Chemistry 1220, Section 1
First Hour Exam
February 5, 2001
Dr. Lisa M. Berreau

Instructions:

Do not begin until 8:30 AM. The exam must be turned in by 9:20 AM.

⇒ The exam has 25 questions. Each question is worth 4 points for a total of 100 points. A periodic table is located on the last page.

⇒ Use only a #2 pencil to mark the answer on the ScanTron sheet. Yow will turn in only the ScanTron sheet and you can keep the rest of the exam. Your exam results will be emailed to you. You can check your answers with the answer key that will be posted on-line immediately after the exam on my website under Exam Scores and Statistics.

⇒ On the ScanTron sheet print your name and identification number in the areas indicated. Indicate a four character code (any combination of letters and numbers) under "version#" for the purpose of reporting final grades.

Equations:

For the reaction: aA + bB ⇌ cC + dD

$$Rate = -\frac{1}{a}\frac{\Delta[A]}{\Delta t} = -\frac{1}{b}\frac{\Delta[B]}{\Delta t} = +\frac{1}{c}\frac{\Delta[C]}{\Delta t} = +\frac{1}{d}\frac{\Delta[D]}{\Delta t}$$

$$K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

1st order reactions:

$\ln [A]_t = -kt + \ln [A]_o$

$t_{1/2} = \frac{0.693}{k}$

2nd order reactions:

$\frac{1}{[A]_t} = kt + \frac{1}{[A]_o}$

$t_{1/2} = \frac{1}{k[A]_o}$

Arrhenius:

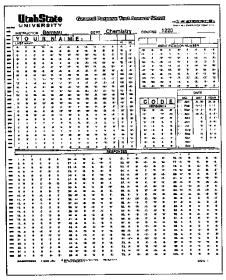
$\ln k = -(E_a/RT) + \ln A$

$\ln (k_1/k_2) = E_a/R\,(1/T_2 - 1/T_1)$

R = 8.314 J/mol·K

$K_p = K_c(RT)^{\Delta n}$
(R = 0.0821 L·atm/mol·K)

$K_w = 1.0 \times 10^{-14}$; pH = -log[H⁺]



UtahState UNIVERSITY
General Purpose Test Answer Sheet
INSTRUCTOR Berreau DEPT. Chemistry COURSE 1220
YOUR NAME
CODE

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1. A catalyst increases reaction rate ___________.

d

a) by decreasing the heat of reaction
b) by increasing the activation energy of the forward reaction
c) by changing the average kinetic energy distribution of molecules
[✓ d)] by lowering the activation energy of the reaction

2. Nitrosyl bromide decomposes according to the following equation:

$$2\ NOBr(g) \rightleftharpoons 2\ NO(g) + Br_2(g)$$

A sample of NOBr (0.64 mol) was placed in a 1.00 L flask containing no NO or Br_2. At equilibrium the flask contained 0.46 mol of NOBr. How many moles of NO and Br_2, respectively, are in the flask at equilibrium?

c

a) 0.18, 0.18
b) 0.46, 0.23
[✓ c)] 0.18, 0.090
d) 0.18, 0.360

	$2\ NoBr_{(g)}$	$\rightleftharpoons 2NO_{(g)}$	$+ Br_2\ (g)$
Initial:	0.64 M	0	0
Δ :	−2x	+ 2x	+ x
Final(Eq):	0.46 M	0.18	0.09

$0.64 - 2x = 0.46$

$x = 0.09$

3. For a first order reaction, a plot of ____ versus ____ is linear.

b

a) ln $[A]_t$, 1/t
[✓ b)] ln $[A]_t$, t
c) 1/[A], t
d) [A], t

4. What is the conjugate acid of NH_3?

c

a) NH_2^+
b) NH_3^+
[✓ c)] NH_4^+
d) NH_4OH

5. If the reaction 2A + 3B → products is first order in A and second order in B, then the rate law will be:

b

a) Rate = k[A][B]
[✓ b)] Rate = $k[A][B]^2$
c) Rate = $k[A]^2[B]$
d) Rate = $k[A]^2[B]^2$

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6. Which of the following does not play a part in determining the rate of a reaction?

d

a) temperature
b) the concentrations of reactants
c) the presence of a catalyst
[✓ d)] the equilibrium constant

7. What is the pH of an aqueous solution at 25 °C in which [OH⁻] is 0.0025 M?

c

a) +2.60
b) -2.60
[✓ c)] +11.40
d) -11.40

$K_w = 1.0 \times 10^{-14} = [H^+][OH^-]$

$[H^+] = \frac{1.0 \times 10^{-14}}{0.0025} = 4.4 \times 10^{-1}$

$pH = -\log 4.4 \times 10^{-12}$

$pH = 11.4$

8. At a certain temperature, a flask at equilibrium contains 0.0114 M HCl, 0.0931 M Cl_2, and 0.0154 M H_2. What is the value of K_c for the equilibrium:

$$2\ HCl(g) \rightleftharpoons Cl_2(g) + H_2(g)$$

b

a) 0.0909
[✓ b)] 11.0
c) 1.63×10^{-5}
d) 0.126

$$K_c = \frac{[Cl_2][H_2]}{[HCl]^2} = \frac{(0.0931)(0.0154)}{(0.0114)^2}$$

$K_c = 11.0$

9. Use the information below to determine the order of the reaction in reactant A.

A + B → P

Experiment Number	[A](M)	[B](M)	Initial Rate (M/s)
1	0.273	0.763	2.83
2	0.273	1.526	2.83
3	0.819	0.763	25.47

c

a) 1
b) 4
[✓ c)] 2
d) 3

$$\left(\frac{0.273}{0.819}\right)^x = \left(\frac{2.83}{25.47}\right.$$

$(0.33)^x = 0.11$

$x = 2$

10. The magnitude of K_w at 25 °C indicates that:

c

a) water autoionizes very slowly
b) water autoionizes very quickly
[✓ c)] water autoionizes only to a very small extent
d) the autoionization of water is exothermic

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11. The activation energy of a first-order reaction that has a rate constant of $4.41 \times 10^{-3}\ s^{-1}$ at 351K and rate constant of $9.79 \times 10^{-2}\ s^{-1}$ at 588K is ________ kJ/mol.

d

a) 2.67
b) 2.90
c) 0.0589
[✓ d)] 22.4

$$\ln\left(\frac{4.41 \times 10^{-3}}{9.79 \times 10^{-2}}\right) = \frac{E_a}{8.314}\left(\frac{1}{588} - \frac{1}{351}\right)$$

$E_a = 22.4$ kJ/mol

12. The reaction $CH_3\text{-}N{\equiv}C \rightarrow CH_3\text{-}C{\equiv}N$ is a first-order reaction. At 230.3 °C, k = $6.29 \times 10^{-4}\ s^{-1}$. If $[CH_3\text{-}N{\equiv}C]_0$ is 0.00100 M, the $[CH_3\text{-}N{\equiv}C]$ in mol/L after 1.000×10^3 s is:

a

[✓ a)] 5.33×10^{-4}
b) 2.34×10^{-4}
c) 2.05×10^{-3}
d) 4.27×10^{-3}

$\ln [A]_t = -(6.29 \times 10^{-4})(1.0 \times 10^{3}) +$

$\ln (0.001$

13. The equilibrium constant for reaction (1) is K. What is the equilibrium constant for equation (2)?

(1) $SO_2(g) + 1/2O_2(g) \rightleftharpoons SO_3(g)$ ⟶ $K_c = \frac{[SO_3]}{[SO_2][O_2]^{1/2}}$

(2) $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

↳ $K_c' = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$

a

[✓ a)] K^2
b) 2K
c) 1/2K
d) $1/K^2$

14. For the gas-phase reaction $CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$

K_c is given by K_c = _____________.

c

a) $[CO]^3[H_2]/[CH_4][H_2O]$
b) $[CO][H_2]^3/[CH_4][H_2O]$
[✓ c)] $[CH_4][H_2O]/[CO][H_2]^3$
d) $[CH_4][H_2O]/[CO]^3[H_2]$

15. A Bronsted-Lowry base is defined as a substance that __________.

a) increases [H^+] when placed in H_2O
b) increases [OH^-] when placed in H_2O
c [✓ c)] acts as a proton acceptor in any system
d) acts as a proton donor in any system

16. A second-order reaction has a half-life of 18 s when the initial concentration of reactant is 0.71 M. The rate constant for this reaction is __________ $M^{-1}s^{-1}$.

[✓ a)] 7.8×10^{-2}
b) 3.8×10^{-2}
a c) 2.0×10^{-2}
d) 1.3

$$t_{1/2} = \frac{1}{k[A_o]} = 18s$$

$$18s = \frac{1}{k(0.71M)} \qquad k = 7.8 \times 10^{-2}$$

17. The reaction A → B is first order in [A]. Using the data below, the rate constant (k) for this reaction is __________ s^{-1}.

Time(s)	[A](M)	ln [A]
0.0	1.60	0.470
5.0	0.80	
10.0	0.40	
15.0	0.20	
20.0	0.10	− 2.30

$$\frac{\Delta y}{\Delta x} = \frac{-2.30-0.470}{20}$$

$$-\text{slope} = -0.14$$

b

a) 0.030
[✓ b)] 0.14
c) 3.0
d) 3.1×10^{-3}

18. In which of the following reactions would decreasing the volume of the reaction vessel at constant temperature not change the concentrations of reactants and products?

a) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
b) $N_2O_4(g) \rightleftharpoons 2NO_2(g)$
d c) $N_2(g) + 2O_2(g) \rightleftharpoons 2NO_2(g)$
[✓ d)] $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$

19. For which one of the following reactions are K_c and K_p the same?

[✓ a)] $Br_2\,(g) + Cl_2\,(g) \rightleftharpoons 2\,BrCl\,(g)$
b) $2SO_3\,(g) \rightleftharpoons 2SO_2(g) + O_2(g)$
a c) $N_2O_4\,(g) \rightleftharpoons 2NO_2(g)$
d) $C(s) + CO_2\,(g) \rightleftharpoons 2CO(g)$

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20. Consider the following reaction at equilibrium:

$$2CO_2(g) \rightleftharpoons 2CO(g) + O_2(g) \qquad \Delta H° = -514\text{ kJ}$$

Increasing the temperature will ________.

b

a) decrease the concentration of $CO_2(g)$ at equilibrium
[✓ b)] shift the reaction to the left
c) shift the reaction to the right
d) increase the concentration of CO(g) at equilibrium

21. The stoichiometric equation for a reaction is:

$$2A + 2B \rightarrow C$$

The mechanism for this reaction is:

(1) $A + B \rightarrow D$ (slow)
(2) $D + B \rightarrow E$ (fast)
(3) $A + E \rightarrow C$ (fast)

c Of the following rate laws, _________ is the correct rate law for this mechanism.

a) Rate = $k_1[A]^2[B]^2$
b) Rate = $k_3[A][E]$
[✓ c)] Rate = $k_1[A][B]$
d) Rate = $k_2[D][B]$

22. Based on the table of data shown below, the average rate of the reaction between 0 s and 10 s is _________ M/s.

A → B

Time (s)	[A] (mol/L)
0.0	0.200
5.0	0.140
10.0	0.100
15.0	0.071
20.0	0.050

$$\frac{0.100-0.200}{10}$$

$$= 1.0 \times 10^{-2}$$

c

a) 5.0×10^{-2}
b) 8.0×10^{-3}
[✓ c)] 1.0×10^{-2}
d) 2.5×10^{-3}

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23. For the following reaction at 25 °C, $K_c = 3.0 \times 10^5$. What is K_p?

$$2\,H_2S\,(g) + 3\,O_2\,(g) \rightleftharpoons 2\,H_2O\,(g) + 2\,SO_2\,(g) \qquad K_p = 1.2 \times 10^4$$

[✓ a)] 1.2×10^4
a b) 8.2×10^{-5}
c) 3.3×10^{-6}
d) 3.0×10^5

$$K_p = K_c(RT)^{\Delta n}$$

$$= (3.0 \times 10^5)\left[\left(0.0821\,\tfrac{L\,atm}{Mol\,K}\right)(298\,K)\right]^{-}$$

24. The expression for K_c for the reaction below is _______________.

$$NiCO_3(s) + 2H^+\,(aq) \rightleftharpoons Ni^{2+}(aq) + CO_2(g) + H_2O(l)$$

a) $[Ni^{2+}]/[NiCO_3]$
c b) $[NiCO_3]/[Ni^{2+}]$
[✓ c)] $[Ni^{2+}][CO_2]/[H^+]^2$
d) $[Ni^{2+}][H^+]^2$

25. Consider the following reaction:

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

Initially, 0.96 mol of $PCl_5(g)$ was placed in a 1.0 L flask at 25 °C. At equilibrium, 0.42 mol of $PCl_5(g)$ was present. The value of K_c for this reaction at 25 °C is __________.

a) 0.54
b) 0.29
[✓ c)] 0.69
d) 0.12 c

	$PCl_5(g) \rightleftharpoons$	$PCl_3(g)$	$+ Cl_2(g)$
Initial:	0.96 mol/L	0	0
Δ :	− x	+ x	+ x
Eq:	0.42 Mol/L		

x = 0.54 M

$$K_c = \frac{(0.54)^2}{0.42} = 0.69$$