Chemistry 142 Name KEY

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Exam 1a March 2nd, 2015

Multiple Choice (30 points)

Page 5 (16 points)

Page 6 (16 points)

Page 7 (16 points)

Page 8 (22 points)

Total (100 points)

Percentage Grade \_\_\_\_\_\_\_\_\_\_\_\_

All work must be shown to receive credit. Give all answers to the correct number of significant figures

**Useful Information**

**R = 0.08206 L • atm / mol • K**

**R = 8.31451 J / mol • K**

***Kw* = 1.00 x 10-14**

**x = -b ± (b2 - 4ac)1/2**

**2a**

Grossmont College

Periodic Table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| IA |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  | VIIA | VIIIA |
| 1  **H**  1.008 | IIA |  |  |  |  |  |  |  |  |  | |  | IIIA | IVA | VA | VIA | 1  **H**  1.008 | 2  **He**  4.002 |
| 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 |
| 11  **Na**  23.00 | 12  **Mg**  24.30 | IIIB | IVB | VB | VIB | VIIB | VIII VIII VIII | | | | IB | IIB | 13  **Al**  27.00 | 14  **Si**  28.09 | 15  **P**  30.97 | 16  **S**  32.06 | 17  **Cl**  35.45 | 18  **Ar**  39.95 |
| 19  **K**  39.10 | 20  **Ca**  40.08 | 21  **Sc**  44.96 | 22  **Ti**  47.90 | 23  **V**  50.94 | 24  **Cr**  52.00 | 25  **Mn**  54.94 | 26  **Fe**  55.85 | 27  **Co**  58.93 | 28  **Ni**  58.70 | | 29  **Cu**  63.55 | 30  **Zn**  65.38 | 31  **Ga**  69.72 | 32  **Ge**  72.59 | 33  **As**  74.92 | 34  **Se**  78.96 | 35  **Br**  79.90 | 36  **Kr**  83.80 |
| 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**  (99) | 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 |
| 55  **Cs**  132.9 | 56  **Ba**  137.3 | 57  **La**  138.9 | 72  **Hf**  178.5 | 73  **Ta**  180.9 | 74  **W**  183.9 | 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) |
| 87  **Fr**  (223) | 88  **Ra**  226.0 | 89  **Ac**  227.0 | 104  **Rf**  (261) | 105  **Db**  (262) | 106  **Sg**  (263) | 107  **Bh**  (262) | 108  **Hs**  (265) | 109  **Mt**  (266) | 110  **??**  (269) |  | |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 58  **Ce**  140.1 | 59  **Pr**  140.9 | 60  **Nd**  144.2 | 61  **Pm**  (147) | 62  **Sm**  150.4 | 63  **Eu**  152.0 | 64  **Gd**  157.3 | 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 |
| 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**  (260) |

Part I – Multiple Choice (30 points)

1. If tripling the concentration of a single reactant R in a multi-reactant reaction (while leaving all other conditions unchanged) leads to a nine−fold increase in rate, it can be deduced
2. That the complete rate law is Rate= k[R]
3. That the complete rate law is Rate= k[R]2
4. That the complete rate law is Rate= k[R]3
5. That the complete rate law is Rate= k[R]9
6. **Only that the order with respect to [R] is 2**
7. Which of the following statements is NOT correct?
8. A reaction intermediate is produced and used up during a reaction mechanism.
9. If a forward reaction is endothermic, the reverse reaction is exothermic.
10. **Activation energy is the same for both a forward and reverse reaction.**
11. In an endothermic reaction, the activation energy is usually greater than the enthalpy.
12. An activated complex has higher energy than any molecule contributing to it.
13. When the reaction A → B + C is studied, a plot of [A] vs. time gives a straight line with a negative slope. The reaction order is:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1. **zero** | 1. first | 1. second | 1. third | 1. fourth |

1. For a mechanism to be feasible, which of the following criteria must be filled?
2. The sum of the overall steps must add up to the overall stoichiometry of the chemical equation
3. The rate determining (slow step) must be the last step in the mechanism.
4. The rate determining (slow step) must include all of the reactants that appear in the rate equation where the stoichiometric coefficients match the powers.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1. **I only** | 1. III only | 1. I and III only | 1. II and III only | 1. I, II, and III |

1. A catalyst alters the rate of a chemical reaction by:
2. Always providing a surface on which molecules react.
3. Changing the products formed in the reaction.
4. **Inducing an alternate pathway for the reaction by lowering the activation energy.**
5. Changing the frequency of collisions between molecules.
6. Increasing the number of collisions of molecules.
7. A sealed rigid container holds two gases, A and B. If additional moles of gas B are added to the container while keeping the temperature constant, what can be said of the reaction under these conditions.
8. The rate of the reaction will increase, as will the rate constant, k.
9. The rate of the reaction will remain unchanged as will the rate constant, k.
10. **The rate of the reaction will increase but the rate constant, k, will remain unchanged**.
11. The rate of the reaction will remain unchanged but the rate constant, k, will increase.
12. The rate of reaction will decrease as will the rate constant, k.
13. What is the conjugate base of HCO3–?

a) OH– b) H2CO3 **c) CO32–** d) HCO3+  e) H3CO3

1. A substance that is capable of acting as both an acid and as a base is \_\_\_\_\_.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **a) Amphiprotic** | b) Conjugated | c) Diprotic | d) Miscible | e) Binary acid-base |

1. According to the Lewis theory, an acid is
   1. **An electron pair acceptor**
   2. An electron pair donor
   3. A proton acceptor
   4. A proton donor
   5. A hydroxide ion donor
2. Which of the following is true?
   1. HF is a stronger acid than HI, because F is more electronegative than I.
   2. HF is a stronger acid than HI, because the HF bond is weaker than the HI bond.
   3. HF is a weaker acid than HI, because I is more electronegative than F.
   4. **HF is a weaker acid than HI, because the HF bond is stronger than the HI bond.**
   5. None of the above
3. A Brønsted-Lowry base is defined as a substance that
   1. Acts as a proton donor.
   2. Increases [H+] when placed in water.
   3. **Acts as a proton acceptor.**
   4. Decreases [H+] when placed in water.
   5. None of the above
4. The magnitude of *Kw* indicates that \_\_\_\_\_\_\_\_\_\_.
   1. Water autoionizes very slowly
   2. Water autoionizes very quickly
   3. **Water autoionizes only to a very small extent**
   4. The autoionization of water is exothermic
   5. Water autoionizes completely
5. Which of the following salts is acidic?
   1. Sodium oxalate (Na2C2O4)
   2. Potassium chloride (KCl)
   3. **Iron (II) chloride (FeCl2)**
   4. Lithium carbonate (Li2CO3)
   5. None of the above salts are acidic
6. As the number of oxygen atoms increases in any series of oxygen acids, such as HXO, HXO2, HXO3,...., which of the following is generally true?
7. The acid strength varies unpredictably.
8. The acid strength decreases only if X is a nonmetal.
9. The acid strength decreases only if X is a metal.
10. The acid strength decreases whether X is a nonmetal or a metal.
11. **The acid strength increases.**
12. Which one of the following aqueous solutions will have a pH of 10.00 at 25ºC

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1. 1.0 x 10-4 HBr | 1. 1.0 x 101 H3PO4 | 1. 1.0 x 102 KOH | 1. 1.0 x 102 HNO2 | 1. **1.0 x 10-4 NaOH** |

Part II – Short answer

1. (8 points) Make a sketch of a reaction profile for a reaction with ΔH = + 20 kJ/mol and Ea (activation energy) of + 50 kJ/mol. Label the axes appropriately and include values on the y-axis.
2. Label the transition state, Eact forward, and Eact reverse, reactants, products.
3. Using a dotted line, sketch a catalyzed pathway on your graph.
4. What is the value of Ea for the reverse reaction? \_\_\_**+ 30 kJ/mol** \_\_\_\_

Transition state

Eact reverse

Product

Reactant

Eact forward

1. (8 points) A city's water supply is contaminated with a toxin at a concentration of 0.68 mg/L. For the water to be safe for drinking the concentration of this toxin must be below 1.5 x 10-3 mg/L. Fortunately, this toxin decomposes to a safe mixture of products by first-order kinetics with a half-life of 1.25 days. How long will it take for the water to be safe to drink?

First order

1. (6 points) The activation energy for a certain reaction is 76.7 kJ/mol. How many times faster will the reaction occur at 50°C compared to 0°C?
2. (4 points) Ammonia is produced by the reaction between nitrogen and hydrogen gases. The concentration of ammonia increases from 0.257 M to 0.815 M in 15.0 min. Calculate the average rate of reaction over this time interval.(hint write equation)

**N2(*g*) + 3 H2(*g*) → 2 NH3(*g*)**



1. (6 points) Given NO2(g) + CO(g) ⇒ NO(g) + CO2(g), a proposed mechanism for this reaction is

2NO2(g) ⮀ NO3(g) + NO(g); fast, equilibrium

NO3(g) + CO(g) ⇒ NO2(g) + CO2(g); slow

* 1. What is the intermediate(s) (2 points)

NO3(g)

* 1. What is the rate law for the net reaction?



1. (6 points) For the following reaction at equilibrium

1st reaction: A(g) + 3B(g) ⮀ AB3(g); K1 = 0.060

2nd reaction: AB3(g) + C(g) ⮀ AB2(g) + BC(g); K2 = 4.9 x 108

Net reaction: 2AB2(g) + 2BC(g) ⮀ 2A(g) + 6B(g) + 2C(g) ; Knet = ?

Show work and state the numeric value for Knet.

~~2AB~~~~3(g)~~ ⮀ 2A(g) + 6 B(g); K1 = (0.060)-2

2AB2(g) + 2BC(g) ⮀ ~~2AB~~~~3(g)~~ + 2C(g); K2 = (4.9 x 108) -2

2AB2(g) + 2BC(g) ⮀ 2A(g) + 6B(g) + 2C(g)



1. (10 points) Experimental data for the following hypothetical reaction are plotted in the figure.
2. Find the instantaneous rate at 40s. (2 points)

Draw a line tangent to the curve at 40s.



1. Find the average rate over the 10 to 50s interval





1. Compare the two rates

**The magnitude of the average rate is greater than the instantaneous rate.**

1. Does the rate remain constant over time?

**No, the magnitude of the rate decreases over time.**

1. What does the rate depend upon?

**The rate is probably dependent upon the concentration of reactants or products.**

1. (8 points) Consider the following equilibrium system in a closed container :

CuS (s) + 2 H+ (aq) ⮀ Cu2+ (aq) + H2S (g) ∆H < 0

|  |  |  |  |
| --- | --- | --- | --- |
| Change | Direction of shift | Effect on quantity | Effect (i, d, nc) |
| Add Cu2+ (aq) |  | H2S ­(g) | decreases |
| Lower temperature |  | Kc | increases |
| Add CuS (s) | No change | H+ (aq) | No change |
| Remove H2S ­(g) |  | Amount of CuS (s) | decrease |

1. (4 points) What does a large Ka value mean in terms of the direction of the dissociation reaction? Will the pKa of a large Ka value be a large or small number? Therefore, do large or small pKa values correspond to strong or weak acids?

**A large Ka value means that the numerator in the K expression is large, there is a lot of products. Since an acid goes into solution and produces H+1 ions (or H3O+1 ions) then we have a lot of H+1 ions present. If the numerator is a large number, then the Ka value will be large number also. If we take the –log of a large number, we get a small number. Since a large Ka value means that we have a lot of H+1 ions present which signifies or indicates that we have a strong acid, then a small pKa will indicate that we have a strong acid also!**

**large Ka = small pKa = strong acid**

**small Ka = large pKa = weak acid**

1. (10 points) Calculate the pH and % dissociation of a solution that contains 24.8 grams of NaCN in 775 mL of solution. Ka for HCN is 4.90 x 10-10.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | CN-(aq) | H2O(l) |  | HCN(aq) | + | OH- (aq) |
| I | 0.653 M |  |  | 0 M |  | 0 M |
| C | -x |  |  | +x |  | +x |
| E | 0.653 M – x |  |  | x |  | x = |

2 points

Assume x<<< 0.653 M

1 point (must show explicitly) separate from check or indicate explicitly the check is the same as % dissociation