

Limiting reactants: exercise

When aluminum reacts with hydrochloric acid the products formed are aluminum trichloride and hydrogen. If 9 g of aluminum and 200 mL of a solution of hydrochloric acid 3 M are added,

- write the adjusted chemical equation
- determine the limiting reactant
- calculate the volume of hydrogen formed at 27 °C and 800 mmHg of pressure
- determine the excess of reactant in grams

Atomic weights: Al=27; H=1; Cl=35.5

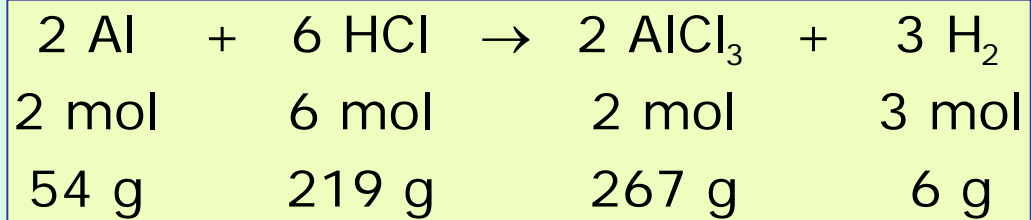
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a) write the adjusted chemical equation



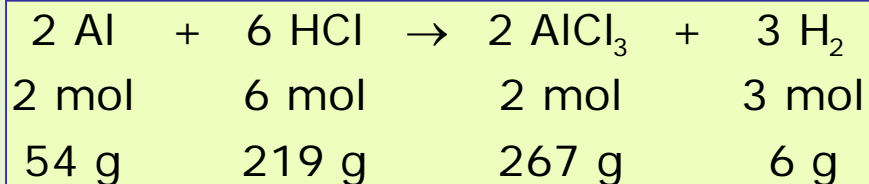
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b) determine the limiting reactant



$$x(\text{Al}) = \frac{9 \text{ g Al}}{54 \text{ g Al}} = 0.167 \text{ times the value of the table}$$

REACTANT IN EXCESS: Al

$$x(\text{HCl}) = \frac{0.2 \text{ L} * \frac{3 \text{ mol}}{1 \text{ L}}}{6 \text{ mol HCl}} = \frac{0.6 \text{ mol HCl}}{6 \text{ mol HCl}} = 0.1 \text{ times the value of the table}$$

LIMITING REACTANT: HCl

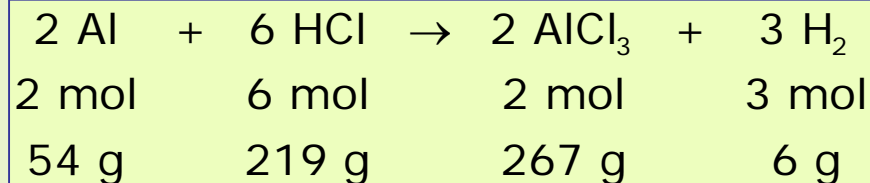
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c) calculate the volume of hydrogen formed at 27 °C and 800 mmHg of pressure



$$n(\text{H}_2) = 0.6 \text{ mol HCl} \times \frac{3 \text{ mol H}_2}{6 \text{ mol HCl}} = 0.3 \text{ mol H}_2$$

$$V(\text{H}_2) = \frac{n \cdot R \cdot T}{p} = \frac{0.3 \text{ mol} \cdot 0.082 \frac{\text{atm} \cdot \text{L}}{\text{K} \cdot \text{mol}} \cdot 300 \text{ K}}{800 \text{ mmHg} \cdot \frac{1 \text{ atm}}{760 \text{ mmHg}}} = \frac{7.38 \text{ atm} \cdot \text{L}}{1.053 \text{ atm}} = 7 \text{ L H}_2$$

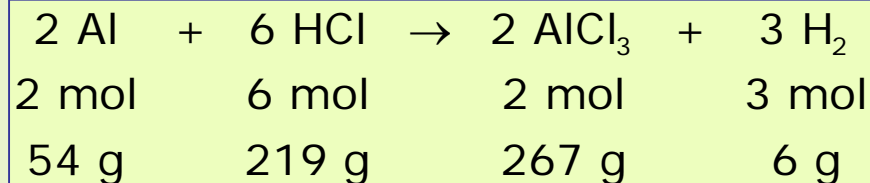
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d) determine the excess of reactant in grams



$$m_{\text{spent}}(\text{Al}) = 0.6 \text{ mol HCl} \times \frac{54 \text{ g Al}}{6 \text{ mol HCl}} = 5.4 \text{ g Al}$$

$$m_{\text{excess}}(\text{Al}) = 9 \text{ g Al} - 5.4 \text{ g Al} = 3.6 \text{ g Al}$$