LESSON MAKER PRO

Matter in Motion

Use mole ratios to track matter through reactions.

HIGH SCHOOL · CHE.4

CHE.4 "Use stoichiometric ratios to support the claim that atoms, and therefore mass, are conserved during chemical reactions. a. Quantitatively apply the concepts of the mole and Avogadro's number to conceptualize and calculate percent..."

NAME _____ **DATE** _____

FROM MOLES TO MASS

A balanced equation gives mole ratios, not mass ratios. To find a product's mass, convert the given mass to moles, use the coefficients to find product moles, then convert to grams. Use these atomic masses in every question, in g/mol: H = 1, C = 12, N = 14, O = 16, Na = 23, Mg = 24, S = 32, Ca = 40, Fe = 56.

WORKED EXAMPLE

For $4Fe + 3O_2 \rightarrow 2Fe_2O_3$, how many grams of Fe_2O_3 can form from 112 g Fe when oxygen is in excess?

1. Convert Fe to moles: 112 g / 56 g/mol = 2 mol Fe.
2. Use the mole ratio: 2 mol Fe × (2 mol Fe_2O_3 / 4 mol Fe) = 1 mol Fe_2O_3.
3. Find the product's molar mass: 2(56) + 3(16) = 160 g/mol.
4. Convert to mass: 1 mol × 160 g/mol = 160 g.

Answer: 160 g Fe_2O_3

PRACTICE 6 problems

1 For $N_2 + 3H_2 \rightarrow 2NH_3$, how many moles of NH_3 can form from 2 mol N_2 when H_2 is in excess?

ANSWER _____

2 For $2Mg + O_2 \rightarrow 2MgO$, how many grams of MgO can form from 48 g Mg when O_2 is in excess?

ANSWER _____

3 For $CaCO_3 \rightarrow CaO + CO_2$, how many grams of CO_2 can form from 100 g $CaCO_3$?

ANSWER _____

4 For $2H_2O \rightarrow 2H_2 + O_2$, how many moles of O_2 can form from 36 g H_2O?

ANSWER _____

5 For $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$, how many grams of H_2O can form from 16 g CH_4 when O_2 is in excess?

ANSWER _____

6 For $Ca + S \rightarrow CaS$, 40 g Ca reacts completely with 32 g S. What mass of CaS forms? Write a mass equality that shows conservation.

ANSWER _____

APPLY IT Show your work

1 A hydrogen fuel cell combines hydrogen and oxygen to produce water: $2H_2 + O_2 \rightarrow 2H_2O$. If it uses 10 g H_2 and has excess O_2, what mass of water can form? What mass of oxygen reacts?

WORK SPACE

ANSWER _____

2 A camping stove burns propane: $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$. If the stove burns 22 g propane with excess oxygen, what mass of CO_2 forms?

WORK SPACE

ANSWER _____

CHALLENGE One step up

For $2Mg + O_2 \rightarrow 2MgO$, you have 72 g Mg and 32 g O_2. Which reactant limits the reaction? How many grams of MgO can form, and how many grams of the excess reactant remain? Show your mole-ratio reasoning.

WORK SPACE AND ANSWER

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	For $N_2 + 3H_2 \rightarrow 2NH_3$, how many moles of NH_3 can form from 2 mol N_2 when H_2 is in excess?	**4 mol NH_3**
2	For $2Mg + O_2 \rightarrow 2MgO$, how many grams of MgO can form from 48 g Mg when O_2 is in excess?	**80 g MgO**
3	For $CaCO_3 \rightarrow CaO + CO_2$, how many grams of CO_2 can form from 100 g $CaCO_3$?	**44 g CO_2**
4	For $2H_2O \rightarrow 2H_2 + O_2$, how many moles of O_2 can form from 36 g H_2O?	**1 mol O_2**
5	For $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$, how many grams of H_2O can form from 16 g CH_4 when O_2 is in excess?	**36 g H_2O**
6	For $Ca + S \rightarrow CaS$, 40 g Ca reacts completely with 32 g S. What mass of CaS forms? Write a mass equality that shows conservation.	**72 g CaS; 40 g + 32 g = 72 g.**

PART 2 · APPLY IT

1. **90 g H_2O; 80 g O_2** 10 g H_2 is 5 mol, which produces 5 mol H_2O, or 90 g. The 5 mol H_2 requires 2.5 mol O_2, or 80 g.
2. **66 g CO_2** 22 g propane is 0.5 mol. The 1:3 mole ratio gives 1.5 mol CO_2, which has a mass of 66 g.

CHALLENGE

O_2 limits the reaction. 32 g O_2 is 1 mol, which reacts with 2 mol Mg, or 48 g Mg, to form 2 mol MgO, or 80 g MgO. The Mg remaining is 72 g − 48 g = 24 g.

Accept equivalent unit-labeled calculations. For the challenge, students should use the 2:1 Mg-to-O_2 mole ratio to justify the limiting reactant.