RLP-CHEMA · RLP Chemistry A — Atoms, Bonding, Reactions, Gases and Solutions

Unit 3: Reactions, the Mole and Stoichiometry

Practice Workbook. The same problems, in the same order, as the Practice sections of the online lessons.

Name _____ Period _____

Lesson 3.1 — Missouri Lead: Writing, Naming and Balancing Reactions

FLUENCY

1. Name Fe_2O_3, showing how you decide the charge on iron.

2. Write the formula for sodium sulfate.

3. Balance: $Fe + O_2 \rightarrow Fe_2O_3$

4. Balance: $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

5. Classify: $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

6. Balance: $PbS + O_2 \rightarrow PbO + SO_2$

APPLICATION

7. Predict the products of H_2SO_4 + NaOH (a double replacement that gives a salt and water) and balance the equation.

8. Aluminum has three outer electrons. Use that to write the formula and name of the compound it forms with oxygen.

9. Lead(II) carbonate, $PbCO_3$, is heated and breaks into a lead oxide and a gas. Name the type of reaction, predict the products and write the balanced equation.

10. Count every kind of atom on each side of $2PbS + 3O_2 \rightarrow 2PbO + 2SO_2$ and state the total number of atoms on each side.

CHALLENGE

11. Balance the lead-acid battery discharge: $Pb + PbO_2 + H_2SO_4 \rightarrow PbSO_4 + H_2O$, and give the atom count for each element on both sides.

12. Balance: $C_4H_{10} + O_2 \rightarrow CO_2 + H_2O$ (use whole-number coefficients).

REVIEW

13. Sodium has one outer electron and sulfur has six. Predict the ion charges and the formula of sodium sulfide.

14. A lead-207 atom has atomic number 82. How many protons, neutrons and electrons does the neutral atom have?

Lesson 3.2 — Sealed Bag, Open Cup: Conservation of Mass and the Mole

FLUENCY

1. Find the molar mass of $NaHCO_3$.
2. Find the molar mass of CO_2.
3. Find the molar mass of H_2O.
4. How many moles are in 25.0 g of water?
5. What is the mass of 0.500 mol of CO_2?

6. How many molecules are in 0.500 mol of CO_2?

APPLICATION

7. In the lab, 2.0 g of baking soda reacts completely with vinegar ($NaHCO_3 + CH_3COOH \rightarrow CH_3COONa + H_2O + CO_2$). Predict the mass of CO_2 released.

8. A student reacts 3.0 g of baking soda with plenty of vinegar. Predict the mass of CO_2 and say what the scale does for an open cup and a sealed bag.

9. An open-cup trial of the 2.0 g reaction lost 0.9 g. What percent of the predicted CO_2 mass was lost?

10. A sealed bag started at 139.0 g with 2.0 g of baking soda and 30 mL of vinegar inside. What mass should the scale read when the fizzing stops, and what mass of CO_2 is inside?

CHALLENGE

11. A student uses only 1.0 g of baking soda with 30 mL of vinegar (assume 1.5 g of acetic acid, 60.052 g/mol). Which reactant limits the reaction, and what mass of CO_2 forms?

12. Account for every gram when 4.0 g of baking soda reacts with 1.5 g of acetic acid (acid is limiting). Give the mass of CO_2, H_2O and CH_3COONa formed, the mass of baking soda left over, and show the total equals the reactants.

REVIEW

13. Balance and classify: $NaHCO_3 + CH_3COOH \rightarrow CH_3COONa + H_2O + CO_2$. Count the atoms of each element on each side.

14. Predict the products of Mg + 2HCl and write the balanced equation (a single replacement; magnesium is more reactive than hydrogen).

Lesson 3.3 — Which Reactant Runs Out? Limiting Reagent and Percent Yield

FLUENCY

1. For $2H_2 + O_2 \rightarrow 2H_2O$ with 4.0 mol H_2 and 3.0 mol O_2, find the limiting reagent, the moles of water and the moles of excess left.

2. A reaction has a theoretical yield of 8.0 g and an actual yield of 7.2 g. What is the percent yield?

3. A run has a percent yield of 75.0% and an actual yield of 45.0 g. What was the theoretical yield?

4. For $N_2 + 3H_2 \rightarrow 2NH_3$ with 2.00 mol N_2 and 5.00 mol H_2, find the limiting reagent, moles of NH_3 and moles of N_2 left.

5. A student reports a percent yield of 112%. Give two reasonable explanations that do not break conservation of mass.

6. A batch has a theoretical yield of 4.00 g and an actual yield of 3.40 g. What is the percent yield?

APPLICATION

7. A reactor receives 56.0 g N_2 and 10.0 g H_2. Find the limiting reagent and the theoretical yield of NH_3.

8. The reactor above delivers 48.0 g of NH_3. What is the percent yield, and what mass of N_2 is left over (to 3 significant figures)?

9. Use the batch table in this lesson's reading. For Batch C, name the limiting reagent, the theoretical yield, the percent yield and the mass of excess reagent.

10. Using Batch B in the reading: how many kilograms of nitric acid are left unreacted, and what does that tell you about adding more nitric acid?

CHALLENGE

11. A two-step process has a 92.0% yield for roasting and a 95.0% yield for reduction. What is the overall percent yield, and how much lead would 1,000 kg of pure PbS give (theoretical lead is 866.0 kg)?

12. A plant needs 1,000 kg of NH_4NO_3 at a 96.0% yield, with nitric acid in excess. What mass of NH_3 must it feed?

REVIEW

13. Convert 250.0 g of $NaHCO_3$ to moles.

14. Balance $NH_3 + O_2 \rightarrow NO + H_2O$.

Lesson 3.4 — The Mole Bridge: Mass-to-Mass Stoichiometry for Missouri Lead

FLUENCY

1. For $2PbS + 3O_2 \rightarrow 2PbO + 2SO_2$, how many moles of Pb can 5.00 mol of PbS give?
2. For the same equation, how many moles of O_2 react with 4.00 mol of PbS?
3. What is the mass of 2.50 mol of H_2SO_4?
4. How many moles are in 500.0 g of lead?
5. What is the mass of 3.00 mol of PbS?

6. In $Pb + PbO_2 + 2H_2SO_4 \rightarrow 2PbSO_4 + 2H_2O$, how many moles of H_2SO_4 react with 1 mol of Pb, and is that ratio also the mass ratio?

APPLICATION

7. What mass of lead can 1,000 kg of pure PbS give at most?

8. What mass of SO_2 is released when 1,000 kg of pure PbS is roasted?

9. A recycler recovers lead from 1.00 kg of $PbSO_4$. What mass of lead does it hold?

10. Using $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$, find the mass of NaOH needed and Na_2SO_4 formed from 1.00 kg of H_2SO_4.

CHALLENGE

11. 1.00 kg of lead in a battery plate reacts in $Pb + PbO_2 + 2H_2SO_4 \rightarrow 2PbSO_4 + 2H_2O$. Find the mass of H_2SO_4 used and $PbSO_4$ formed.

12. For the same 1.00 kg of lead, calculate the mass of PbO_2 consumed and the mass of water formed, then show that reactant mass equals product mass.

REVIEW

13. A cell has 3.00 mol Pb and 5.00 mol H_2SO_4 with plenty of PbO_2. Using $Pb + PbO_2 + 2H_2SO_4 \rightarrow 2PbSO_4 + 2H_2O$, find the limiting reagent and the mass of $PbSO_4$ formed.

14. A recycler recovers 0.640 kg of lead from 1.00 kg of $PbSO_4$. What is the percent yield (theoretical lead is 0.683 kg)?

Unit 3 checkpoint

1. Which equation is balanced?
   A. Fe + O₂ → Fe₂O₃
   B. 4Fe + 3O₂ → 2Fe₂O₃
   C. 2Fe + 3O₂ → 2Fe₂O₃
   D. 4Fe + 2O₂ → 2Fe₂O₃
2. What is the name of the lead compound PbO₂?
   A. lead(II) oxide
   B. lead(IV) oxide
   C. lead(II) dioxide
   D. lead peroxygen
3. True or false: To balance an equation you may change a subscript when it is convenient.
4. What is the molar mass of CO₂ (C 12.011, O 15.999)?
   A. 28.010 g/mol
   B. 44.009 g/mol
   C. 76.007 g/mol
   D. 40.021 g/mol
5. The number of moles in 25.0 g of water is _____ mol (to 4 significant figures).
6. True or false: An open cup of vinegar and baking soda loses mass because atoms are destroyed.

7. In N₂ + 3H₂ → 2NH₃, 3.00 mol N₂ reacts with 6.00 mol H₂. Which reactant limits, and how many moles of NH₃ form?
   A. N₂ limits; 6.00 mol NH₃
   B. H₂ limits; 4.00 mol NH₃
   C. H₂ limits; 6.00 mol NH₃
   D. neither limits; 9.00 mol NH₃

8. A run with a theoretical yield of 4.00 g and an actual yield of 3.40 g has a percent yield of _____ %.

9. What mass of lead can 1,000 kg of pure PbS give at most?
   A. 866.0 kg
   B. 1,154.7 kg
   C. 500.0 kg
   D. 207.2 kg

10. True or false: The coefficients in a balanced equation give the ratio of masses of the substances.

11. What percent of the mass of NH₄NO₃ is nitrogen?
   A. 35.0%
   B. 82.2%
   C. 17.5%
   D. 50.0%

12. At 169 lb of nitrogen per acre, one acre needs _____ kg of NH₃ to supply that nitrogen (to 3 significant figures).