LESSON MAKER PRO

Gas Reaction Math

Track moles, mass, and gas volume at STP

HIGH SCHOOL · CHE.4.e

CHE.4.e "Use mathematics and computational thinking to perform gas stoichiometry calculations involving mass, volume, and number of moles at standard temperature and pressure (STP)."

NAME _____ DATE _____

FOLLOW THE MOLE RATIO

At standard temperature and pressure (STP), 1 mol of any gas occupies 22.4 L. Use the coefficients in a balanced equation to convert between moles of substances. To convert mass to moles, divide by molar mass.

WORKED EXAMPLE

For $2CO + O_2 \rightarrow 2CO_2$, how many liters of CO_2 form at STP from 5 mol O_2? Assume CO is in excess.

1. The equation shows that 1 mol O_2 produces 2 mol CO_2.
2. 5 mol O_2 × (2 mol CO_2/1 mol O_2) = 10 mol CO_2.
3. 10 mol CO_2 × 22.4 L/mol = 224 L CO_2.

Answer: 224 L CO_2

PRACTICE 6 problems

1 For $2H_2 + Cl_2 \rightarrow 2HCl$, how many liters of HCl form at STP from 2 mol H_2? Assume Cl_2 is in excess.

ANSWER _____

2 For $2Mg + O_2 \rightarrow 2MgO$, what mass of MgO forms from 44.8 L O_2 at STP? Assume Mg is in excess. The molar mass of MgO is 40 g/mol.

ANSWER _____

3 For $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$, how many liters of CO_2 form at STP from 32 g CH_4? Assume O_2 is in excess. The molar mass of CH_4 is 16 g/mol.

ANSWER _____

4 For $N_2 + 3H_2 \rightarrow 2NH_3$, how many moles of NH_3 form from 134.4 L H_2 at STP? Assume N_2 is in excess.

ANSWER _____

5 For $2KClO_3 \rightarrow 2KCl + 3O_2$, what mass of $KClO_3$ produces 33.6 L O_2 at STP? The molar mass of $KClO_3$ is 122.5 g/mol.

ANSWER _____

6 At high temperature, $N_2 + O_2 \rightarrow 2NO$. How many liters of NO form at STP from 28 g N_2? Assume O_2 is in excess. The molar mass of N_2 is 28 g/mol.

ANSWER _____

APPLY IT Show your work

1 A car airbag uses a reaction that produces nitrogen gas: $2NaN_3 \rightarrow 2Na + 3N_2$. If 130 g NaN_3 reacts completely, what volume of N_2 would it produce at STP? The molar mass of NaN_3 is 65 g/mol.

WORK SPACE

ANSWER _____

2 A student tests a baking-soda bottle rocket. With excess vinegar, 42 g $NaHCO_3$ reacts according to $NaHCO_3 + CH_3COOH \rightarrow CH_3COONa + H_2O + CO_2$. What volume of CO_2 would this produce at STP? The molar mass of $NaHCO_3$ is 84 g/mol.

WORK SPACE

ANSWER _____

CHALLENGE One step up

A burner has 16 g CH_4 and 22.4 L O_2 measured at STP. The reaction is $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$. What volume of CO_2 forms at STP, and what mass of CH_4 remains? The molar mass of CH_4 is 16 g/mol.

WORK SPACE AND ANSWER

Gas Reaction Math

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	For $2H_2 + Cl_2 \rightarrow 2HCl$, how many liters of HCl form at STP from 2 mol H_2? Assume Cl_2 is in excess.	**44.8 L HCl**
2	For $2Mg + O_2 \rightarrow 2MgO$, what mass of MgO forms from 44.8 L O_2 at STP? Assume Mg is in excess. The molar mass of MgO is 40 g/mol.	**160 g MgO**
3	For $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$, how many liters of CO_2 form at STP from 32 g CH_4? Assume O_2 is in excess. The molar mass of CH_4 is 16 g/mol.	**44.8 L CO_2**
4	For $N_2 + 3H_2 \rightarrow 2NH_3$, how many moles of NH_3 form from 134.4 L H_2 at STP? Assume N_2 is in excess.	**4 mol NH_3**
5	For $2KClO_3 \rightarrow 2KCl + 3O_2$, what mass of $KClO_3$ produces 33.6 L O_2 at STP? The molar mass of $KClO_3$ is 122.5 g/mol.	**122.5 g $KClO_3$**
6	At high temperature, $N_2 + O_2 \rightarrow 2NO$. How many liters of NO form at STP from 28 g N_2? Assume O_2 is in excess. The molar mass of N_2 is 28 g/mol.	**44.8 L NO**

PART 2 · APPLY IT

1. **67.2 L N_2** 130 g NaN_3 is 2 mol, which produces 3 mol N_2. Multiply by 22.4 L/mol to get 67.2 L.
2. **11.2 L CO_2** 42 g $NaHCO_3$ is 0.5 mol and produces 0.5 mol CO_2. At STP, 0.5 × 22.4 L = 11.2 L.

CHALLENGE

11.2 L CO_2; 8 g CH_4 remains. The 1 mol O_2 available reacts with 0.5 mol CH_4, leaving 0.5 mol CH_4.

Accept equivalent unit notation. Volumes are theoretical volumes at STP; the challenge requires identifying O_2 as the limiting reactant.