Name: _____Key_____

This test is closed note/book, but one 8.5 x 11 handwritten crib sheet (one sided) is permitted.

Please turn off cell phones.

Calculators are permitted; however, computers, PDAs, and other electronic devices with a keyboard are not permitted. Cell phones may not be used as calculators.

Complete the Scantron card as shown below. **Identify your version as indicated to receive credit.**

A total of 50 minutes will be allotted for the exam. Answer every question. There is no guessing penalty.

Circle Your Section

Mindi Ogden	A1 W 3-6
Denise Enekwa	A2 W 3-6
Deborah Ortiz	A3 W 3-6
Yo-Yuan Cheng	A4 W 3-6
Wei Long	A4 W 3-6
Chiaolong Hsiao	B1 Th 3-6
Michael Rood	B2 Th 3-6

1. What is $[H^+]$ in an aqueous solution with a pH of 9.097?
   A) 2×10^{-8} *M*
   B) 1×10^{-1} *M*
   C) 9.1 *M*
   D) 4.9 *M*
   E) 8.0×10^{-10} *M*

answer E
$[H+] = 10^{-9.097} = 8.0 \times 10^{-10}$

2. What is pOH of an aqueous solution with $[HCl] = 10^{-9}$ M
   A) 9
   B) 10^{-5}
   C) 5
   D) -5
   E) 7

answer E. In pure water, $[H^+]=[OH^-]=10^{-7}$. If you add any acid or base to a concentration of much less than 10^{-7}, it will not alter the pH or the pOH. If you answered C (pOH=5), than that would imply that adding a slight amount of strong acid to water would render the water basic (pH>7, pOH<7). Not possible.

3. What concentration of HF ($K_a = 7.2 \times 10^{-4}$) has the same pH as that of 0.044 *M* HCl?
   A) 0.37 *M*
   B) 2.7 *M*
   C) 0.044 *M*
   D) 3.2×10^{-6} *M*
   E) 1.6×10^{-2} *M*

answer B
This requires and ICE diagram

4. What is the molality of a solution of 39.6 g of ethanol (CH_3CH_2OH) in 442 mL of water?
   A) 1.94 *m*
   B) 89.6 *m*
   C) 0.0350 *m*
   D) 1.78 *m*
   E) 0.0338 *m*

answer A

5. A 90.0 g sample of glucose (a non-dissociating, non-volatile solute with the formula $C_6H_{12}O_6$) is dissolved in 180.0 g water. What is the vapor pressure of this solution at 100°C?
   A) 722 torr
   B) 760 torr
   C) 29 torr
   D) 23 torr
   E) 738 torr

answer A
(90 g) $[6(12)+12+6(16)\ g/mol]^{-1} = n_{glucose} = 90/180 = 0.5$
(180 g) $[18g/mol)]^{-1} = n_{water} = 10.0$
$X_{H2O} = n_{H2O}/(n_{H2O} + n_{glucose}) = 10/(10.0+0.5) = 10/10.5 = 0,95$
$0.95*760 = 722$ torr

6. For the reaction: $aA(g) + bB(g) \rightleftharpoons cC(g)$ + heat
   with a = 1, b=1 and c=3. An increase in total pressure (at const T)
   A) increases the number of moles of A
   B) decreases the number of moles of A
   C) does not change the number of moles of A

answer A
There are more molecules in the gas phase on the RH side, to increasing the P drives it to the left

7. For the reaction: $aA(g) + bB(g) \rightleftharpoons cC(g)$ + heat
   with a = 1, b=1 and c=3. An increase in total pressure (at const T)
   A) increases the equilibrium constant
   B) decreases the equilibrium constant
   C) does not change the equilibrium constant

answer C
Changing P will not change K

8. For the reaction: $aA(g) + bB(g) \rightleftharpoons cC(g)$ + heat
   with a = 1, b=1 and c=3. An increase in T
   A) Increases the number of moles of A.
   B) Decreases the number of moles of A
   C) Does not change the number of moles of A

answer A
For a reaction that evolves heat, adding heat drives it to the left (and changes K).

9. Which one of the following is the strongest intermolecular force in Ar(liq)?
   A) dipole-dipole interactions
   B) ionic bonding
   C) London dispersion forces
   D) polar covalent bonds
   E) hydrogen bonding

answer C
Argon is non-polar.

10. The equilibrium constant for the reaction

$$A^- + H^+ \rightleftharpoons HA$$

is:
   A) $\frac{K_w}{K_b}$
   B) $\frac{1}{K_a}$
   C) K_a
   D) $K_w K_a$
   E) K_b

answer B

11. Consider the following reaction:

$$2HF(g) \rightleftharpoons H_2(g) + F_2(g) \qquad (K = 1.00 \text{ at some temperature, T})$$

Given 1.0 mol of HF(*g*), 0.5 mol of $H_2(g)$, and 1.0 mol of $F_2(g)$ are mixed in a 1.00-L flask, determine the direction required to achieve equilibrium.
   A) the system is at equilibrium.
   B) the system shifts to the right to reach equilibrium.
   C) the system shifts to the left to reach equilibrium.
   D) the direction of the driving force cannot be determined by the information provided.

answer B

12. Air is 79% N_2 and 21% O_2 weight to volume. Calculate the density of air at 1.0 atm, 25°C.
   A) 14.1 g/L
   B) 2.46 g/L
   C) 0.590 g/L
   D) 1.18 g/L
   E) 1.29 g/L

answer D
% is weight to volume

for 1 g of air
N_2: (0.79g) $(28g/mol)^{-1}$ = n_{N2} = 0.0282 mol
O_2: (0.21g) $(32g/mol)^{-1}$ = n_{O2} = 0.0066 mol

$V_{TOT} = (n_{N2}+n_{O2})RT/P$ = (0.0348 mol) (0.082 L atm mol^{-1} K^{-1})(298 K)$(1 atm)^{-1}$
=0.850 L

1g/0.850 L = 1.18 g/L

13. Which of the following does not represent a conjugate acid-base pair?
    A) $C_5H_5NH^+$ and C_5H_5N
    B) HCN and NH_3
    C) HF and F^-
    D) H_3O^+ and H_2O

answer B

14. A cylinder is fitted with a movable piston containing an ideal gas. The pressure inside the cylinder is P_i and the volume is V_i. What is the new pressure in the system when the piston decreases the volume of the cylinder by half, at constant T?
    A) $2V_iP_i$
    B) $(1/4)P_i$
    C) P_i^2
    D) $2P_i$
    E) $(1/2)P_i$

answer D

15. Consider two samples of helium in the gas phase in separate containers of the same volume and pressure. Sample 1 has an absolute temperature four times that of Sample 2. Calculate the molar ratio n_1/n_2.
    A) 1:2
    B) 4:1
    C) 1:1
    D) 1:4
    E) 2:1

answer D

16. What is the equilibrium expression for the reaction
$2SO_2(aq) + O_2(aq) \rightleftharpoons 2SO_3(aq)$?

A) $\dfrac{[SO_3]}{[SO_2]\,[O_2]}$

B) $\dfrac{[SO_3]^2}{[SO_2]^2[O_2]}$

C) $\dfrac{[SO_3]^2}{[SO_2]^2[O_2]^2}$

D) $\dfrac{[SO_2]^2[O_2]}{[SO_3]^2}$

answer B

17. Which of the following has the highest boiling point?
A) N_2
B) CH_4
C) F_2
D) NH_3
E) Ne

answer D

18A.
Consider the following equilibrium:
$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $K = 0.5$
Each reactant and product is placed in a 1.00-L container (i.e., all three in the same container) to a partial pressure of 2 atm. Which way will the reaction initially proceed?
A) To the left.
B) To the right.
C) The system is at equilibrium.
D) We need to know the temperature.

answer B (**revised)

$Q=2^2/2x2^3 = 0.25$. Since Q<K the reaction will go to the right to reach equilibrium.

19A. A system in a state of chemical equilibrium is
A) microscopically dynamic and macroscopically dynamic.
B) microscopically static and macroscopically dynamic.
C) microscopically dynamic and macroscopically static.
D) microscopically static and macroscopically static.

answer C

18B. To calculate the freezing point of an ideal dilute solution of a single, non-dissociating solute, the minimum information one must know is

I. the molality (of the solute).
II. the freezing-point-depression constant of the solvent
III. the freezing point of the pure solvent.
IV. the molecular weight of the solute.
V. the weight of the solvent.

A) II, III, IV
B) I only
C) II only
D) II, III, V
E) I, II, III only

answer E

19B. Which of the following statements is true?

A) Catalysts change equilibrium constants.
B) If all opposing processes proceed at identical rates, a system is at equilibrium.
C) An exothermic reaction consumes heat.
D) The concentration of the products equals that of the reactants at equilibrium.

answer B

20. This is exam version (look at the top of the page):

A) A
B) B
C) C
D) D

answer A

Constants:

$1\,\text{mole} = 6.022 \times 10^{23}\,atoms$

$1\,\text{mole} = 6.022 \times 10^{23}$ molecules

$1\,\text{mole} = 6.022 \times 10^{23}\,ions$

$h = 6.626x10^{-34}\,Js$

$1\,\text{J (Joule)} = 1\,\text{kg}\,\frac{\text{m}^2}{s^2}$

$c = 3.0x10^{8}\,m/s$

Mass of an Electron $= 9.10939 \times 10^{-31}\,kg$

Mass of a Proton $= 1.67 \times 10^{-27}\,kg$

Mass of a Neutron $= 1.67 \times 10^{-27}\,kg$

$R = 0.0821\frac{Latm}{molK}$

$R = 8.31\frac{J}{molK}$

$V.P.(H_2O, 373K) = 760torr$

Stoichiometry:

$Density = \frac{mass}{volume}$

$Molarity = M = \frac{\text{mole of solute}}{\text{L of solvent}}$

$\text{n (number of moles)} = \frac{\text{mass}}{\text{Molar Mass}}$

$M_1V_1 = M_2V_2$

Quantum Mechanics

$c = \lambda\nu$

$E = mc^2$

$\lambda = \frac{h}{p}$

$\hat{H}\psi = E\psi$

$\Delta x * m\Delta v \geq \frac{h}{4\pi}$

Maximum Occupancy $= 2n^2$

Solubility Rules

1. All alkali metal salts are soluble.
2. All ammonium (NH_4^+) salts are soluble.
3. All chlorides, bromides, and iodides are soluble except those of Ag^+, Hg_2^{2+}, and Pb^{2+}.
4. All nitrates, chlorates, and perchlorates are soluble.
5. All sulfates except those of Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}, Hg_2^{2+}, and Ag^+.
6. All carbonates, chromates, oxalates, and phosphates are insoluble except those of the alkali metals and ammonium.
7. All hydroxides are insoluble except those of the alkali metals.

Bonding

Formal Charge = V – (L + 0.5 S)

V = Number of Valence Electrons

L = The Number of Lone Pair Electrons

S = The Number of Shared Electrons

Solutions

$$P = X_1 \bullet P^o$$

$$m = molality = \frac{\text{mol of solute}}{kg \text{ of solvent}}$$

$$\Delta T_f = -m \bullet K_f$$

$$\Delta T_b = m \bullet K_b$$

$$X_1 = \text{mole fraction} = \frac{\text{n}_1}{\text{n}_{\text{total}}}$$

$$\Pi = MRT$$

Gas Laws

$$P_1V_1 = P_2V_2$$

$$V_1T_2 = V_2T_1$$

$$PV = nRT$$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$Kelvin = {}^oC + 273.15$$

$$(P + a\frac{n^2}{V^2})(V - nb) = nRT$$

$$P_{total} = P_1 + P_2 + ... + P_n$$

$$KE(mol) = \frac{3}{2}RT \text{ (monoatomic)}$$

$$\text{KE (particle)} = \frac{1}{2}mu^2$$

Acid-Base Chemistry

$$pH = -\log\left[H^+\right]$$

$$pOH = -\log\left[OH^-\right]$$

$$K_w = K_aK_b$$

$$pH + pOH = 14$$

$$HA(aq) \leftrightarrow H^+(aq) + A^-(aq)$$

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

$$K_w = 1 \times 10^{-14} \text{ at } 25^oC$$

$$B(aq) \leftrightarrow BH^+(aq) + OH^-(aq)$$

$$K_b = \frac{[BH^+][OH^-]}{[B]}$$

$$pKa = -\log \text{K}_\text{a}$$

$$pKw = 14 \text{ at } 25^oC$$