Chem30A, Fall12, FH College, LecExam3 Name KEY Section Thurs.

Read questions carefully to understand them before answering. No outside paper is allowed. Use the reverse side of your answer paper as scratch. For partial points, provide supporting evidence (structure or reason) next to the answer. Total points = 38 + (28 x 3) 84 = 122.

SHORT ANSWER. Be clear with your answer. If I don't understand what you are doing, then you will lose points. In calculation, write the set-up equation, put the raw data with units in the equation.

1) Given the hydrogen combustion reaction

$2\ H_2\ (g) + O_2\ (g) \rightarrow 2\ H_2O\ (g) \quad \Delta H = -483.6\ kJ$

Calculate the amount of heat (in kJ) produced when 1.6 kg of hydrogen is burned. (6 pts.)

1) 1.9×10^5 ~~3.9×10^5~~ kJ

$$1.6\ kg\ H_2 \times \left(\frac{1000\ g\ H_2}{1\ kg\ H_2}\right)\left(\frac{1\ mol\ H_2}{2.0\ g\ H_2}\right)\left(\frac{-483.6\ kJ}{2\ mol.\ H_2}\right) = -1.9 \times 10^5\ kJ$$

i.e. 1.9×10^5 kJ of heat is released

Volume!!

2) Calculate the amount of a 5% (w/v) acetic acid (CH_3CO_2H) needed to react with enough sodium bicarbonate ($NaHCO_3$) to produce 500.0 mL of carbon dioxide (CO_2) gas at 20°C and 760 mmHg pressure. (MW of CH_3CO_2H = 60 g/mol). The balanced chemical equation is:

$NaHCO_3\ (s) + CH_3CO_2H\ (aq) \longrightarrow CH_3CO_2Na\ (aq) + H_2O\ (l) + CO_2\ (g)$ (8 pts.)

excess

2) 25.0 mL.

$CO_2 \rightarrow V = 500\ mL = 0.500\ L$

$T = 20°C = (273.15 + 20)\ K = 293\ K$

$P = 760\ mmHg = 1\ atm$

using $PV = nRT$, $n = \frac{PV}{RT}$

$$\therefore \text{moles of } CO_2\ (n) = \frac{PV}{RT} = \frac{(1\ atm)(0.500\ L)}{0.0821\ atm \cdot L \cdot mol^{-1} \cdot K^{-1}(293\ K)} = 2.08 \times 10^{-2}\ mol\ CO_2$$

$$2.08 \times 10^{-2}\ mol\ CO_2 \left(\frac{1\ mol\ CH_3CO_2H}{1\ mol\ CO_2}\right)\left(\frac{60\ g\ CH_3CO_2H}{1\ mol\ CH_3CO_2H}\right)\left(\frac{100\ mL\ CH_3CO_2H}{5\ g\ CH_3CO_2H}\right) = 25.0\ mL$$

3) The following reaction is carried out in presence of iron catalyst:

$3\ H_2\ (g) + N_2\ (g) \longrightarrow 2\ NH_3\ (g)$ Write (next to the questions) if the reaction rate will increase or decrease or remain unchanged when following changes are made to the reaction conditions (2 pts each; total 6 pts.):

3) _____

(a) The temperature is raised from 600K to 700K: increase

(b) The iron catalyst is removed: decrease

(c) The concentration of hydrogen gas is halved: decrease

↑ rate: ↑ T
↑ [rea]
+ catalyst

4) At 318 mmHg of oxygen pressure in the atmosphere, the solubility of oxygen in the blood is 0.88 g per 0.1 L. Calculate the solubility of oxygen in the blood (per 0.1L) when the oxygen pressure is 112 mmHg (6 pts.).

4) 0.31g O_2/0.1L

Henry's law: $\frac{C_1}{P_1} = \frac{C_2}{P_2} = K$. where P = partial pressure

$C_1 = 0.88g\,O_2/0.1L$
$P_1 = 318\,mmHg$
$C_2 = ?$
$P_2 = 112\,mmHg$

$\therefore C_2 = \frac{C_1 P_2}{P_1} = \left(\frac{0.88g\,O_2}{0.1L}\right) \times \left(\frac{112\,mmHg}{318\,mmHg}\right) = \frac{0.88g\,O_2 \times \left(\frac{112}{318}\right)}{0.1L}$

$= \frac{0.31g\,O_2}{0.1L}$

5) In the reaction, SO_2 (g) + O_2 (g) ------> SO_3 (g), if $[SO_2]$ = 0.062 mol/L; $[O_2]$ = 0.538 mol/L and $[SO_3]$ = 0.938 mol/L, when equilibrium is reached at 727°C, then calculate the equilibrium constant for the reaction (6 pts.). [Note: the equation is not balanced].

5) 425

balanced Eq'n: $2\,SO_2(g) + O_2(g) \longrightarrow 2\,SO_3(g)$

$K = \left\{\frac{[SO_3]^2}{[SO_2]^2[O_2]^1}\right\}_{Eq} = \frac{(0.938\,mol/L)^2}{(0.062\,mol/L)^2(0.538\,mol/L)^1} = 425$ (K is unitless)

6) Calculate the molarity of a sulfuric acid (H_2SO_4) solution, when 1.178g of the acid is dissolved in water and diluted to a final volume of 25.0 mL. MW of H_2SO_4 = 98.1 g/mol (6 pts.)

6) 0.480 mol H_2SO_4/L

* Solution → V = 25.0mL = 25.0×10^{-3} L = 0.0250 L
* moles of H_2SO_4: $n = 1.178\,g_{H_2SO_4}\left(\frac{1\,mol.H_2SO_4}{98.1\,g_{H_2SO_4}}\right) = 0.0120\,mol.H_2SO_4$

$\therefore$ molarity = $\frac{n}{V} = \frac{0.0120\,mol\,H_2SO_4}{0.0250\,L} = 0.480\,\frac{mol\,H_2SO_4}{L}$

MULTIPLE CHOICE. On your scantron start from row 7. Choose the one alternative that best completes the statement or answers the question (3pts/each).

7) Consider the reaction shown: → release heat ∴ exothermic ΔH is ⊖ 7) _____

$$2\,CO\,(g) + O_2\,(g) \rightarrow CO_2\,(g) + 135.2\ kcal$$

This reaction is _____ because the sign of ΔH is _____.

A) exothermic; positive
B) endothermic; positive
C) exothermic; negative
D) endothermic; negative
E) exothermic; neither positive nor negative

8) All of the statements regarding the symbol "ΔH" are correct **except** 8) _____

A) It can be called heat of reaction. ✓
B) It represents the difference between the energy used in breaking bonds and the energy released in forming bonds in a chemical reaction.
C) It has a negative value for an exothermic reaction.
D) It can be called entropy change.
E) It can be called enthalpy change.

9) Entropy can be defined as 9) _____

A) the amount of energy required to initiate a reaction.
B) the amount of energy required to rearrange chemical bonds.
C) the state of equilibrium in a system.
D) the amount of disorder in a system.
E) the number of chemical bonds which are changed during a reaction.

10) If heat is consumed during a reaction, the reaction is said to be _____. 10) _____

A) endergonic
B) endothermic endothermic
C) exothermic
D) can't tell.
E) exothermic

11) Reaction rates are determined by all of the following factors **except** 11) _____

A) the activation energy of the reaction. True
B) the force of collisions between molecules.
C) the spontaneity of the reaction.
D) the number of collisions between molecules.
E) the orientation of collisions between molecules.

↑ rate: ↑T ↑[r] + cat

12) Which factors would increase the rate of a chemical reaction? 12) _____

I. Increasing the temperature ✓
II. Removing products as they are formed
III. Adding a catalyst ✓

A) I only
B) II only
C) II and III
D) I and II
E) I, II, and III

13) Which statement best describes the way a catalyst works? 13) _____

A) It decreases the value of ΔH.
B) It increases the value of ΔG.
C) It increases the value of E_{act}.
D) It increases the value of ΔH.
E) It decreases the value of E_{act}.

14) The position of the equilibrium for a system where $K = 4.6 \times 10^{-15}$ can be described as being favored to _____; the concentration of products is relatively _____. 14) _____

A) the right; small
B) the left; small
C) the left; large
D) the right; large
E) neither direction; large

15) Diatomic nitrogen is added to the equilibrium system: 15) _____

$$N_2(g) + H_2(g) \rightleftharpoons 2\,NH_3(g) + \text{heat}$$

When a new equilibrium is established the concentration of H_2 will be _____ the amount at the original equilibrium, and the amount of NH_3 will be _____ the amount at the original equilibrium.

A) less than; less than
B) greater than; greater than
C) greater than; less than
D) less than; greater than
E) Both changes will be impossible to determine.

16) In the following reaction, what is the effect of adding more NO_2 to the starting reaction mixture? 16) _____

$$2NO_2 \rightleftharpoons N_2O_4$$

A) It would decrease the final quantity of products.
B) It would make the reaction more endothermic.
C) It would slow the reaction down.
D) It would make the reaction more exothermic.
E) It would increase the final quantity of products.

$K << 1$ Rxn barely goes more reactants than products.

17) In the following reaction, K_c is much less than 1. At equilibrium, which of the following statements is true? 17) _____

$$COCl_2 \rightleftharpoons CO + Cl_2$$

A) At equilibrium, the concentrations of reactants and products are equal.
B) The concentrations of products and reactants are approximately equal.
C) The concentration of products is much greater than the concentration of reactants.
D) A catalyst will increase the concentration of products formed.
E) The concentration of reactant is much greater than the concentration of products.

18) The number of components in a solution is _____ 18) _____
A) 3 B) 5 C) at least 2. D) 6 E) 4

19) The solubility of gases in liquids 19) _____
A) increases as temperature increases and increases as pressure increases
B) is independent of temperature and increases as pressure increases
C) decreases as temperature increases and decreases as pressure increases
D) increases as temperature increases and decreases as pressure increases
E) decreases as temperature increases and increases as pressure increases

20) How many grams of NaOH are needed to make 750 mL of a 2.5% (w/v) solution? 20) _____
A) 7.5 g B) 19 g C) 20 g D) 3.9 g E) 50 g

21) Which information is necessary to determine the molarity of a solution if the chemical formula of the solute is known? 21) _____
A) the mass of solute dissolved and the final volume of the solution
B) the molar mass of both the solute and the solvent used
C) only the volume of solvent used
D) the mass of solute dissolved and the volume of solvent added
E) only the mass of solute dissolved

then you know molar mass

Still need to know volume of solution & mass of solute

$$750\,mL\left(\frac{2.5\,g\ NaOH}{100\,mL}\right) = 18.75\,g = 19\,g$$

$M = \frac{n}{V}$ ⇒ $n = \left(\frac{1.5 \text{ mol NaOH}}{L}\right) \times 0.05 L = 0.0075 \text{ mol}$

22) What is the final concentration of a solution prepared by adding water to 50.0 mL of 1.5 M NaOH to make 1.00 L of solution? 22) _____

A) 0.030 M B) 0.075 M C) 1.5 M D) 30 M E) 7.5 M

23) Red blood cells are placed in a solution and neither hemolysis nor crenation occurs. Therefore the solution is 23) _____

A) isotonic.
B) concentrated.
C) hypotonic.
D) hypertonic.
E) isotopic.

24) The H_3O^+ ion is called the _____ ion. 24) _____

A) protium
B) water
C) hydroxide
D) hydrogen
E) hydronium

25) A Bronsted-Lowry acid is a substance which 25) _____

A) donates protons to other substances.
B) accepts protons from other substances.
C) accepts hydronium ions from other substances.
D) produces hydroxide ions in aqueous solution.
E) produces hydrogen ions in aqueous solution.

26) Which of the following is a diprotic acid? 26) _____

A) acetic acid
B) nitric acid HNO_3
C) sulfuric acid H_2SO_4
D) hydrochloric acid HCl
E) phosphoric acid

H_2SO_4

27) What is the conjugate acid of HSO_4^-? 27) _____

A) SO_4^{2-} B) H_2SO_4 C) OH^- D) H_2SO_3 E) H_3O^+

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

28) The major component in a solution is called the solute. 28) B

29) The solubility of gases in water increases with increasing pressure above the water. 29) A

30) At equilibrium, the concentrations of the reactants and products are always equal. 30) B

31) A catalyst for a chemical reaction affects the magnitude of the equilibrium constant. 31) B

32) Evaporation is an endothermic process. 32) A

33) An Arrhenius base is a proton acceptor. (→ Bronsted-Lowry) 33) B

34) H_2SO_3 and H_2SO_4 are considered an acid-base conjugate pair. 34) B