Multistep Stoichiometry and Representation Choice

Student Worksheet | `g10_u01_w01`

I can: choose and defend a mass, mole, or particle pathway through a balanced equation; show unit cancellation; and interpret a theoretical result as a model prediction.
Grade 9 retrieval: coefficients are recipe amounts; subscripts identify a substance. Convert mass ↔ moles before using coefficients, and use $N_A = 6.02214076 \times 10^{23}\ \text{mol}^{-1}$ when particles are requested.
Frozen values: H 1.008, C 12.011, N 14.007, O 15.999, Na 22.990, Mg 24.305, Al 26.982, Cl 35.45, K 39.098, Ca 40.078, Fe 55.845. Values are from `audits/atomic_masses_v2024.1.json`; use calculator guard digits and round at the end. All contexts are paper data cards, not laboratory procedures.

1. For $4Al + 3O_2 \rightarrow 2Al_2O_3$, explain why the 4 may change but the 2 in Al_2O_3 may not. Then use 10.8 g Al and excess O_2 to predict grams of Al_2O_3.

2. For the same equation, use 16.0 g O_2 and excess Al to predict grams of Al_2O_3. Name the mole ratio used.

3. A card lists 9.00 g Al and 12.0 g O_2. Identify the limiting reactant, then predict grams of Al_2O_3.

4. Use item 3 to calculate grams of the excess reactant remaining. State the subtraction in moles before converting to grams.

5. For $N_2 + 3H_2 \rightarrow 2NH_3$, use 14.0 g N_2 and excess H_2 to predict grams of ammonia.

6. A card lists 6.00 g H_2 and 28.0 g N_2. Identify the limiting reactant and predict grams of NH_3.

7. Use item 6 to calculate grams of the excess reactant remaining.

8. For $2KClO_3 \rightarrow 2KCl + 3O_2$, use 24.5 g $KClO_3$ to predict grams of O_2.

9. Use item 8 to predict grams of KCl produced. Explain why the two product masses together can equal the starting mass in this closed-system model.

10. For $CaCO_3 \rightarrow CaO + CO_2$, use 18.0 g $CaCO_3$ to predict the number of CO_2 molecules.

11. For $2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$, use 16.8 g $NaHCO_3$ to predict grams of CO_2 and grams of H_2O.

12. For $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$, use 16.0 g Fe_2O_3 and excess CO to predict grams of Fe.

13. A card lists 16.0 g Fe_2O_3 and 8.00 g CO. Identify the limiting reactant and predict grams of Fe.

14. Use item 13 to calculate grams of excess Fe_2O_3 remaining.

15. For $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$, use 11.0 g C_3H_8 and excess O_2 to predict grams of CO_2.

16. A card lists 11.0 g C_3H_8 and 32.0 g O_2. Identify the limiting reactant, predict grams of CO_2, and calculate grams of excess reactant left.

17. For $Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$, use 7.40 g $Ca(OH)_2$ and excess HCl to predict grams of $CaCl_2$.

18. A data card reports a theoretical $CaCl_2$ prediction of 11.1 g and a collected mass of 10.2 g. Calculate percent yield, then state one collection or measurement limit that could explain a value below 100%.

19. Choose a particle-first pathway: 3.00×10^{23} Mg atoms react with excess O_2 in $2Mg + O_2 \rightarrow 2MgO$. Predict grams of MgO.

20. For $2H_2O_2 \rightarrow 2H_2O + O_2$, use 34.0 g H_2O_2 to predict the number of O_2 molecules. End with one sentence distinguishing the predicted amount from a measured collection.