_____
Last name *First name*

First letter of your last name: ☐

_____
perm number

EXAM 2 – **FORM A**
22 May 2009

Chem 1B
Instructor: Ortony

INSTRUCTIONS:

Use a pencil, fill in the bubbles dark and completely.
Bubble in **Form A** on your Scantron Form
Write your perm number and **bubble in your perm number**, write your name.

Work out the answer to each problem on this exam then bubble in the correct answer on your scantron. **Turn in BOTH the Scantron form and the exam**.

The equation sheet is on the last page, you may remove it from your exam.

The key to the exam will be posted on the course webpage this afternoon.

Exam scores will be posted on "Online Grades". To access your grade you must create an account first, there is a link on our course webpage (everyone in Chem 1B must create an account – even if you already did so in the past).

Good luck!

CONSTANTS

$R = 8.3145\ \text{J mol}^{-1}\text{K}^{-1}$
$R = 0.08206\ \text{L atm mol}^{-1}\text{K}^{-1}$
$N_A = 6.022 \times 10^{23}\ \text{atoms/mol}$
$F = 96{,}485\ \text{C / mol}$

$c = 3 \times 10^{8}\ \text{m/s}$
$h = 6.626 \times 10^{-34}\ \text{J s}$

CONVERSION FACTORS

1 atm = 760 torr
1 A = 1 C/sec
1 V = 1 J/C
1 L atm = 101.3 J

EQUATIONS

$$E = E^{o} - \left(\frac{RT}{nF}\right) \ln Q$$

$$E = E^{o} - \left(\frac{0.0257}{n}\right) \ln Q \quad \text{at } 25\,^{o}\text{C}$$

$$E = E^{o} - \left(\frac{0.0592}{n}\right) \log Q \quad \text{at } 25\,^{o}\text{C}$$

$$E^{o} = \left(\frac{RT}{nF}\right) \ln K$$

zero order: $[A] = -kt + [A]_o$ $\qquad t_{1/2} = \dfrac{[A]_o}{2k}$

first order: $\ln [A] = -kt + \ln [A]_o$ $\qquad t_{1/2} = \dfrac{0.693}{k}$

second order: $\dfrac{1}{[A]} = kt + \dfrac{1}{[A]_o}$ $\qquad t_{1/2} = \dfrac{1}{k[A]_o}$

$$I = \frac{nF}{t}$$

$$\Delta G = \Delta H - T\Delta S \qquad \Delta G = -nFE \qquad k = A\, e^{-E_a / RT}$$

$$\Delta G^{o} = \Delta H^{o} - T\Delta S^{o} \qquad \Delta G^{o} = -nFE^{o} \qquad \ln k = \frac{-E_a}{R}\left(\frac{1}{T}\right) + \ln A$$

$$\Delta G^{o} = -RT \ln K \qquad \Delta G = \Delta G^{o} + RT \ln Q \qquad \ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$E = h\nu = \frac{hc}{\lambda}$$

PERIODIC TABLE

Period	1A	2A											3A	4A	5A	6A	7A	8A
	1 H 1.008																	2 He 4.003
2	3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.30	3	4	5	6	7	8	9	10	11	12	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	La-Lu	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra (226)	Ac-Lr	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (264)	108 Hs (265)	109 Mt (268)	110 Uun (269)	111 Uuu (272)	112 Uub (269)		114 Uuq		116 Uuh		118 Uuo

Lanthanides	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
Actinides	89 Ac (227)	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

Exam 2, Chem 1B – Form A **Name:**_____
Spring 2009, Instructor: Ortony

Use the following to answer questions 1-2:

For a galvanic cell, the **unbalanced** reaction is:
$(AuCl_4)^-(aq) + Cu(s) \rightarrow Au(s) + Cl^-(aq) + Cu^{2+}(aq)$

1. Given the following information, determine the standard cell potential.

Species	Standard Reduction Potential (V)
$Au^{3+}(aq)$	1.498
$Cu^{2+}(aq)$	0.339

A) 1.159 V
B) 1.837 V
C) 1.979 V
D) 1.462 V
E) 2.102 V

2. Determine the number of electrons transferred during the reaction (**when balanced**).
A) 2
B) 3
C) 4
D) 6
E) 9

3. Consider an electrochemical cell that has a nickel electrode immersed in 1.0 *M* Ni^{2+} and a cobalt electrode immersed in 0.010 *M* Co^{2+}.

$Co^{2+} + 2e^- \rightarrow Co$ $\quad E° = -0.28$ V
$Ni^{2+} + 2e^- \rightarrow Ni$ $\quad E° = -0.23$ V

Calculate *E* for this cell.

A) 0.07 V
B) 0.11 V
C) 0.51 V
D) 0.56 V
E) none of these

4. What quantity of charge is required to reduce 32.4 g of $NiCl_2$ to nickel metal? (1 faraday = 96,485 coulombs/mol)

A) 2.41×10^4 C
B) 4.82×10^4 C
C) 1.07×10^5 C
D) 7.24×10^4 C
E) 9.65×10^4 C

5. An electrolytic cell process involves plating Zr(*s*) from a solution containing Zr^{4+}. If 5.80 amp is run through this mixture for 1.86 h, what mass of Zr is plated?

A) 36.7 g
B) 0.153 g
C) 0.101 g
D) 9.18 g
E) none of these

6. How many seconds would it take to deposit 21.40 g of Ag (atomic mass = 107.87) from a solution of $AgNO_3$ using a current of 10.00 amp? (*hint* $AgNO_3 \rightarrow Ag^+ + NO_3^-$)
   A) 9649 s
   B) 4825 s
   C) 3828 s
   D) 1914 s
   E) none of these

7. What are the units of the *rate* of a chemical reaction?
   A) $mol\ L^{-1}$
   B) $L\ mol^{-1}\ sec^{-1}$
   C) $mol\ L^{-1}\ sec^{-1}$
   D) sec^{-1}
   E) $L^2\ mol^{-2}\ sec^{-1}$

8. What are the units of the *rate constant* for a zero order rate law?
   A) $mol\ L^{-1}$
   B) $L\ mol^{-1}\ sec^{-1}$
   C) $mol\ L^{-1}\ sec^{-1}$
   D) sec^{-1}
   E) $L^2\ mol^{-2}\ sec^{-1}$

9. What are the units of the *rate constant* for a first order rate law?
   A) $mol\ L^{-1}$
   B) $L\ mol^{-1}\ sec^{-1}$
   C) $mol\ L^{-1}\ sec^{-1}$
   D) sec^{-1}
   E) $L^2\ mol^{-2}\ sec^{-1}$

10. What are the units of the *rate constant* for a second order rate law?
   A) $mol\ L^{-1}$
   B) $L\ mol^{-1}\ sec^{-1}$
   C) $mol\ L^{-1}\ sec^{-1}$
   D) sec^{-1}
   E) $L^2\ mol^{-2}\ sec^{-1}$

11. Initial rate data have been determined at a certain temperature for the gaseous reaction

$2NO + 2H_2 \rightarrow N_2 + 2H_2O$

$[NO]_0$ (M)	$[H_2]_0$ (M)	Initial Rate (M/s)
0.16	0.32	0.0200
0.16	0.48	0.0300
0.32	0.32	0.0800

What is the numerical value of the rate constant?

A) 2.4
B) 7.6
C) 0.39
D) 1.2
E) 0.13

12. For which order reaction is the half-life of the reaction independent of the initial concentration of the reactant(s)?

A) zero order
B) first order
C) second order
D) all of these
E) none of these

13. If the reaction $2HI \rightarrow H_2 + I_2$ is second order, which of the following will yield a linear plot?

A) log [HI] vs. time
B) 1/[HI] vs. time
C) [HI] vs. time
D) ln [HI] vs. time

Use the following to answer questions 14-15:

The reaction

$2NOBr \rightarrow 2NO + Br_2$

exhibits the rate law

$$\text{Rate} = k[NOBr]^2 = -\frac{\Delta[NOBr]}{\Delta t}$$

where $k = 1.0 \times 10^{-5}\ M^{-1} \bullet s^{-1}$ at 25° C. This reaction is run where the initial concentration of NOBr ($[NOBr]_0$) is $1.00 \times 10^{-1}\ M$.

14. What is one half-life for this experiment?
    A) 5.0×10^{-1} s
    B) 6.9×10^{4} s
    C) 1.0×10^{-5} s
    D) 1.0×10^{6} s
    E) none of these

15. The [NO] after 1.00 h has passed is
    A) $3.5 \times 10^{-4}\ M$
    B) $9.9 \times 10^{-3}\ M$
    C) $9.7 \times 10^{-3}\ M$
    D) $1.0 \times 10^{-3}\ M$
    E) none of these

16. Consider the second-order reaction $aA \rightarrow$ products (which has a first half-life of 22 s). If the concentration of A after 13.4 s is 0.46 *M*, determine the initial concentration of A.
    A) 0.69 *M*
    B) 0.18 *M*
    C) 0.36 *M*
    D) 0.26 *M*
    E) 0.74 *M*

17. The reaction

$$2A + B \rightarrow C$$

has the following proposed mechanism.

Step 1: $A + B \rightleftharpoons D$ (fast equilibrium)

Step 2: $D + B \rightarrow E$

Step 3: $E + A \rightarrow C + B$

If step 2 is the rate-determining step, what should be the rate of formation of C?

A) $k[A]$
B) $k[A]^2[B]$
C) $k[A]^2[B]^2$
D) $k[A][B]$
E) $k[A][B]^2$

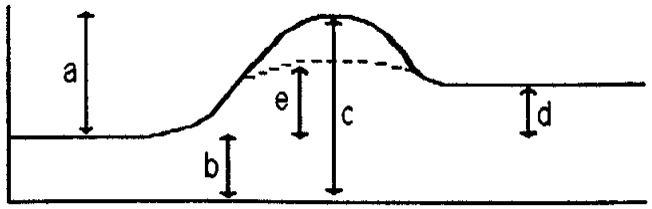
18. The rate constant for a reaction increases from 10.0 s^{-1} to 100. s^{-1} when the temperature is increased from 317 K to 427 K. What is the activation energy for the reaction in kJ/mol? (R = 8.314 J/mol • K)

A) 23.6 kJ/mol
B) 10.2 kJ/mol
C) 1.74 kJ/mol
D) 21.1 kJ/mol
E) 0.0756 kJ/mol

One more page →

Use the following to answer questions 19-21:

Use the potential energy diagram shown to answer the following questions.



19. Which letter shows the activation energy?
    A) a
    B) b
    C) c
    D) d
    E) e

20. Which letter shows the change in energy (ΔE) for the overall reaction?
    A) a
    B) b
    C) c
    D) d
    E) e

21. Which letter shows the activation energy using a catalyst?
    A) a
    B) b
    C) c
    D) d
    E) e

22. Light has a wavelength of 6.0×10^{2} nm. What is the energy of a photon of this light?
    A) 1.10×10^{-19} J
    B) 3.31×10^{-19} J
    C) 2.71×10^{18} J
    D) 3.68×10^{-20} J
    E) 1.33×10^{-18} J