

Part 1. (40 pts, 2 pts each) SHORT ANSWERS

1. What is the standard for the atomic weight scale?

^{12}C (= 12.000...)

2. What information was learned through Rutherford's experiment involving α particles deflected by a thin gold foil?

nuclear atom
small massive nucleus, electrons occupy most of volume

3. How many neutrons are there in the nucleus of an atom of ^{32}S ?

mass no (32) - at no (16) =

16

4. The halogens are in what group in the periodic table?

7A

5. Identify one chemical property of water.

(electrolysis $\rightarrow \text{H}_2 + \text{O}_2$)
reaction with Na
other answers are possible

6. Boron exists as two isotopes, ^{10}B and ^{11}B . Estimate the % abundance of ^{10}B (at. wt. = 10.8)

0 20% 40% 60% 80% 100%

7. 8. Which has a larger number of oxygen atoms, 2.0 mol of SO_2 or 0.50 mol of P_4O_{10} ?

4.0 mol O atoms 5 mol O atoms

P_4O_{10}

8. How many protons and electrons are there in one Mg^{2+} ion?

Protons 12 electrons 10

9. What is the formula for the ionic compound containing calcium and sulfate ions?

CaSO_4

10. Which of the following are metals (circle all correct answers)?

Sc Si S Sr Se

(Estimated time for this page is 5 minutes)

11. In the reaction $\text{Fe}_2\text{O}_3 + 2 \text{Al} \rightarrow \text{Al}_2\text{O}_3 + 2 \text{Fe}$ what element is reduced? Fe

12. Write a balanced equation for the reaction of magnesium and oxygen. $2 \text{Mg} + \text{O}_2 \rightarrow 2 \text{MgO}$

13. Which 1.0 g sample of a group 2A metal chloride contains the largest number of moles? (Circle answer) BeCl_2 MgCl_2 CaCl_2 SrCl_2 BaCl_2

14. Which of the following compounds is/are ionic? (Circle all correct answers) NaCl MgCl_2 AlCl_3 SiCl_4 PCl_3 SCl_2 Cl_2

15. True or False? To prepare 0.50 L of 0.20 M solution of NaOH, you should dissolve 0.10 mol of NaOH in exactly 500. mL of water. T or F

16. Which of the following are strong acids? (Circle all correct answers) HCl H_2S HCN HAc HClO_4

17. What is the oxidation number of P in P_4O_{10} ? +5

18. You mix 1.0 g of Fe and 1.0 g of S and allow them to react ($\text{Fe} + \text{S} \rightarrow \text{FeS}$). Which is the limiting reagent in this reaction? Fe
55.8 g/mol *32 g/mol* — fewer moles of Fe

19. Ozone is an allotrope of oxygen. Give the formula for the most common allotrope of this element. O_2

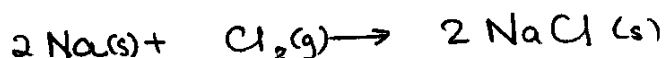
20. By balancing the deflection of a beam of charged particles in a cathode ray tube using electric and magnetic fields, scientists were able to identify what property of these particles? e/m
 (change to mass ratio)

(Estimated time for this page is 7 minutes)

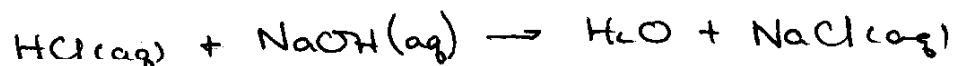
PART 2 (14 pts) REACTIONS, EQUATIONS

1. (6 pts) Write chemical equations for three reactions in which NaCl is a product. You may select any reagents as reactants. Label all reactants and products with appropriate symbols representing states (s, l, g, or aq).

a) A reaction between elements forming NaCl



b) An acid-base reaction forming an aqueous solution of NaCl

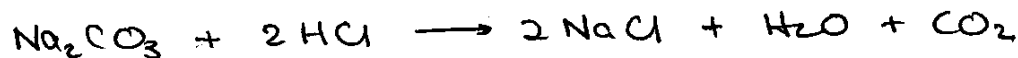


c) A precipitation reaction leaving an aqueous solution of NaCl.

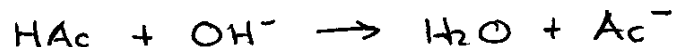


2. (4 pts) Write the appropriate equations illustrating the following. Choose the reactants based on the question.

a) A molecular equation for a gas forming reaction.



b) The net ionic equation for reaction between any weak acid and aqueous KOH.



3. (4 pts) In the reaction $\text{CuO}(s) + \text{H}_2(g) \rightarrow \text{Cu}(s) + \text{H}_2\text{O}(g)$

What is the reducing agent?

H₂

What is the change in oxidation number of each atom of the element being oxidized?

From 0 to +1

(Estimated time for this page is 12 minutes)

PART 3. (18 pts, 6 pts each) DO 3 OUT OF 4 PROBLEMS ON THIS PAGE. If you do 4 only the first 3 will count. (Show work)

1. Calculate the percent nitrogen in $\text{Ca}(\text{NO}_3)_2$.

Ca	40.08	$\% \text{N} = \frac{28.02}{164.09} (100\%)$
2 N	28.01	
6 O	<u>96.00</u>	
	164.09	

$\% \text{N} \underline{\hspace{2cm} 17.10 \% \hspace{2cm}}$

2. How many molecules of water are there in 1.000 g of water?

$$1.000 \text{ g H}_2\text{O} \left(\frac{1 \text{ mol H}_2\text{O}}{18.02 \text{ g H}_2\text{O}} \right) \left(\frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mole}} \right)$$

of molecules 3.342×10^{22} molecules

REMINDER: do only 3 problems on this page.

3. What mass of $\text{O}_2(\text{g})$ is required to form 0.24 moles of Al_2O_3 ? ($4 \text{ Al} + 3 \text{ O}_2 \rightarrow 2 \text{ Al}_2\text{O}_3$)

$$0.24 \text{ mol Al}_2\text{O}_3 \left(\frac{3 \text{ mol O}_2}{2 \text{ mol Al}_2\text{O}_3} \right) \left(\frac{32 \text{ g O}_2}{1 \text{ mol O}_2} \right) = 11.52 \text{ g} \quad (2 \text{ sig figs})$$

Mass O_2 required 12g (11.5 g)

4. A 10.0 mL sample of 2.0 M HNO_3 is diluted in water to give 500. mL of solution. What is the molarity of HNO_3 in the dilute solution?

$$M \times V = M \times V$$

$$2.0 \times 10.0 = M \times 500.$$

$$M = 0.040$$

Concentration 0.040 M

(Estimated time for this page is 10 minutes)

6. (6 pts) You have a cube of gold with a volume of 1.00 cm^3 . What 3 pieces of information do you need to find to calculate how many atoms are in this sample?

look up

1) density of Au

2) atomic wt of Au (molar mass)

3) Avogadro's No

7. (6 pts) You have an irregular shaped piece of one of the substances listed below. To determine its identity you decide to measure the density. The mass is 21.16 g ; the volume was found by immersing it in water in a graduated cylinder, in which the water level rose from 12.9 mL to 15.3 mL . ($1 \text{ mL} = 1 \text{ cm}^3$) The last 3 entries are alloys of Ni, Cu, and another metal; the percent Ni is given in parentheses for use in the problem on the next page. (Work must be shown)

1. Nickel, 8.89 g/cm^3
2. Monel, 8.84 g/cm^3 (Ni, 60%, Cu, 33%, Fe, 7%)
3. Nickel silver, 8.75 g/cm^3 (Ni, 52%, Cu 52%, Zn 26%)
4. German silver, 8.45 g/cm^3 (18% Ni; 65% Cu, 17% Zn)

Calculate the density: Can you identify the metal from the density? Can you eliminate any as possibilities?

$$d = \frac{\text{mass}}{V} = \frac{21.16 \text{ g}}{2.4 \text{ cm}^3} = 8.8 \text{ g/cm}^3 \quad \left(\begin{array}{l} \text{between} \\ 8.7 \text{ g/cm} \text{ and } 8.9 \text{ g/cm} \end{array} \right)$$

Density: 8.8 g/cm^3

Identify the metal? no Eliminate any? # 4

(Estimated time for this page is 10 minutes)

MORE PROBLEMS.

8. (8 pts) Having been unsuccessful in determining which metal was present from its density, you decide to do an experiment to determine ~~composition~~ ^{of Ni in the sample of metal.} Ni, as it happens, can be converted to a brick-red, insoluble compound, nickel bis(dimethylglyoxime), $\text{Ni}(\text{C}_4\text{H}_7\text{N}_2\text{O}_2)_2$ (molar mass = 288.9) You dissolve the 21.16 g piece of the metal in a mixture of acids, then add a solution containing an excess of dimethylglyoxime, precipitating, collecting, and weighing 54.2 g of the brick-red product. Calculate the % Ni in the sample, and from this value identify the metal from the list ~~above~~ ^{below}. (Work must be shown.) _{of metal}

Calc. mass of Ni in 54.2g ppt; then calc %

$$54.2\text{g ppt} \left(\frac{1\text{mol ppt}}{288.9\text{g ppt}} \right) \left(\frac{1\text{mol Ni}}{1\text{mol ppt}} \right) \left(\frac{58.69\text{g Ni}}{1\text{mol Ni}} \right) = 11.01\text{g}$$

$$\% \text{ Ni} = \frac{11.01\text{g}}{21.16\text{g}} (100\%) = 52\%$$

% Ni 52%

Identity (use data below) # 3

1. Nickel 8.89 g/cm³
2. Monel, 8.84 g/cm³ (Ni 60%, Cu, 33%, Fe, 7%)
3. Nickel silver, 8.75 g/cm³ (Ni, 52%, Cu 52%, Zn 26%)
4. German Silver, 8.45 g/cm³ (18% Ni; 65% Cu, 17% Zn)

(Estimated time for this page is 8 minutes)

DO ONLY ONE OF THE PROBLEMS ON THIS PAGE

9. (8 pts) A reaction was carried out, using 4.25 g Al foil and 18.0 g of Cl₂. Calculate the theoretical yield of AlCl₃. (2 Al + 3 Cl₂ → 2 AlCl₃). (Work must be shown)

$$\begin{aligned} \text{mol Al} &= 4.25 \text{ g} \left(\frac{1 \text{ mol}}{26.98 \text{ g}} \right) = 0.1575 \text{ mol Al} \\ \text{mol Cl}_2 &= 18.0 \text{ g} \left(\frac{1 \text{ mol}}{70.9 \text{ g}} \right) = 0.2539 \text{ mol Cl}_2 \end{aligned}$$

Assuming Al limiting; Cl₂ required is 0.1575 mol Al $\left(\frac{3 \text{ mol Cl}_2}{2 \text{ mol Al}} \right)$ = 0.2363 mol Cl₂ would be needed (thus Cl₂ is in excess) Al is limiting reactant

$$0.1575 \text{ mol Al} \left(\frac{2 \text{ mol AlCl}_3}{2 \text{ mol Al}} \right) \left(\frac{133.3 \text{ g AlCl}_3}{1 \text{ mol}} \right) = 20.99 \text{ g}$$

(3 sig figs - round off)

Yield 21.0 g

REMINDER: do only 1 problem on this page

10. (8 pts) A 3.48 g sample of an unknown metal reacts with oxygen to form 3.96 g of an oxide known to have the formula MO₂. Calculate the atomic weight of M and from this determine the identity of M. (O = 16.00) (Work must be shown)

0.48 g Oxygen (3.96 - 3.48)

$$\frac{\text{mass } 1 \text{ M}}{\text{mass } 2 \text{ O}} = \frac{3.48}{0.48} = 7.25$$

so

$$\frac{\text{mass } 1 \text{ M}}{\text{mass } 1 \text{ O}} = 14.5$$

given O = 16
atomic wt of M
is 14.5 x 16 = 232

Atomic wt of M 232

Identity of M Th

(Estimated time for this page is 8 minutes)