

Mole Calculations – Answer Sheet (Worked Solutions)

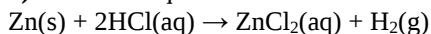
Given Data:

Mass of Zn = 6.00 g, Molar mass of Zn $\approx$ 65.4 g/mol

Volume of HCl = 250 cm³ = 0.250 dm³, Concentration = 0.200 mol/dm³

Molar gas volume = 24.0 dm³/mol, $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$

a) Balanced Equation:



b) Limiting Reagent:

Moles Zn = $6.00 \div 65.4 = 0.0917 \text{ mol}$

Moles HCl = $c \times V = 0.200 \times 0.250 = 0.0500 \text{ mol}$

Reaction requires 2 mol HCl per 1 mol Zn $\rightarrow$ required HCl for all Zn = 0.183 mol

Available HCl = 0.0500 mol $\rightarrow$ HCl is limiting, Zn is in excess.

c) Moles Zn reacted = $0.0500 \div 2 = 0.0250 \text{ mol}$

Moles Zn left = $0.0917 - 0.0250 = 0.0667 \text{ mol}$ ($\approx$ 4.36 g left)

d) Volume H₂ produced:

Moles H₂ = 0.0250 mol (1:1 ratio with Zn reacted)

Volume = $0.0250 \times 24.0 = 0.600 \text{ dm}^3 = 600 \text{ cm}^3$

e) Mass of one H₂ molecule:

Molar mass H₂ = 2.0 g/mol $\rightarrow$ mass per molecule = $2.0 \div (6.022 \times 10^{23}) = 3.32 \times 10^{-24} \text{ g}$

f) Theoretical mass ZnCl₂:

Moles ZnCl₂ = 0.0250 mol, $M_r(\text{ZnCl}_2) = 136.3 \text{ g/mol}$ Mass =

$0.0250 \times 136.3 = 3.41 \text{ g}$

g) Percentage Yield:

$(\text{Actual} \div \text{Theoretical}) \times 100 = (2.70 \div 3.41) \times 100 = 79.2 \%$

h) Atom Economy:

$(M_r \text{ desired product} \div \sum M_r \text{ reactants}) \times 100$

$= (136.3 \div [65.4 + (2 \times 36.5)]) \times 100 = (136.3 \div 138.4) \times 100 = 98.5 \%$

i) Mass of H₂ produced:

Moles H₂ = 0.0250 mol, Mass = $0.0250 \times 2.0 = 0.0500 \text{ g}$