

ANSWER KEY (PRINT)

LAST NAME, FIRST NAME

Academic Integrity is expected of everyone and anyone caught cheating will receive an F in the course.

A number 2 pencil must be used to fill out the Scantron form. If you must erase a mark on your Scantron form, please erase it completely. Write your name and section number on your Scantron form.

Equations and Constants

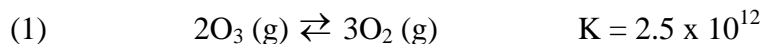
$$\text{pH} = -\log[\text{H}^+] \quad \text{pOH} = -\log[\text{OH}^-] \quad \text{pH} + \text{pOH} = 14 \quad \mathbf{K_a \cdot K_b = K_w}$$

$$\mathbf{K_w = 1.0 \times 10^{-14} \text{ (at } 25^\circ\text{C)}}$$

$$\mathbf{N_A = 6.022 \times 10^{23}}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

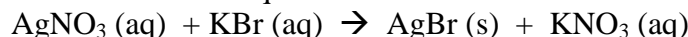
(4pts for each question, all or nothing, fill in your answers for questions 1-25 with a Number 2 pencil on the Scantron Answer Sheet) **ANSWERS ARE IN RED**



Consider a system at equilibrium based on the reaction above at a given temperature. In such a system, the concentration of $\text{O}_2(\text{g})$ is

- (A) constant and equal to the concentration of $\text{O}_3(\text{g})$
- (B) constant and less than the concentration of $\text{O}_3(\text{g})$
- (C) constant and greater than the concentration of $\text{O}_3(\text{g})$**
- (D) increasing and the concentration of $\text{O}_3(\text{g})$ is increasing
- (E) decreasing and the concentration of $\text{O}_3(\text{g})$ is increasing

(2) What is the net ionic equation for the reaction below?



- (A) $\text{K}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{KNO}_3(\text{s})$
- (B) $\text{Ag}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) + \text{K}^+(\text{aq}) + \text{Br}^-(\text{aq}) \rightarrow \text{AgBr}(\text{s}) + \text{K}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$
- (C) $\text{K}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{KNO}_3(\text{aq})$
- (D) $\text{AgNO}_3(\text{aq}) + \text{KBr}(\text{aq}) \rightarrow \text{AgBr}(\text{s}) + \text{KNO}_3(\text{aq})$
- (E) $\text{Ag}^+(\text{aq}) + \text{Br}^-(\text{aq}) \rightarrow \text{AgBr}(\text{s})$**

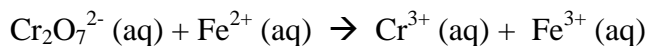
(3) SnCl_4 accepts two electron pairs and acts as

- (A) a Brønsted acid.
- (B) a Lewis acid.**
- (C) an Arrhenius base.
- (D) a Lewis base.
- (E) a Brønsted base.

(4) What volume of 0.306 M Na_2CO_3 solution can be prepared from 164 g of Na_2CO_3 ? (Molar Mass $\text{Na}_2\text{CO}_3 = 106.0 \text{ g/mol}$)

- (A) 1.55 L
- (B) 5.06 L**
- (C) 0.198 L
- (D) 2.11 L
- (E) 0.473 L

Problems 5 and 6 refer to the following reaction in acidic solution:



(5) What is the stoichiometric coefficient of H^+ in the balanced chemical equation for the following reaction in acidic solution?

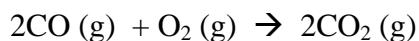
- (A) 1
- (B) 6
- (C) 7
- (D) 14**
- (E) H^+ does not appear in the balanced chemical equation

(6) Identify the reducing agent in the reaction

- (A) $\text{Cr}_2\text{O}_7^{2-}$
- (B) Fe^{2+}**
- (C) Cr^{3+}
- (D) Fe^{3+}
- (E) H_2O

(7) One of the functions of the catalytic converter in your car is to oxidize carbon monoxide to carbon dioxide. If 0.536 mol of carbon monoxide reacts with 0.281 mol of oxygen, how many grams of which compound remains unreacted?

(Molar Mass CO: 28.01 g/mol, Molar Mass O_2 : 32.0 g/mol)

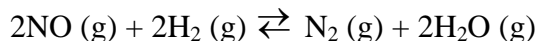


- (A) 0.42 g of oxygen remains unreacted**
- (B) 0.75 g of carbon monoxide remains unreacted
- (C) 7.1 g of carbon monoxide remains unreacted
- (D) 8.1 g of oxygen remains unreacted
- (E) 0.013 g of oxygen remains unreacted

(8) What is the pH of a 0.151 M solution of $\text{Sr}(\text{OH})_2$?

- (A) 0.82
- (B) 0.52
- (C) 13.48**
- (D) 13.18
- (E) 13.00

(9) The following reaction has an K_c value of 7.5×10^4 at a particular temperature:



At a given instant, the concentrations of the reactants and products are determined to be: $[\text{H}_2\text{O}] = 0.25\text{M}$, $[\text{N}_2] = 1.3\text{M}$, $[\text{NO}] = 0.19\text{M}$, $[\text{H}_2] = 0.08\text{M}$.

What is true about this reaction?

- (A) **The reaction is not at equilibrium and will shift to the right to reach equilibrium.**
- (B) The reaction is not at equilibrium and will shift to the left to reach equilibrium.
- (C) This reaction is at equilibrium.
- (D) Not enough information given to determine if reaction is at equilibrium.

(10) HSO_3^- has a K_a of 6.5×10^{-8} . What is the conjugate base of HSO_3^- and what is the value of K_b for the conjugate base?

- (A) H_2SO_3 , $K_b = 1.5 \times 10^{-7}$
- (B) H_2SO_3 , $K_b = 6.5 \times 10^6$
- (C) SO_3^{2-} , $K_b = 6.5 \times 10^6$
- (D) SO_3^{2-} , $K_b = 6.5 \times 10^{-22}$
- (E) **SO_3^{2-} , $K_b = 1.5 \times 10^{-7}$**

(11) The following data were collected at the endpoint of a titration performed to find the molarity of an HCl solution.

Volume of acid (HCl) used = 14.4 mL
Volume of base (NaOH) used = 22.4 mL
Molarity of standard base (NaOH) = 0.20M

What is the molarity of the acid solution?

- (A) 1.6M (B) 0.64M **(C) 0.31M** (D) 0.13M (E) 0.065M

(12) Polyethylene is a polymer consisting of only carbon and hydrogen. If 1.000g of the polymer is burned in oxygen it produces 1.285 g H_2O and 3.138 g CO_2 . What is the empirical formula for polyethylene? (Molar Mass H_2O : 18.01 g/mol, Molar Mass CO_2 : 44.0 g/mol)

- (A) $\text{C}_{22}\text{H}_{29}$
- (B) C_2H
- (C) C_2H_3
- (D) C_7H_8
- (E) **CH_2**

(13) Chemical equilibrium is the *result* of

- (A) a decrease in speed of reaction.
- (B) one reactant being completely consumed.
- (C) a stoppage of further reaction.
- (D) opposing reactions attaining equal rates.**
- (E) formation of products equal in mass to the reactants.

(14) According to the Brønsted–Lowry definition, which chemical species can function *both* as an acid and as a base?

- (A) Cl^- (B) SO_4^{2-} (C) NH_4^+ **(D) HCO_3^-** (E) H_3O^+

(15) What is the oxidation number of phosphorus in CaHPO_4 ?

- (A) -3 (B) -1 (C) +1 (D) +3 **(E) +5**

(16) The ions present in solid silver chromate Ag_2CrO_4 are

- (A) Ag^+ and CrO_4^{2-}**
- (B) Ag^{2+} and CrO_4^{4-}
- (C) Ag^+ , Cr^{6+} , and O^{2-}
- (D) Ag^+ , Cr^{3+} , and O^{2-}
- (E) Ag^+ and CrO_4^-

(17) What volume of 12.0 M HCl is needed to prepare 1.50 L of 0.300 M HCl?

- (A) 5.40 mL
- (B) 16.7 mL
- (C) 37.5 mL**
- (D) 600 mL
- (E) 60 mL

(18) The concentration of ions in a Na_2SO_4 solution is 1.5 M. (Na_2SO_4 is completely soluble.) What is the concentration of Na_2SO_4 in the solution?

- (A) 1.5 M (B) 1.0 M (C) 3.5 M **(D) 0.5 M** (E) 0.25 M

(19) Consider the following reaction: $2\text{CH}_4(\text{g}) \rightleftharpoons \text{C}_2\text{H}_6(\text{g}) + \text{H}_2(\text{g})$

K_c for this reaction is 9.5×10^{-8} at a given temperature. If the reaction vessel initially contains 0.018M CH_4 , what is the equilibrium concentration of C_2H_6 ?

- (A) **5.5×10^{-6} M**
- (B) 4.1×10^{-5} M
- (C) 0.018 M
- (D) 3.1×10^{-11} M

(20) Which statement below regarding acid-base chemistry is **incorrect**?

- (A) **The strength of an acid refers to the concentration of the aqueous acid solution.**
- (B) The pH at the equivalence point of a strong acid/strong base titration is always 7.
- (C) Acid-base indicators typically change color over a range of pH values.
- (D) Water acts as both a Brønsted acid and a Brønsted base when it reacts with itself.
- (E) All of the statements above are correct statements.

(21) Aqueous solutions of sodium iodide and lead (II) nitrate are mixed. What are the spectator ions in the resulting solution?

- (A) Na^+ and I^-
- (B) Pb^{2+} and I^-
- (C) **Na^+ and NO_3^-**
- (D) Pb^{2+} and NO_3^-
- (E) There are no spectator ions in solution.

(22) When 50 mL of 0.10 M HCl is mixed with 50 mL of 0.30 M NaOH, what is the approximate pH of the resulting solution?

- (A) 1 (B) 7 (C) 9 (D) 11 **(E) 13**

(23) The density of liquid carbon tetrachloride, CCl_4 , is 1.60 g/mL. How many moles of CCl_4 are there in a liter of pure CCl_4 ? (Molar Mass $\text{CCl}_4 = 153.8$ g/mol)

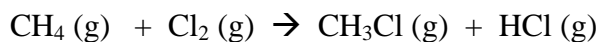
- (A) 11.3 mol (B) 33.7 mol **(C) 10.4 mol** (D) 23.7 mol (E) 9.50 mol

(24) Which of the following is a strong acid?

- (A) NH_4^+ ($K_a = 5.6 \times 10^{-10}$)
- (B) HCN ($K_a = 6.2 \times 10^{-10}$)
- (C) HNO_3 ($K_a \gg 1$)**
- (D) CH_3COOH ($K_a = 1.8 \times 10^{-5}$)
- (E) HF ($K_a = 6.8 \times 10^{-4}$)

(25) When 24.0 g of CH_4 reacts completely with excess chlorine yielding 44.2 g of HCl , what is the percent yield of the reaction?

(Molar Masses: CH_4 : 16.0 g/mol, HCl : 36.5 g/mol)



- (A) 80.7%**
- (B) 54.3%
- (C) 20.0%
- (D) 44.2%
- (E) 65.8%