

**PART I Multiple Choice** (45 pts.) Choose **one** correct answer for each of the following 15 questions.

- If 18.50 moles of  $\text{C}_2\text{Cl}_4(\ell)$  are required for a chemical reaction, determine the volume, in liters, of this liquid compound that are needed. The density of  $\text{C}_2\text{Cl}_4(\ell)$  is 1.63 g/mL and its MW = 165.8 g/mole.

  - 5.00 mL
  - 1.88 L
  - 5.00 L
  - 1.88 mL
  - none of the above
- An example of a **weak** electrolyte in aqueous solution is

  - only nitric acid solution
  - only ammonium chloride solution
  - only acetic acid solution
  - only sodium chlorate solution
  - more than one of the above
- How many **atoms** are in 75.0 g of nitrogen gas?

  - $1.61 \times 10^{24}$  atoms
  - $6.44 \times 10^{24}$  atoms
  - $6.32 \times 10^{24}$  atoms
  - $3.22 \times 10^{24}$  atoms
  - none of the above
- How many grams of Al metal,  $\text{Al}(s)$ , are needed to produce 100.0 g of  $\text{Al}_2(\text{SO}_4)_3(s)$  (FW = 342.17) from the reaction of aluminum metal with sulfuric acid?

  - 7.90 g
  - 316 g
  - 15.8 g
  - 31.6 g
  - none of the above
- A sample of  $\text{Mg}(\text{ClO}_3)_2$  (FW = 191.2) contains  $3.60 \times 10^{23}$  oxygen atoms. How many grams of chlorine atoms does the sample contain?

  - 21.2 g
  - 19.8 g
  - 7.1 g
  - 14.1 g
  - none of the above

6. An oxide of lead contains 90.65% Pb and 9.35% O by weight. Determine its empirical formula.

AW of Pb = 207.2 g/mole; AW of O = 16.0 g/mole

- A.  $\text{PbO}_2$   
B.  $\text{Pb}_2\text{O}_3$   
C.  $\text{PbO}$   
D.  $\text{Pb}_3\text{O}_4$   
E. none of the above
7. How many grams of magnesium (at.no.12) contain the same number of atoms as 20.04 g of calcium (at.no.20)?
- A. 24.30 g  
B. 40.08 g  
C. 12.15 g  
D. 48.60 g  
E. none of the above
8. The complete combustion of propane gas,  $\text{C}_3\text{H}_8(\text{g})$  with oxygen gas produces carbon dioxide and water. How many grams of  $\text{O}_2(\text{g})$  are required to burn 150 of propane?
- A. 545 g  
B. 109 g  
C. 1320 g  
D. 273 g  
E. none of the above
9. How many mL of water should be added to 25.0 mL of a stock 12.0 M  $\text{HCl}(\text{aq})$  solution to make 1.50 M  $\text{HCl}(\text{aq})$ ? Assume that the volumes are additive.
- A. 175 mL  
B. 200 mL  
C. 4.50 mL  
D. 275 mL  
E. none of the above
10. Element M forms an oxide,  $\text{M}_2\text{O}_3$ , that is 65.2% M and 34.8% oxygen by weight. The atomic mass (weight) of M is
- A. 52.0 g/mole  
B. 65.4 g/mole  
C. 45.0 g/mole  
D. 55.8 g/mole  
E. none of the above

11. How many mL of a 0.200 M NaOH(aq) solution contain 2.00 g NaOH (FW = 40.0)?
- A. 400 mL
  - B. 25.0 mL
  - C. 40 mL
  - D. 250 mL
  - E. none of the above
12. The element  ${}_{29}\text{Cu}$ , which has an average atomic mass of 63.546, consists of two isotopes: isotope A with an isotopic mass of 62.930 amu, and isotope B with an isotopic mass of 64.928 amu. The relative fractional abundance of the heavier isotope B is
- A. 0.36
  - B. 0.69
  - C. 0.64
  - D. 0.31
  - E. none of the above
13. What weight of  $\text{KClO}_3(\text{s})$  (FW = 122.55) contains 5.0 g of oxygen atoms?
- A. 1.99 g
  - B. 7.66 g
  - C. 12.77 g
  - D. 38.3 g
  - E. none of the above
14. Which of the following equations represents a redox reaction?
- 1.  $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$
  - 2.  $\text{CaO}(\text{s}) + \text{H}_2\text{O}(\ell) \rightarrow \text{Ca}(\text{OH})_2(\text{s})$
  - 3.  $2 \text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{SO}_3(\text{g})$
  - 4.  $\text{P}_4\text{O}_{10}(\text{s}) + 6 \text{H}_2\text{O}(\ell) \rightarrow 4 \text{H}_3\text{PO}_4(\text{aq})$
- A. one of the four reactions
  - B. two of the four reactions
  - C. three of the four reactions
  - D. four of the four reactions
  - E. none of the four reactions
15. If 26.32 mL of 0.10 M  $\text{H}_2\text{SO}_4(\text{aq})$  is neutralized by 34.56 mL of NaOH(aq) solution, determine the molarity of the NaOH(aq).
- A. 0.26 M
  - B. 0.15 M
  - C. 0.075 M
  - D. 0.13 M
  - E. none of the above

**PART IIA** (14 pts.)

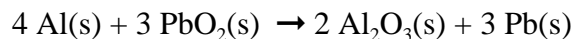
1. The common name of the symbol  ${}_{33}\text{As}$  is \_\_\_\_\_
2. The common name of the symbol  ${}_{27}\text{Co}$  is \_\_\_\_\_
3. The name of  $\text{Mn}_3(\text{PO}_4)_2$  is \_\_\_\_\_
4. The name of  $\text{SiF}_4$  is \_\_\_\_\_
5. The formula of iron(III) sulfide is \_\_\_\_\_
6. The formula of aluminum nitrite is \_\_\_\_\_
7. The oxidation state of Cr in  $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$  is \_\_\_\_\_

**PART IIB** (22 pts.)

1. (8 pts.)
  - A. 4.0 kilograms is equivalent to \_\_\_\_\_ nanograms.
  - B. The diameter of  $6.0\ \mu\text{m}$  (micrometers) of a red blood cell is equivalent to \_\_\_\_\_ picometers.
  - C. The density of a  $6.0\ \text{g}/\text{cm}^3$  is equivalent to \_\_\_\_\_  $\text{lb}/\text{m}^3$ , where 1.0 pound is equivalent to 454 grams.
  - D. If the mass of one atom of an element is  $1.709 \times 10^{-22}\ \text{g}$ , the identity (symbol) of the element is \_\_\_\_\_.
2. (6 pts.) For **one** particular  $\text{X}^{2+}$  ion with pure (100%) isotopic mass of 49.9621 amu which has 20 electrons.
  - A. The mass number is \_\_\_\_\_.
  - B. The number of protons is \_\_\_\_\_.
  - C. The number of neutrons is \_\_\_\_\_.
3. (8 pts.)
  - A. The J.J. Thomson cathode ray experiment in 1897 determined the \_\_\_\_\_ of an electron.
  - B. The R. Millikan oil drop experiment in 1909 determined the \_\_\_\_\_ of an electron.
  - C. The E. Rutherford scattering experiment in 1911 involving the bombardment of gold foil with alpha  ${}^4_2\text{He}^{2+}$  particles determined the \_\_\_\_\_.
  - D. Isotopes and their relative fractional abundances of an element were determined from analytical measurements with \_\_\_\_\_.

**PART IIC** (7 pts.) For the problem below, show all of your work (including units) for credit.

1. Aluminum metal reacts with  $\text{PbO}_2(\text{s})$  to give  $\text{Al}_2\text{O}_3(\text{s})$  and  $\text{Pb}(\text{s})$  in accordance with the following balanced equation.



In one experiment, 200 g of  $\text{Al}(\text{s})$  and 400 g of  $\text{PbO}_2(\text{s})$  are mixed and allowed to react by ignition to form the above products.

A. The limiting reactant (reagent) is \_\_\_\_\_.

B. Calculate the maximum number of atoms of solid lead,  $\text{Pb}(\text{s})$  formed by the above reaction.

answer \_\_\_\_\_

C. The reducing agent in the above redox reaction is \_\_\_\_\_.

**PART IID** (15 pts.) Write a **balanced net** equation for each of the following. If no reaction occurs, write NO REACTION as the final answer in the space provided.

**Hint:** Initially write a balanced molecular equation and then the corresponding net equation.

1. (3 pts.) Electrolysis of liquid water to give hydrogen and oxygen gases (demo).
2. (3 pts.) Preparation of aqueous ammonium nitrate solution from acid/base reaction.
3. (3 pts.) Formation of magnesium chlorate(aq) from a reaction producing carbon dioxide gas.
4. (3 pts.) Zinc metal is added to hydrochloric acid (demo). Note that  $\text{ZnCl}_2$  is soluble in  $\text{H}_2\text{O}(\ell)$ .
5. (3 pts.) Milk of magnesia (magnesium hydroxide) is taken to reduce acidity of hydrochloric acid (demo) in stomach. Note that  $\text{MgCl}_2$  is soluble in  $\text{H}_2\text{O}(\ell)$ .