

CHEMISTRY 102**FALL 2008****EXAM 2 FORM D****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: $[\text{Co}(\text{CO})_4]_2(\text{s}) \rightleftharpoons 2\text{Co}(\text{s}) + 8\text{CO}(\text{g})$?

(a) $K_c = \frac{[\text{Co}]^2[\text{CO}]^8}{[[\text{Co}(\text{CO})_4]_2]}$

(b) $K_c = \frac{[[\text{Co}(\text{CO})_4]_2]}{[\text{Co}]^2[\text{CO}]^8}$

(c) $K_c = \frac{[\text{CO}]^8}{[[\text{Co}(\text{CO})_4]_2]}$

(d) $K_c = \frac{2[\text{Co}] + 8[\text{CO}]}{[[\text{Co}(\text{CO})_4]_2]}$

(e) $K_c = [\text{CO}]^8$

3&4. Consider the equilibrium: $\text{H}_2(\text{g}) + \text{Br}_2(\text{g}) \rightleftharpoons 2\text{HBr}(\text{g})$ $K_c = 7.9 \times 10^{-11}$

What is the equilibrium constant for the equilibrium: $4\text{HBr}(\text{g}) \rightleftharpoons 2\text{H}_2(\text{g}) + 2\text{Br}_2(\text{g})$?

(a) 1.5×10^{-10}

(b) 2.2×10^{12}

(c) 1.6×10^{20}

(d) 3.1×10^{15}

(e) 6.8×10^{-21}

5&6. Consider the conversion of a substance between liquid and a gas: liquid \rightleftharpoons gas .

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

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

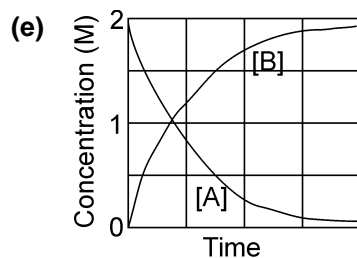
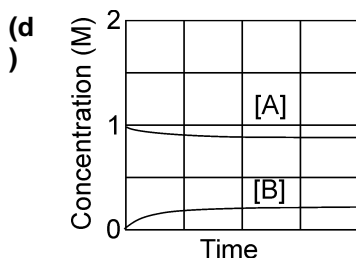
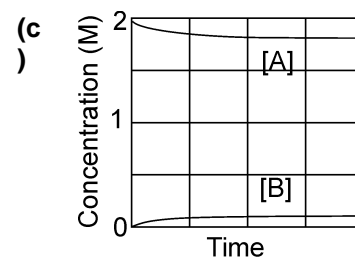
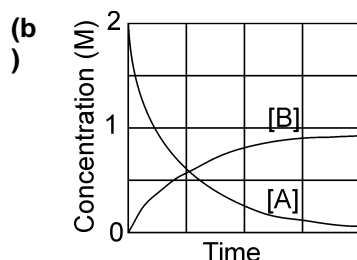
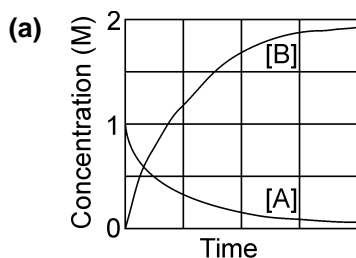
13&14. Consider the following rate law expression for the reaction: $X + 2Y \rightarrow 2Z$

$$\text{Rate} = k[X]^2$$

The units of the specific rate constant, k , are:

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

15&16. 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 less than 1. Assume that initially only A is in the container at 1 M concentration.



17&18. Consider the following gas phase reaction: $H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g)$. The equilibrium constant at a particular temperature is 16. At that temperature the following is measured:

$$[H_2] = [Cl_2] = 0.10 \text{ M}$$

$$[HCl] = 2.00 \text{ M}$$

Which of the following statements is TRUE?

- (a) $Q > K$; the equilibrium is shifting so that more $H_2(g) + Cl_2(g)$ will be produced.
 (b) $Q > K$; the equilibrium is shifting so that more $HCl(g)$ will be produced.
 (c) $Q < K$; the equilibrium is shifting so that more $H_2(g) + Cl_2(g)$ will be produced.
 (d) $Q < K$; the equilibrium is shifting so that more $HCl(g)$ will be produced.
 (e) $Q = K$; the system is at equilibrium.

19&20. Rate data were collected for the following reaction at a particular temperature. What is the correct rate law expression?



Experiment	[X] _{initial}	[Y] _{initial}	Initial Rate of Reaction
1	0.60 M	0.20 M	0.050 M/s
2	0.30 M	0.20 M	0.025 M/s
3	0.60 M	0.40 M	0.20 M/s

(a) Rate = $k[X][Y]$

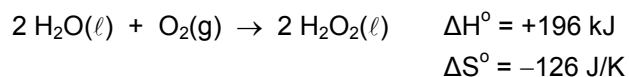
(b) Rate = $k[X]^2[Y]$

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

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

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

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



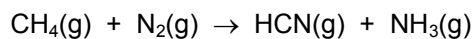
- (a) The reaction is spontaneous at all temperatures.
- (b) The reaction is nonspontaneous at all temperatures.
- (c) The reaction becomes spontaneous as the temperature increases.
- (d) The reaction becomes spontaneous as the temperature decreases.
- (e) The temperature does not influence the spontaneity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

23&24. Consider the equilibrium at a certain temperature: $Z \rightleftharpoons X + 3Y$

A reaction begins with 6.0 moles of Z in a 3.0 L container. When the system reaches equilibrium, there are 3.0 moles of X present. What is the value of the equilibrium constant, K_c ?

- (a) 0.037 (b) 6 (c) 0.11 (d) 27 (e) 0.081

25&26. Consider the reaction below at 25°C for which $\Delta G^\circ = +159$ kJ/mol rxn and $\Delta H^\circ = +164$ kJ/mol rxn. Calculate ΔS° at 25°C.



- (a) +2.0 J/K (b) +440 J/K (c) +68 J/K (d) +110 J/K (e) +17 J/K

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27&28. Consider the equilibrium at a certain temperature: $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$ $K_c = 63.0$
If 2.00 mol of HI are placed in a 1.00 L container, what is the concentration of HI at equilibrium?

- (a) 1.60 M (b) 1.86 M (c) 0.85 M (d) 0.27 M (e) 0.51 M

PART 2

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

- (12 pts) **29.** Consider the equilibrium: $W(g) + 2X(s) \rightleftharpoons Y(s) + 3Z(g)$
 The reaction as written is strongly endothermic. Predict how the following changes will affect
 (i) the moles of Z,
 (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 Z	K	E_a
(a) The concentration of X is doubled.			
(b) The temperature is decreased.			
(c) A catalyst is introduced.			
(d) The volume of the container is doubled.			

- 30.** Consider the following first order decomposition reaction: $A(g) \rightarrow B(g) + C(g)$

You are given the following data:

$$\text{rate constant at } 0.0^\circ\text{C} = 8.0 \times 10^{-7} \text{ s}^{-1}$$

$$\text{rate constant at } 50.0^\circ\text{C} = 8.9 \times 10^{-4} \text{ s}^{-1}$$

$$\Delta E_{\text{rxn}} = \Delta H_{\text{rxn}} = +51.5 \text{ kJ/mol}$$

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

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

(4 pts) (b) Sketch a potential energy diagram for this reaction. Label the axes. Use 50 kJ/mol for E_a if you did not do part (b).

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

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

(5 pts) (e) How many grams of a 20.0 g sample of A remain unreacted at 0.0°C after 2.00 days?

(1 pt) **31.** Grammar bonus: Each time I go to an aquarium, I always check to see if there is an _____
(octopus or octopi).

SCRAP PAPER OR COMMENTS ON EXAM

CHEMISTRY 102
EXAM 2 Form D

FALL 2008
S 502

NAME _____
