

CHEMISTRY 102**EXAM 2 FORM A****SECTION 501****FALL 2010****DR. KEENEY-KENNICUTT**

- Directions:
- (1) Put your name on PART 1 and 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 35 questions (19 actual questions).

PART 1

1&2. Which is the correct K_c expression for the equilibrium: $\text{N}_2\text{H}_4(l) \rightleftharpoons \text{N}_2(g) + 2\text{H}_2(g)$?

(a) $K_c = \frac{[\text{N}_2] \cdot 2[\text{H}_2]}{[\text{N}_2\text{H}_4]}$

(b) $K_c = \frac{[\text{N}_2][2\text{H}_2]^2}{[\text{N}_2\text{H}_4]}$

(c) $K_c = \frac{[\text{N}_2][\text{H}_2]^2}{[\text{N}_2\text{H}_4]}$

(d) $K_c = [\text{N}_2][2\text{H}_2]^2$

(e) $K_c = [\text{N}_2][\text{H}_2]^2$

3&4. The rate law for the chemical reaction, $5\text{Br}^- + \text{BrO}_3^- + 6\text{H}^+ \rightarrow 3\text{Br}_2 + 3\text{H}_2\text{O}$ has been determined experimentally to be:

$$\frac{-\Delta[\text{BrO}_3^-]}{\Delta t} = k[\text{Br}^-][\text{BrO}_3^-][\text{H}^+]^2$$

The reaction order with respect to the hydrogen ion is

(a) 1

(b) 2

(c) 6

(d) $k[\text{H}^+]^2$

(e) $k[\text{Br}^-][\text{BrO}_3^-][\text{H}^+]^2$

5&6. If a reaction has a highly negative value of ΔG , such as -300 kJ , the reaction will occur:

(a) slowly.

(b) rapidly.

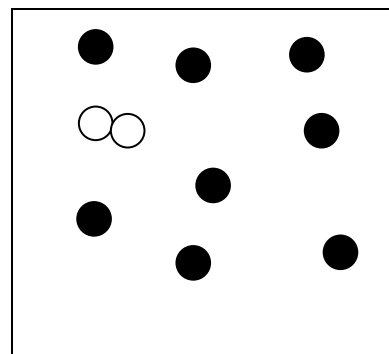
(c) with a high activation energy.

(d) with a low activation energy.

(e) It is impossible to know from the ΔG information.

7&8. This sketch represents which of the following situations where
: ○ is X and ● is Y?

- (a) $Y_2 \rightleftharpoons X$ $K \ll 1$
- (b) $2X \rightleftharpoons Y$ $K \gg 1$
- (c) $X_2 \rightleftharpoons Y$ $K \ll 1$
- (d) $Y \rightleftharpoons X_2$ $K \ll 1$
- (e) $Y \rightleftharpoons 2X$ $K \gg 1$



9&10. Most reactions are more rapid at high temperatures than at low temperatures. This is consistent with:

- (1) An increase in the percentage of “high energy” collisions with increasing temperature.
 - (2) An increase in the activation energy with increasing temperature
 - (3) An increase in the rate constant with increasing temperatures
- (a) only (1) (b) only (2) (c) only (3) (d) only (2) and (3) (e) only (1) and (3)

11&12. The ΔH ($=\Delta E$) for a reaction is +70 kJ. The activation energy for the reverse reaction is 30 kJ. What is the activation energy for the forward reaction? It might be helpful to sketch the potential energy diagram.

- (a) +100 kJ (b) +70 kJ (c) -100 kJ (d) -70 kJ (e) +40 kJ

13&14. Which of the following statements is/are TRUE concerning the action of catalysts?

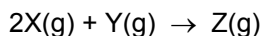
- (1) Their presence always changes the mechanism of the reaction.
- (2) Catalysts do not participate in the reaction.
- (3) The activation energy of the rate-determining step is lowered and the reaction speeds up.

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

15&16. Which CANNOT be true for the 1 step reaction: $C\equiv O + O=N-O \rightarrow O=C=O + N=O$?

- (a) As temperature increases, the rate of the reaction increases.
- (b) $\text{Rate} = k[\text{CO}][\text{NO}_2]$
- (c) The oxygen atom in CO must collide with the O in NO_2 for an effective collision.
- (d) The rate determining step is a bimolecular collision.
- (e) All the statements are true.

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



Experiment	[X] _{initial}	[Y] _{initial}	Initial Rate of Reaction
1	0.10 M	0.10 M	0.040 M/s
2	0.10 M	0.20 M	0.16 M/s
3	0.30 M	0.20 M	0.48 M/s

- (a) Rate = $k[X][Y]$ (b) Rate = $k[X]^2[Y]$ (c) Rate = $k[X]^2[Y]^2$
 (d) Rate = $k[X][Y]^2$ (e) Rate = $k[X]^2[Y]^3$

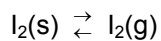
19&20. At 460°C, the value for K_c for the following reaction is 51: $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$
 A mixture of H_2 , I_2 and HI in a vessel has the following concentrations:

$$[H_2] = 1.0 \text{ M} \quad [I_2] = 3.0 \text{ M} \quad [HI] = 0.10 \text{ M}$$

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

- (a) $Q_c = K_c$; and the system is at equilibrium.
 (b) $Q_c = 0.0033$; more HI will be produced as the system proceeds to equilibrium.
 (c) $Q_c = 0.0033$; more H_2 and I_2 will be produced as the system proceeds to equilibrium.
 (d) $Q_c = 300$; more HI will be produced as the system proceeds to equilibrium.
 (e) $Q_c = 300$; more H_2 and I_2 will be produced as the system proceeds to equilibrium

21&22. Estimate the sublimation temperature of solid iodine, I_2 , given the following data from thermodynamic tables. Assume that $\Delta H_{f,298}^\circ$ and S° do not change with temperature:



	$\Delta H_{f,298}^\circ$ (kJ/mol)	S° (J/mol·K)	$\Delta G_{f,298}^\circ$ (kJ/mol)
$I_2(s)$	0	116.1	0
$I_2(g)$	62.4	260.6	19.4

(a) 273 °C

(b) 317 °C

(c) 159 °C

(d) 425 °C

(e) 0.45 °C

23&24. Consider the following equilibrium at 300°C: $A + B \rightleftharpoons 2C$, with a K_c of 64.0.

Initially, there is 3.00 M of C in the container. What is the concentration of C in the container after the system has reached equilibrium?

(a) 1.6 M

(b) 2.4 M

(c) 2.8 M

(d) 0.35 M

(e) 0.70 M

25&26. Consider the reaction: $A \rightarrow B$. What is the activation energy for the forward reaction (in kJ) when the rate constant at 20°C is 0.0850 min^{-1} and the rate constant at 50°C is 1.34 min^{-1} ?

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

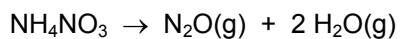
- (a) 764 J (b) 39.4 kJ (c) 22.9 kJ (d) 72.3 kJ (e) 61.5 kJ

27&28. The decomposition of N_2O_5 , dinitrogen pentoxide, is a first order reaction. If the half-life of the decomposition is 17.3 min at 80°C, what percentage of N_2O_5 will be converted to products after 4,000 seconds?



- (a) 39% (b) 61% (c) 93% (d) 7.2% (e) $3 \times 10^{-70} \%$

29&30. Calculate ΔG° for the following reaction at 25°C in kJ:



at 25°C , $\Delta H_{\text{rxn}}^\circ = -35.9 \text{ kJ}$ and $\Delta S_{\text{rxn}}^\circ = +446 \text{ J/K}$

- (a) +47.1 kJ (b) +97.0 kJ (c) +10.7 kJ (d) -24.8 kJ (e) -169 kJ

31&32. For the reaction: $\text{NH}_4\text{NO}_3 \rightarrow \text{N}_2\text{O}(\text{g}) + 2 \text{H}_2\text{O}(\text{g})$ at 25°C , $\Delta H_{\text{rxn}}^\circ = -35.9 \text{ kJ}$ and $\Delta S_{\text{rxn}}^\circ = +446 \text{ J/K}$

Which of the following statements is TRUE? The reaction

- (a) is spontaneous at all temperatures.
- (b) is nonspontaneous at all temperatures.
- (c) will become spontaneous at higher temperatures.
- (d) will become spontaneous at lower temperatures.
- (e) Nothing can be said about the spontaneity of a reaction from the values of ΔH° and ΔS° only.

PART 2

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

- (4 pts) **33.** Consider the equilibrium: $2A(g) + B(g) \rightleftharpoons 2C(g)$
The reaction as written is strongly exothermic. Predict how the following changes will affect the moles of B at equilibrium,
The possible answers are: increase (I), decrease (D), or remain unchanged (U)

	Moles of B
(a) The concentration of A is increased.	
(b) The temperature is increased.	
(c) A catalyst is introduced.	
(d) The volume of the container is doubled.	

- (3 pt) Explain briefly how changing temperature will affect the value of K_c for this reaction?

- (3 pts) **34.** Consider the equilibrium: $2C(g) \rightleftharpoons D(g)$ with $K_c = 5$.

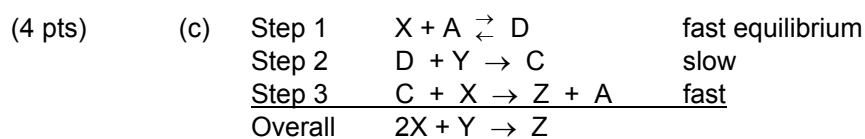
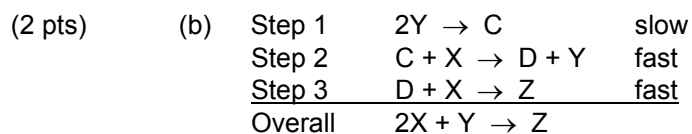
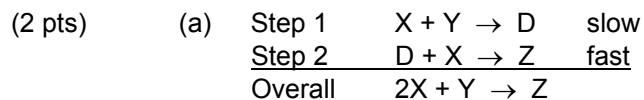
Calculate the equilibrium constant for $2D(g) \rightleftharpoons 4C(g)$

OVER \Rightarrow

35. Consider the following gas phase reaction: $2X + Y \rightarrow Z$.

The experimentally-derived rate-law expression is: $\text{Rate} = k[Y]^2$.

For each mechanism below, write the rate-law expression that fits it and state whether or not that mechanism could be the correct one. **Show your work for Part (c)** - I want to know that you understand how the equilibrium constant works into the problem.



(1 pt) (d) In mechanism (c), what is/are the intermediate(s) (if any): _____

(1 pt) In mechanism (c), what is the catalyst (if any): _____

SCRAP PAPER OR COMMENTS ON EXAM

CHEMISTRY 102

EXAM 2 Form A

Fall 2010

S 501

NAME _____
