text{HBr}] = 3.00 \text{ M}$$

Which of the following statements is TRUE?

- (a) $Q > K$; the equilibrium is shifting so that more HBr(g) will be produced.
- (b) $Q > K$; the equilibrium is shifting so that more $\text{H}_2\text{(g)} + \text{Br}_2\text{(g)}$ will be produced.
- (c) $Q < K$; the equilibrium is shifting so that more HBr(g) will be produced.
- (d) $Q < K$; the equilibrium is shifting so that more $\text{H}_2\text{(g)} + \text{Br}_2\text{(g)}$ will be produced.
- (e) $Q = K$; the system is at equilibrium.

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 first order decomposition reaction: $\text{N}_2\text{O}(g) \rightarrow \text{N}_2(g) + 1/2\text{O}_2(g)$

You are given the following data:

$$\text{rate constant at } 300^\circ\text{C} = 2.6 \times 10^{-11} \text{ s}^{-1}$$

$$\text{rate constant at } 330^\circ\text{C} = 2.1 \times 10^{-10} \text{ s}^{-1}$$

$$\Delta E_{\text{rxn}} = \Delta H_{\text{rxn}} = -164 \text{ kJ/mol}$$

- (5 pts) (a) How many grams of N_2O remain when a 10.0 gram sample of N_2O is allowed to decompose at 300°C for 25.0 years (1 year = 365 days)?

- (5 pts) (b) Calculate the activation energy, E_a , (in kJ/mol rxn) for the reaction.

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

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(4 pts) (c) Sketch a potential energy diagram for this reaction. Label the axes. Use 150 kJ/mol for E_a if you did not do part (b).

(1 pt) (d) Does the reaction release or absorb energy? (Look at the original data)

(3 pts) (e) Determine the activation energy for the reverse reaction.

(12 pts) **30.** Consider the equilibrium: $2X(g) + Y(s) \rightleftharpoons Z(g)$
The reaction as written is strongly exothermic. Predict how the following changes will affect
(i) the concentration of X,
(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 X	K	E_a
(a) The amount of Y is halved.			
(b) A catalyst is introduced.			
(c) The temperature is decreased.			
(e) The volume of the container is doubled.			

(1 pt) **31.** Grammar bonus: The students in the First Year Chemistry laboratory collected lots of _____
(datum or data) as they produced their titration curves.

SCRAP PAPER OR COMMENTS ON EXAM

CHEMISTRY 102
EXAM 2 Form C

FALL 2008
S 502

NAME _____
