CHY 103 MID 2 F2014

Enter All Answers on the Bubble Sheet

PART 1: MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) The equilibrium constant is given for one of two reactions below. Determine the value of the missing equilibrium constant.

$H_2(g) + Br_2(g) \rightleftharpoons 2HBr(g)$ $\quad K = 3.8 \times 10^4$

$4HBr(g) \rightleftharpoons 2H_2(g) + 2Br_2(g)$ $\quad K = ?$

A) 1.4×10^9
B) 6.9×10^{-10}
C) 2.6×10^{-5}
D) 4.8×10^{-14}
E) 1.9×10^4

2) When preparing an aqueous solution of a solid solute in the CHY113 laboratory, a student noticed that some of the solid remained at the bottom of his flask despite vigorously shaking the flask when attempting to dissolve the entire solid sample at room temperature. Which statement below is TRUE about the solution?
A) The solution is considered saturated.
B) The solution is considered unsaturated.
C) The solution would be considered unsaturated if it were cooled a bit to increase the solubility of the solid.
D) The solution is considered supersaturated.
E) None of the above is true.

3) Which of the following concentration units are temperature dependent?
A) molality
B) mass percent
C) mole fraction
D) molarity
E) None of the above

4) Consider the following reaction, equilibrium concentrations, and equilibrium constant at a particular temperature. Determine the equilibrium concentration of $H_2O(g)$.

$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$ $\quad K_c = 9.0 \times 10^3\ L\ mol^{-1}$

$[C_2H_4]_{eq} = 0.015\ mol\ L^{-1}$ $\quad [C_2H_5OH]_{eq} = 1.69\ mol\ L^{-1}$

A) $9.9 \times 10^{-7}\ mol\ L^{-1}$
B) $1.0\ mol\ L^{-1}$
C) $80.\ mol\ L^{-1}$
D) $0.013\ mol\ L^{-1}$
E) $1.68\ mol\ L^{-1}$

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5) Consider the following reaction and its equilibrium constant:

$$I_2(g) + Br_2(g) \rightleftharpoons 2IBr(g) \qquad K_c = 1.1 \times 10^2$$

A reaction mixture contains 0.41 mol L^{-1} I_2, 0.27 mol L^{-1} Br_2 and 3.5 mol L^{-1} IBr. Which of the following statements is TRUE concerning this system? Be sure to take significant digits into consideration.

A) The reaction will shift in the direction of products.
B) The system is at equilibrium.
C) The equilibrium constant will increase.
D) The reaction will shift in the direction of reactants.
E) The reaction quotient will decrease.

6) Calculate the mole fraction of total ions in an aqueous solution prepared by dissolving 0.400 moles of $MgCl_2$ in 850.0 g of water.

A) 0.00841
B) 0.00900
C) 0.0167
D) 0.0248
E) 0.0252

7) Determine the pOH of a 0.116 mol L^{-1} $Ba(OH)_2$ solution at 25 °C.

A) 0.635
B) 13.06
C) 0.936
D) 13.37
E) 1.871

8) Which of the following species is amphoteric?

A) CO_3^{2-}
B) HCl
C) NH_4^+
D) HPO_4^{2-}
E) NaOH

9) Identify the change that will **always** shift the equilibrium to the right.

A) remove reactant
B) increase product
C) remove product
D) increase volume
E) increase pressure

10) Determine the K_b for CN^- at 25 °C. The K_a for HCN is 4.9×10^{-10}.

A) 4.9×10^4
B) 2.3×10^{-9}
C) 4.9×10^{-24}
D) 1.4×10^{-5}
E) 2.0×10^{-5}

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11) Which of the following solutions would have the highest pH? Assume that they are all 0.10 mol L^{-1} in acid at 25 °C? The acid is followed by its K_a value.

A) HNO_2, 4.6×10^{-4}

B) HF, 3.5×10^{-4}

C) HCN, 4.9×10^{-10}

D) $HCHO_2$, 1.8×10^{-4}

E) $HClO_2$, 1.1×10^{-2}

12) Choose the aqueous solution with the lowest vapour pressure. These are all solutions of nonvolatile solutes and you should assume ideal van't Hoff factors where applicable.

A) 0.040 mol kg^{-1} $(NH_4)_2SO_4$

B) 0.060 mol kg^{-1} K_2CO_3

C) 0.120 mol kg^{-1} $C_2H_6O_2$

D) 0.030 mol kg^{-1} $LiC_2H_3O_2$

E) They all have the same vapour pressure.

13) Determine the solubility of N_2 in water exposed to air at 25 °C if the atmospheric pressure is 1.2 bar. Assume that the mole fraction of nitrogen is 0.78 in air and the Henry's law constant for nitrogen in water at this temperature is 6.1×10^{-4} mol L^{-1} bar^{-1}.

A) 4.8×10^{-4} mol L^{-1}

B) 6.5×10^{-4} mol L^{-1}

C) 3.7×10^{-4} mol L^{-1}

D) 5.7×10^{-4} mol L^{-1}

E) 9.4×10^{-4} mol L^{-1}

14) Which of the following statements is TRUE?

A) A reaction quotient (Q) larger than the equilibrium constant (K) means that the reaction will favour the production of more products.

B) Dynamic equilibrium is established when $K = 0$.

C) Dynamic equilibrium indicates that the amount of reactants and products are equal.

D) Dynamic equilibrium occurs when the rate of the forward reaction equals the rate of the reverse reaction.

E) The equilibrium constant for the forward reaction is equal to the equilibrium constant for the reverse reaction.

15) Which one of the following salts, when dissolved in water, produces the solution with a pH closest to 7.00?

A) NH_4ClO_4

B) $NaCO_3$

C) NaO

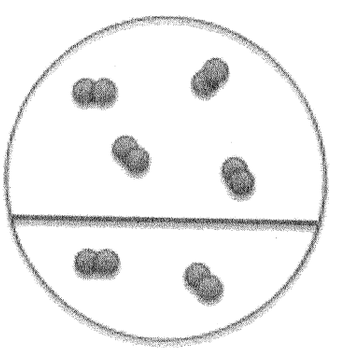
D) KI

Part II: Short Answer Problems
Answer the Questions Below in the Space Provided.

19. (a: 3 Marks) The addictive painkiller morphine ($C_{14}H_{19}NO_3$) is the principal molecule found in the milky juice that exudes from unripe poppy seed capsules. Calculate the pH of a 0.015 mol L^{-1} solution of morphine given that $K_b = 7.9 \times 10^{-7}$?

(b: 1 Mark) Does the autoionization of water contribute significantly to the $[OH^-]$ when the system is at equilibrium? Support your answer.

20. Gaseous O_2 in equilibrium with O_2 dissolved in water at 283 K is depicted at the right.



(a: 1 Mark) Which scene or scenes below (A, B or C) represents the system at 298 K?

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(b: 1 Mark) Which scene or scenes below (A, B or C) represents the system when the pressure of O_2 has been increased by half?

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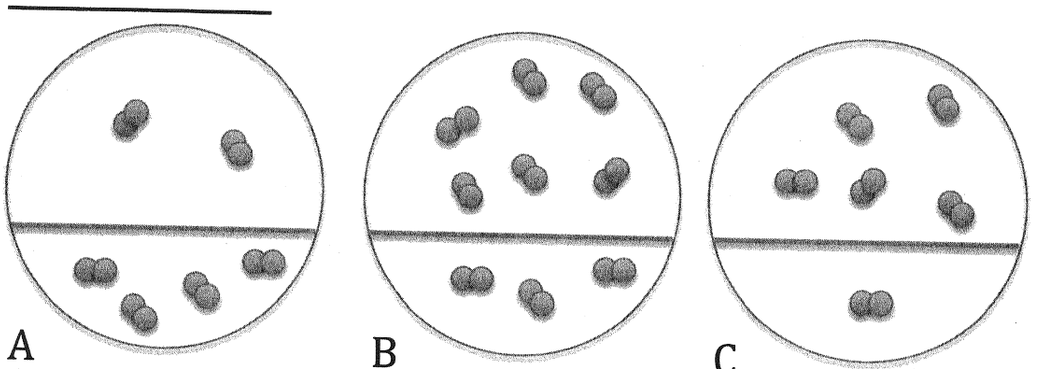

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21. (4 Marks) The equilibrium constant, K, for the Haber reaction is 2.81×10^{-5} at 472 °C. If a reaction starts with 3.0 bar of H_2 (g) and 5.0 bar of N_2 (g) at 472 °C, what is the equilibrium pressure of NH_3 (g)? Be sure to justify whether or not any assumptions made in the calculation are appropriate.

$$N_2\,(g) \quad + \quad 3\,H_2\,(g) \quad \rightleftharpoons \quad 3\,NH_3\,(g)$$