MC, Chem1B, Spring17, Test 2 Name________________________________

Read questions carefully before answering. No outside paper is allowed. Write **set up equation** for a mathematical problem, then put the raw data with **units**, before showing the calculation. Use the reverse side of your answer paper as scratch. Use the periodic table and important constants charts provided. (Total points = 68 + (17*3=)51 = 119).

Show your calculation with set up and units (when appropriate)

1) The following experimental data were obtained at constant temperature for the reaction: 1) ______________

$$2NO(g) + O_2\ (g) \longrightarrow 2\ NO_2(g)$$

| Experiment | Initial Concentrations [NO] | [O2] | Initial Rate ( M $s^{-1}$) |
|---|---|---|---|
| 1 | 0.0010 | 0.0010 | $7.0 \times 10^{-6}$ |
| 2 | 0.0010 | 0.0020 | $1.4 \times 10^{-5}$ |
| 3 | 0.0010 | 0.0030 | $2.1 \times 10^{-5}$ |
| 4 | 0.0020 | 0.0030 | $8.4 \times 10^{-5}$ |
| 5 | 0.0030 | 0.0030 | $1.9 \times 10^{-4}$ |

a. Following formal method calculate the order of the reaction with respect to each reactant (6 pts.).

b. Write the rate law for the reaction (3 pts.).

c. Calculate rate of $NO_2$ formation when [NO] = [$O_2$] = 0.005 M (3 pts.).

2) If the rate of foramtion of oxygen gas is $6.0 \times 10^{-5}$ M/s in the following conversion: $2\ O_3\ (g)$ -------> 3 O2 , then calculate the rate of disappearance of $O_3$ (g) at that same time. (4 pts.) 2) ______________

3) In the reaction $N_2\ (g) + 3\ H_2\ (g) \leftrightarrow 2\ NH_3\ (g)$, if the $K_c = 9.60$ at 573 K, then calculate the Kp at this temperature (4 pts.). 3) ______________

4) In the equilibrium rxn. Butane (g) $\leftrightarrow$ Isobutane (g), assume equlibrium has reached in a 1.0 L flask with [Butane] = 0.5 M and [Isobutane] = 1.23 M at 298 K. The equlibrium constant for the reaction = 2.5 and afterwards 1.5 mol of Butane was added to the mixture. Calculate the new values of [Butane] and [Isobutane] when equilibrium was reestablished (8 pts.)? 4) ______________

5) Equilibrium was established when a mixture of 0.20 mol of NO(g), 0.10 mol of $H_2$(g), and 0.20 mol of $H_2O$(g) is placed in a 2.0-L vessel at 400 K. The equilibrium reaction is : 2 NO(g) + 2 $H_2$(g) <——> $N_2$(g) + 2 $H_2O$(g). If at equilibrium [NO] = 0.062 *M*, then calculate $K_p$. (10 pts.) 5) ____________

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6) Calculate the pH of a solution made by dissolving 1.00 gram of NaOH in 300.00 mL water. (8 pts.) 6) ____________

7) Ammonia is a weak base with pKb = 4.74 at 25°C. Calculate the pH of a 0.2 M ammonia solution in water at that temperature (8 pts.). 7) ____________

8) A 0.20-M solution of sodium nitrite, $NaNO_2$, has a pH of 8.57. 8) ____________

a) Write a chemical equation showing why this salt has the given pH. Hint: you should write a $K_b$ chemical hydrolysis equation. (4 pts.)

b) Calculate $K_b$ for the basic anion (6 pts.)

c) And $K_a$ for the corresponding conjugate acid given the measured pH (4 pts.).

MULTIPLE CHOICE. On your scantron, start answering from number 9. Select the one alternative that best completes the statement or answers the question (3 pts each).

9) Which one of the following is not a valid expression for the rate of the reaction below? 9) ______

$4NH_3 + 7O_2 \rightarrow 4NO_2 + 6H_2O$

A) $\frac{1}{4}\frac{\Delta[NO_2]}{\Delta t}$

B) $-\frac{1}{7}\frac{\Delta[O_2]}{\Delta t}$

C) $\frac{1}{6}\frac{\Delta[H_2O]}{\Delta t}$

D) $-\frac{1}{4}\frac{\Delta[NH_3]}{\Delta t}$

E) All of the above are valid expressions of the reaction rate.

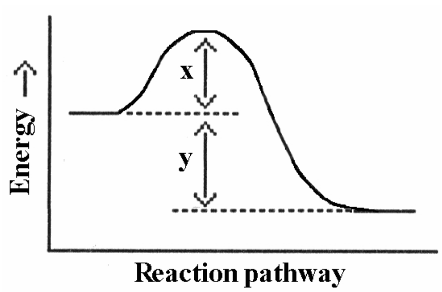
10) Of the units below, __________ are appropriate for a first-order reaction rate constant. 10) ______

A) $M\ s^{-1}$
B) $s^{-1}$
C) $M^{-1}\ s^{-1}$
D) $L\ mol^{-1}\ s^{-1}$
E) mol/L

11) As the temperature of a reaction is increased, the rate of the reaction increases because the __________. 11) ______

A) reactant molecules collide less frequently and with greater energy per collision
B) activation energy is lowered
C) reactant molecules collide more frequently and with greater energy per collision
D) reactant molecules collide less frequently
E) reactant molecules collide more frequently with less energy per collision

12) Which energy difference in the energy profile below corresponds to the activation energy for the forward reaction? 12) ______




A) x B) y C) y - x D) x - y E) x + y

13) How does the reaction quotient of a reaction (Q) differ from the equilibrium constant ($K_{eq}$) of the same reaction? 13) ______

A) K does not depend on the concentrations or partial pressures of reaction components.
B) Q is the same as $K_{eq}$ when a reaction is at equilibrium.
C) Q does not depend on the concentrations or partial pressures of reaction components.
D) $K_{eq}$ does not change with temperature, whereas Q is temperature dependent.
E) Q does not change with temperature.

14) The equilibrium constant for reaction 1 is K. The equilibrium constant for reaction 2 is __________. 14) ______

(1) $SO_2\,(g) + (1/2)\,O_2\,(g) \rightleftharpoons SO_3\,(g)$
(2) $2SO_3\,(g) \rightleftharpoons 2SO_2\,(g) + O_2\,(g)$

A) 1/2K B) $K^2$ C) $-K^2$ D) 2K E) $1/K^2$

15) The reaction below is exothermic: 15) ______

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

Le Châtelier's Principle predicts that __________ will result in an increase in the number of moles of $SO_3$ (g) in the reaction container.

A) removing some oxygen
B) increasing the pressure
C) increasing the volume of the container
D) decreasing the pressure
E) increasing the temperature

16) The equlibrium reaction $Co(H_2O)_6^{2+}$ (aq) (Pink) + 4 $Cl^-$ (aq) <-> $CoCl_4^{\,2-}$ (aq) (Blue) + 6 $H_2O$(l) turns pink when placed in ice water mixture but turns blue in hot water. The reaction, as shown, is: 16) ______

A) Nonthermic B) Endothermic
C) Exothermic D) Insufficient data

17) In which of the following aqueous solutions does the weak acid exhibit the highest percentage ionization? 17) ______

A) 0.01 M HClO ($K_a = 3.0 \times 10^{-8}$)
B) 0.01 M $HNO_2$ ($K_a = 4.5 \times 10^{-4}$)
C) 0.01 M $HC_2H_3O_2$ ($K_a = 1.8 \times 10^{-5}$)
D) 0.01 M HF ($K_a = 6.8 \times 10^{-4}$)
E) These will all exhibit the same percentage ionization.

18) Which of the following aqueous solutions has the highest $[OH^-]$? 18) ______

A) a solution with a pOH of 12.0

B) a $1 \times 10^{-3}$ M solution of $NH_4Cl$

C) a $1 \times 10^{-4}$ M solution of $HNO_3$

D) a solution with a pH of 3.0

E) pure water

19) A 0.1 M aqueous solution of _________ will have a pH of 7.0 at 25.0 °C. 19) ______

NaOCl KCl $NH_4Cl$ $Ca(OAc)_2$

A) NaOCl

B) KCl

C) $NH_4Cl$

D) $Ca(OAc)_2$

E) KCl and $NH_4Cl$

TRUE/FALSE. On the scantron, select answer 'A' if the statement is true and 'B' if the statement is false (3 pts each).

20) The half-life for a first order rate law depends on the starting concentration. T or F

21) Units of the rate constant of a reaction are independent of the overall reaction order. T or F

22) $H_2SO_3$ and $H_2SO_4$ are considered an acid-base conjugate pair. T or F

23) The conjugate base to $HSO_4^-$ is $SO_4^{2-}$. T or F

24) At constant temperature, reducing the volume of a gaseous equilibrium mixture causes the reaction to shift in the direction that increases the number of moles of gas in the system. T or F

25) In an exothermic equilibrium reaction, increasing the reaction temperature favors the formation of reactants. T or F