Exam 4
Chem 1121
Fall 2009

Name:_____KEY_____

MULTIPLE CHOICE. [3 pts ea.]

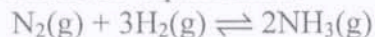Q1. Consider the equilibrium:

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
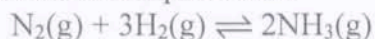
Which direction would the equilibrium shift if NH_3 was added to the reaction mixture?

A) LEFT   B) RIGHT   C) NO CHANGE

Q2. Consider the equilibrium:

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

Which direction would the equilibrium shift if H_2 was removed from the reaction mixture?

A) LEFT   B) RIGHT   C) NO CHANGE

Q3. The half-life of a radioactive nuclide is
 A) that period of time in which 25% of the original number of atoms undergoes radioactive decay.
 B) the time at which the isotope becomes nonradioactive.
 C) that period of time in which 50% of the original number of atoms undergoes radioactive decay.
 D) the period of time it takes to reduce the radioactivity by 100%.
 E) none of the above

Q4. The iodine-131 radioisotope has a half-life of 8.0 days. If you originally have a 630-g sample, after 16 days you will have.
 A) 630 g   B) 315 g   C) 157.5 g   D) 63 g   E) 0 g

Q5. True or false? Arrhenius postulated that acids produce hydrogen ions in aqueous solution, whereas bases produce hydroxide ions.
 A) True   B) False

Q6. A solution with a pH of 2.17 is
 A) basic   B) acidic   C) neutral

Q7. What is a catalyst?
A) A Substance that speeds up the rate of a chemical reaction
B) A Substance that causes more heat to be released in a chemical reaction
C) A Substance that decreases the activation energy of a chemical reaction
D) both (A) and (C)
E) both (A) and (B)

Q8. Which of the following statements is/are correct?
A) In an acidic solution, $[H^+] > [OH^-]$.

B) In a basic solution, $[OH^-] > [H^+]$.

C) In a neutral solution, $[H^+] = [OH^-]$.

D) None of the above statements (a-c) are correct.
E) All of the above statements (a-c) are correct.

Warning
Battery acid

Q9. True or false? A solution is buffered by the presence of a weak acid and its conjugate base.
A) True   B) False

Q10. A solution where $[H^+] = 10^{-13}$ M is _____.
A) basic   B) neutral   C) acidic   D) strongly acidic   E) two of these

Q11. A solution has $[H^+] = 4.6 \times 10^{-3}$ M. The $[OH^-]$ in this solution is
A) 4.6×10^{11} M B) 4.6×10^{-17} M C) 2.2×10^{-12} M
D) 1.0×10^{-14} M E) none of these

Q12. A solution has $[OH^-] = 2.6 \times 10^{-7}$ M. The $[H^+]$ in this solution is
A) 1.0 M B) 2.6×10^7 M C) 1.0×10^{-7} M
D) 3.8×10^{-8} M E) none of these

Q13. Calculate the $[H^+]$ in a solution that has a pH of 8.95.
A) 8.9×10^8 M B) 1.1×10^5 M C) 1.0×10^{-7} M
D) 1.1×10^{-9} M E) none of these

Q14. Calculate the pH of 3.0×10^{-4} M HCl.
A) 2.19   B) 10.48   C) 3.52
D) 7.00   E) none of these

Q15. A reaction that releases heat is called:
A) Endothermic   B) Exothermic   C) Catalytic   D) Osmotic
E) Activated

Q16. Which of the following mixtures would be a buffer?
A) NH_3/NH_4Cl B) $HC_2H_3O_2/NaC_2H_3O_2$ C) HCl/NaOH
D) Both (A) and (B)   E) Both (B) and (C)

Q17. Why does increasing the concentration of reactants speed up the rate of a chemical reaction?

A) The reactants are more likely to have an energy greater than the activation energy when the concentration is increased.

B) The reactants move faster when the concentration is greater.

C) The reactants release more heat when the concentration is greater.

D) The reactants collide with each other more often when the concentration is greater.

Q18. Polonium is a naturally radioactive element decaying with the loss of an alpha particle.

$$^{210}_{84}\text{Po} \rightarrow ^{4}_{2}\text{He} + ?$$
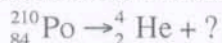
What is the second product of this decay?

A) $^{214}_{86}\text{Rn}$ B) $^{206}_{82}\text{Pb}$ C) $^{206}_{85}\text{At}$ D) $^{208}_{80}\text{Hg}$ E) none of these

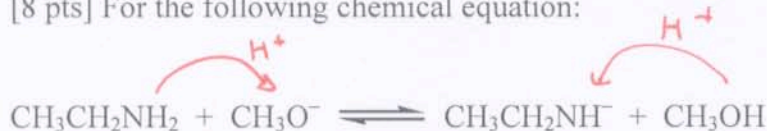Q19. Thorium-234 ($^{234}_{90}\text{Th}$) undergoes beta decay. What is the other product?

A) $^{234}_{91}\text{Pa}$ B) $^{234}_{89}\text{Ac}$ C) $^{233}_{90}\text{Th}$ D) $^{233}_{91}\text{Th}$ E) none of these

Q20. Alpha particles are

A) electrons   B) protons   C) neutrons   D) helium nuclei   E) X rays

Short Response. Show all work to receive credit.

Q21 [8 pts] For the following chemical equation:

$$CH_3CH_2NH_2 + CH_3O^- \rightleftharpoons CH_3CH_2NH^- + CH_3OH$$

Identify each of the four molecules/ions as being either an acid or a base according to the Brønsted-Löwry of acids and bases. Identify the two conjugate acid-base pairs.

Species	Acid OR Base
$CH_3CH_2NH_2$	ACID
CH_3O^-	BASE
$CH_3CH_2NH^-$	BASE
CH_3OH	ACID

Conjugate Pair: $CH_3CH_2NH_2$ and $CH_3CH_2NH^-$

Conjugate Pair: CH_3OH and CH_3O^-

Q22 [6 pts.] Complete the table for the radioactive particles:

| Name	Charge	Mass Number
Alpha	2+	4
Beta	1−	0
Gamma	0	0

Q23 [5 pts.] Acetic acid ($HC_2H_3O_2$) is considered to be a relatively *weak* acid, whereas hydrochloric acid (HCl) is a *strong* acid. Explain what this means.

Acetic acid undergoes partial dissociation in water: $HC_2H_3O_2 \rightleftharpoons H^+ + C_2H_3O_2^-$

Hydrochloric acid undergoes ≈100% " ———— " : $HCl \longrightarrow H^+ + Cl^-$

Q24 [7 pts.] Sketch a diagram of energy vs. time for an EXOTHERMIC reaction. Be sure to clearly label the position of the Reactants, Products, Transition-State, and the Activation Energy.

potential energy

Transition state

activation energy

E_A

Reacts

$\Delta H = -ve$

Prods

time
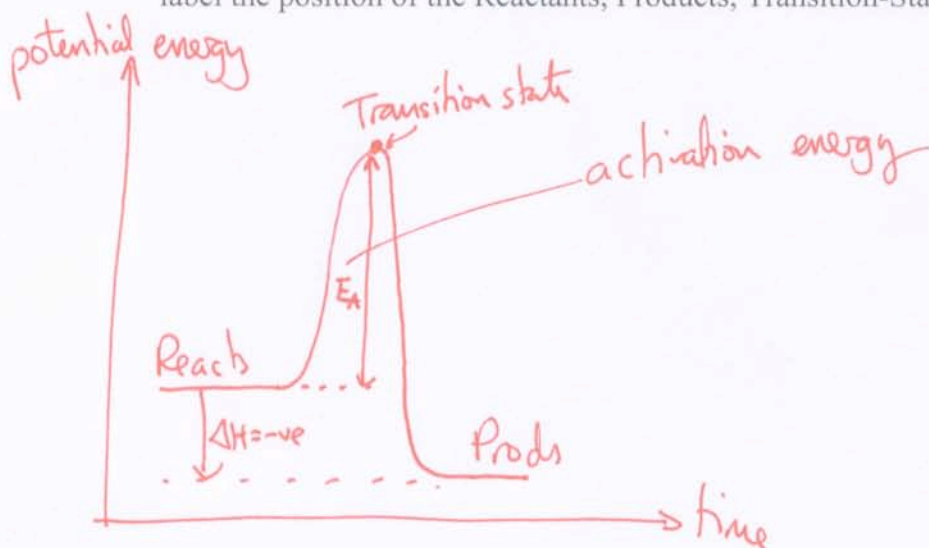
Q25 [6 pts.] Calculate the concentration of H^+ ions and the pH of an aqueous solution where $[OH^-] = 3.5 \times 10^{-4}$M. Is the solution acidic or basic? **Show all work.**

$$[OH^-] \times [H^+] = 1.0 \times 10^{-14} \Rightarrow [H^+] = \frac{1.0 \times 10^{-14}}{[OH^-]} = \frac{1.0 \times 10^{-14}}{3.5 \times 10^{-4}} = 2.9 \times 10^{-11} M$$

$$pH = -\log[H^+] = -\log[2.9 \times 10^{-11}] = 10.54$$

BASIC, since $[OH^-] > [H^+]$ (and pH > 7)

Q26 [4 pts.] The radioisotope Iodine-131 is used to treat people with Graves' disease, a thyroid disease. The treatment is so successful that it has virtually replaced thyroid surgery. Write the nuclear equation for the radioactive decay of Iodine-131 (a beta emitter).

$$^{131}_{53}I \longrightarrow ^{131}_{54}Xe + ^{0}_{-1}e$$

Q27 [4 pts.] Carbon-14 is a beta emitter with a half-life of 5700 years. What percentage of carbon-14 atoms remain in a sample that is 17,100 years old?

$$\frac{17,100}{5700} = 3.0$$

so, 3 half-lives have passed !

$\Rightarrow$ Percent remaining is:

$100\% \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = 12.5\%$

BONUS 1: [3 pts.] Write the Greek letters, alpha, beta, and gamma that describe the three common forms of radiation.

Alpha: α

Beta: β

Gamma: γ

BONUS 2: [2 pts.] Which form of radiation is the most penetrating: alpha, beta, or gamma?

γ

"This is a lovely old song that tells of a young woman who leaves her cottage, and goes off to work. She arrives at her destination, and places some solid NH_4HS in a flask containing 0.50 atm of ammonia, and attempts to determine the pressures of ammonia and hydrogen sulfide when equilibrium is reached."