

# NAME \_\_\_\_\_ DATE \_\_\_\_\_ CLASS \_\_\_\_\_ **CHAPTER 12** **STUDY GUIDE FOR CONTENT MASTERY**

## Section 12.3 Limiting Reactants

In your textbook, read about why reactions stop and how to determine the limiting reactant.

Study the diagram showing a chemical reaction and the chemical equation that represents the reaction. Then complete the table. Show your calculations for questions 25–27 in the space below the table.



The molar masses of  $\text{O}_2$ ,  $\text{NO}$ , and  $\text{NO}_2$  are 32.00 g/mol, 30.01 g/mol, and 46.01 g/mol, respectively.

| Amount of $\text{O}_2$ | Amount of $\text{NO}$ | Amount of $\text{NO}_2$ | Limiting Reactant | Amount and State of Excess Reactant |
|------------------------|-----------------------|-------------------------|-------------------|-------------------------------------|
| 1 molecule             | 2 molecules           | 2 molecules             | none              | none                                |
| 4 molecules            | 4 molecules           | 4 molecules             | NO                | 2 molecules $\text{O}_2$            |
| 2 molecules            | 8 molecules           | 1. 4 molecules          | 2. $\text{O}_2$   | 3. 4 molecules NO                   |
| 1.00 mol               | 2.00 mol              | 4. 2.00 mol             | 5. none           | 6. none                             |
| 4.00 mol               | 4.00 mol              | 7. 4.00 mol             | 8. NO             | 9. 2.00 mol $\text{O}_2$            |
| 1.00 mol               | 7.00 mol              | 10. 7.00 mol            | 11. NO            | 12. 1.50 mol $\text{O}_2$           |
| 1.00 mol               | 4.00 mol              | 13. 2.00 mol            | 14. $\text{O}_2$  | 15. 2.00 mol NO                     |
| 0.500 mol              | 0.200 mol             | 16. 0.200 mol           | 17. NO            | 18. 0.400 mol $\text{O}_2$          |
| 32.00 g                | 60.02 g               | 19. 92.02 g             | 20. none          | 21. none                            |
| 16.00 g                | 60.02 g               | 22. 46.01 g             | 23. $\text{O}_2$  | 24. 58.12 g NO                      |
| 16.00 g                | 20.00 g               | 25. 28.76 g             | 26. $\text{O}_2$  | 27. 1.24 g NO                       |

balanced equation mole ratio = 2 mol  $\text{NO}$ /1 mol  $\text{O}_2$

$16.00 \text{ g } \text{O}_2 \times 1 \text{ mol } \text{O}_2 / 32.00 \text{ g } \text{O}_2 = 0.5125 \text{ mol } \text{O}_2$

$20.00 \text{ g } \text{NO} \times 1 \text{ mol } \text{NO} / 30.01 \text{ g } \text{NO} = 0.6664 \text{ mol } \text{NO}$

actual mole ratio =  $0.6664 \text{ mol } \text{NO} / 0.5125 \text{ mol } \text{O}_2 = 2.132 \text{ mol } \text{NO} / 1.000 \text{ mol } \text{O}_2$

Because the actual mole ratio of  $\text{NO}:\text{O}_2$  is larger than the balanced equation mole ratio of  $\text{NO}:\text{O}_2$ , there is an excess of  $\text{NO}$ ;  $\text{O}_2$  is the limiting reactant.

Mass of  $\text{NO}$  used =  $0.5125 \text{ mol } \text{O}_2 \times 2 \text{ mol } \text{NO} / 1 \text{ mol } \text{O}_2 = 0.4250 \text{ mol } \text{NO}$

$0.4250 \text{ mol } \text{NO} \times 30.01 \text{ g } \text{NO} / 1 \text{ mol } \text{NO} = 12.76 \text{ g } \text{NO}$

Mass of  $\text{NO}_2$  produced =  $0.4250 \text{ mol } \text{NO} \times 46.01 \text{ g } \text{NO}_2 / 1 \text{ mol } \text{NO} = 19.56 \text{ g } \text{NO}_2$

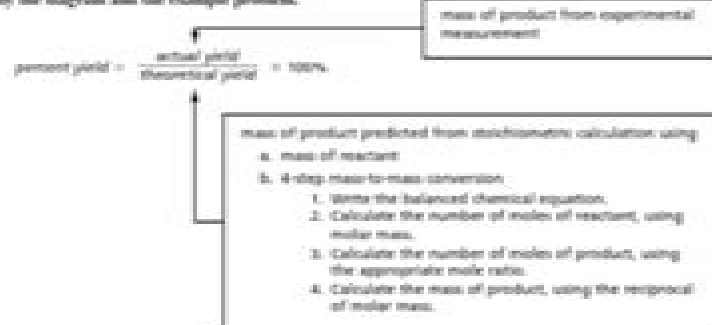
Excess  $\text{NO} = 20.00 \text{ g } \text{NO} - 12.76 \text{ g } \text{NO} = 7.24 \text{ g } \text{NO}$

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## Section 12.4 Percent Yield

In your textbook, read about the yield of products.

Study the diagram and the example problem.



**Example Problem:** The following chemical equation represents the production of gallium oxide, a substance used in the manufacturing of some semiconductor devices.



In one experiment, the reaction yielded 7.42 g of the oxide from a 7.00-g sample of gallium. Determine the percent yield of this reaction. The molar masses of Ga and  $\text{Ga}_2\text{O}_3$  are 69.72 g/mol and 187.44 g/mol, respectively.

Use the information in the diagram and example problem to evaluate each value or expression below. If the value or expression is correct, write correct. If it is incorrect, write the correct value or expression.

- actual yield: unknown 7.42 g  $\text{Ga}_2\text{O}_3$
- mass of reactant: 7.00 g Ga correct
- number of moles of reactant:  $7.00 \text{ g } \text{Ga} \times \frac{69.72 \text{ g } \text{Ga}}{1 \text{ mol } \text{Ga}} = 7.00 \text{ g } \text{Ga} \times 1 \text{ mol } \text{Ga} / 69.72 \text{ g } \text{Ga}$
- number of moles of product:  $0.100 \text{ mol } \text{Ga} \times \frac{2 \text{ mol } \text{Ga}_2\text{O}_3}{1 \text{ mol } \text{Ga}} = 0.100 \text{ mol } \text{Ga} \times \frac{2 \text{ mol } \text{Ga}_2\text{O}_3}{1 \text{ mol } \text{Ga}}$
- theoretical yield:  $0.100 \text{ mol } \text{Ga}_2\text{O}_3 \times \frac{187.44 \text{ g } \text{Ga}_2\text{O}_3}{1 \text{ mol } \text{Ga}_2\text{O}_3} = 18.74 \text{ g } \text{Ga}_2\text{O}_3$  correct
- percent yield:  $\frac{7.42 \text{ g } \text{Ga}_2\text{O}_3}{18.74 \text{ g } \text{Ga}_2\text{O}_3} \times 100 = 7.42 \text{ g } \text{Ga}_2\text{O}_3 / 18.74 \text{ g } \text{Ga}_2\text{O}_3 \times 100$

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**RD Boyd**



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