RLP-PSA · RLP Physical Science A — Matter, Bonding, Reactions and the Nucleus

Unit 3: Chemical Reactions, Conservation of Mass and the Mole

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

Name _____ Period _____

Lesson 3.1 — Rust on a St. Louis Bridge: Evidence of Chemical Change

FLUENCY

1. Balance: $Al + O_2 \rightarrow Al_2O_3$

2. Balance: $Na + Cl_2 \rightarrow NaCl$

3. Balance: $CH_4 + O_2 \rightarrow CO_2 + H_2O$

4. Balance: $N_2 + H_2 \rightarrow NH_3$

5. Count the atoms of each element on both sides of $2H_2O_2 \rightarrow 2H_2O + O_2$. Is it balanced?

6. Which of these is evidence of a chemical change: ice melting, sugar dissolving, a nail rusting, a gas forming when vinegar meets baking soda, water boiling?

APPLICATION

7. Backyard grills burn propane: $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$. Balance the equation and give the atom count for each side.

8. Use outer electrons to explain why sodium and chlorine form NaCl and why the equation needs 2Na for each Cl_2.

9. Explain why a steel guardrail on a Missouri highway overpass, splashed with salty slush every winter, rusts faster than an identical railing on a sheltered porch that never touches road salt.

CHALLENGE

10. Rust often forms as iron(III) hydroxide. Balance: $Fe + H_2O + O_2 \rightarrow Fe(OH)_3$

REVIEW

11. Convert 37 mL to L.

12. Electronegativities: O 3.44, H 2.20. Classify the O–H bond.

13. Predict the formula of the compound of calcium and chlorine.

Lesson 3.2 — Sealed-Bag Conservation of Mass

FLUENCY

1. A sealed bag reads 186.3 g before and 186.2 g after the reaction. The scale reads to ±0.1 g. Is mass conserved within the uncertainty?

2. An open cup reads 98.7 g before and 97.8 g after. What is the mass change?

3. Is a sealed zip-top bag an open or a closed system? Can energy pass through it?

4. Name the gas produced when baking soda reacts with vinegar.

5. Count the atoms on each side of $NaHCO_3 + CH_3COOH \rightarrow NaCH_3COO + H_2O + CO_2$.

APPLICATION

6. Six trials' open-cup changes (g) were −0.9, −0.8, −1.0, −0.7, −0.9, −0.8, and their sealed-bag changes were 0.0, −0.1, −0.2, 0.0, −0.1, 0.0 (illustrative data). Find both averages and state what they show.

7. The maximum CO_2 from 2.0 g of baking soda is 1.05 g. An open cup lost 0.9 g. What percentage of the maximum escaped, and give one reason it is less than 100%.

8. A student's sealed bag lost 0.6 g and they heard a hiss while tipping it. What is the most likely error, and how would you redesign the trial?

CHALLENGE

9. 2.0 g of baking soda makes about 0.58 L of CO_2, and air has a density of about 1.2 g/L. Estimate how much lighter a fully inflated bag could read because of buoyancy, and explain why this does not mean mass was lost.

REVIEW

10. What is the mass of 20.0 cm^3 of olive oil (density 0.92 g/cm^3)?

11. Why does salt water conduct electricity but sugar water does not?

Lesson 3.3 — Hand Warmers and Cold Reactions: Energy in Bonds

FLUENCY

1. A reaction mixture's temperature falls from 21.5 °C to 17.8 °C. Is the reaction exothermic or endothermic? By how much did the temperature change?
2. Does breaking a bond absorb or release energy? Does forming one absorb or release?
3. Using H–H 436, O=O 498 and O–H 464 kJ/mol, find the energy to break the bonds in $2H_2 + O_2$.
4. Using O–H 464 kJ/mol, find the energy released forming the bonds in $2H_2O$.
5. A reaction's bond calculation gives +120 kJ. Will the surroundings warm or cool?

APPLICATION

6. Estimate the energy change for $N_2 + 3H_2 \rightarrow 2NH_3$ using N≡N 946, H–H 436 and N–H 390 kJ/mol. Is it exothermic or endothermic?

7. Splitting water, $2H_2O \rightarrow 2H_2 + O_2$, is the reverse of burning hydrogen. Use the bond energies above to find its energy change and explain why electrolysis of water needs a steady energy supply.

8. A hand warmer's temperature rose from 20 °C to 52 °C in 5 minutes. Write a claim, evidence and reasoning explaining the rise with the bond-energy model.

CHALLENGE

9. Burning hydrogen releases about 486 kJ per 4.032 g of H_2 (2 mol), and burning methane about 806 kJ per 16.04 g of CH_4 (1 mol), by the bond-energy estimate. Compare the energy released per gram and suggest one reason hydrogen is attractive as a vehicle fuel and one engineering difficulty.

REVIEW

10. Convert 25 m/s to km/h.

11. Balance: $2Mg + O_2 \rightarrow ___MgO$

Lesson 3.4 — Counting Atoms by Weighing: The Mole

FLUENCY

1. What is the mass of 2.0 mol of $CaCO_3$?

2. How many moles are in 10.0 g of H_2SO_4?

3. How many molecules (or formula units) are in 2.5 mol of MgO? (Avogadro's number = 6.022×10^{23})

4. Find the molar mass of CH_4.

5. For the balanced reaction $4Fe + 3O_2 \rightarrow 2Fe_2O_3$, what mass of Fe_2O_3 forms from 50.0 g of Fe, assuming Fe is the limiting reactant?

6. For the balanced reaction $4Fe + 3O_2 \rightarrow 2Fe_2O_3$, what mass of Fe_2O_3 forms from 25.0 g of Fe, assuming Fe is the limiting reactant?

APPLICATION

7. How much CO_2 can 3.0 g of baking soda ($NaHCO_3$, 84.006 g/mol) produce with excess vinegar? (CO_2 44.009 g/mol)

8. A 5.00 g steel wool pad (treat as pure iron) rusts completely to Fe_2O_3. Find the mass of rust and the mass of oxygen taken from the air.

9. Propane burns: $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$. For 88.2 g of propane (44.097 g/mol), find the masses of O_2 used and of CO_2 and H_2O produced, and show that mass is conserved. (O_2 31.998, CO_2 44.009, H_2O 18.015 g/mol)

CHALLENGE

10. A group puts 2.0 g of baking soda (0.0238 mol) with only 10 mL of 5% vinegar (about 0.50 g of acetic acid, 60.052 g/mol) in a sealed bag. Which reactant is limiting, and what mass of CO_2 forms?

REVIEW

11. What is the mass of 5.0 cm^3 of granite (density 2.75 g/cm^3)?

12. Explain why water boils at a much higher temperature than methane even though both are small molecules.

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. In rusting, iron atoms
   A. gain electrons
   B. lose electrons to oxygen
   C. share electrons equally with oxygen
   D. become a different element
3. An open cup of vinegar and baking soda loses mass during the reaction because
   A. atoms are destroyed
   B. carbon dioxide gas escapes
   C. the balance is broken
   D. water evaporates instantly
4. True or false: A nail gains mass as it rusts.
5. A reaction is exothermic when
   A. the bonds broken are stronger in total than the bonds formed
   B. the bonds formed are stronger in total than the bonds broken
   C. no bonds are broken
   D. it happens in a sealed bag
6. Broken bonds total 1,370 kJ and formed bonds total 1,856 kJ, so the energy change is _____ kJ.
7. True or false: Breaking chemical bonds releases energy.
8. What is the molar mass of CO₂ (C 12.011, O 15.999)?
   A. 28.01 g/mol
   B. 44.01 g/mol
   C. 60.01 g/mol
   D. 32.00 g/mol

9. In 2H₂ + O₂ → 2H₂O, how many moles of water form from 3.0 mol of H₂ with excess O₂?
   A. 1.5 mol
   B. 3.0 mol
   C. 6.0 mol
   D. 2.0 mol
10. The reactant that runs out first and limits the amount of product is the _____ reactant.
11. Zinc galvanizing protects steel because
   A. zinc is less reactive than iron
   B. zinc gives up electrons more easily than iron, so it corrodes first
   C. zinc reflects oxygen
   D. zinc is a nonmetal
12. True or false: One mole of iron atoms has a mass of about 55.8 g.

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