Mole Calculations – Answer Sheet (Worked Solutions)

Given Data:
Mass of Zn = 6.00 g, Molar mass of Zn ≈ 65.4 g/mol
Volume of HCl = 250 cm^3 = 0.250 dm^3, Concentration = 0.200 mol/dm^3
Molar gas volume = 24.0 dm^3/mol, $N_2 = 6.022 \times 10^{23}$ mol^{-1}

a) Balanced Equation:
$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

b) Limiting Reagent:
Moles Zn = 6.00 ÷ 65.4 = 0.0917 mol
Moles HCl = c × V = 0.200 × 0.250 = 0.0500 mol
Reaction requires 2 mol HCl per 1 mol Zn → required HCl for all Zn = 0.183 mol
Available HCl = 0.0500 mol → HCl is limiting, Zn is in excess.

c) Moles Zn reacted = 0.0500 ÷ 2 = 0.0250 mol
Moles Zn left = 0.0917 – 0.0250 = 0.0667 mol (≈ 4.36 g left)

d) Volume H_2 produced:
Moles H_2 = 0.0250 mol (1:1 ratio with Zn reacted)
Volume = 0.0250 × 24.0 = 0.600 dm^3 = 600 cm^3

e) Mass of one H_2 molecule:
Molar mass H_2 = 2.0 g/mol → mass per molecule = 2.0 ÷ $(6.022 \times 10^{23}) = 3.32 \times 10^{-24}$ g

f) Theoretical mass $ZnCl_2$:
Moles $ZnCl_2$ = 0.0250 mol, M_r ($ZnCl_2$) = 136.3 g/mol Mass =
0.0250 × 136.3 = 3.41 g

g) Percentage Yield:
(Actual ÷ Theoretical) × 100 = (2.70 ÷ 3.41) × 100 = 79.2 %

h) Atom Economy:
(M_r desired product ÷ Σ M_r reactants) × 100
= (136.3 ÷ [65.4 + (2×36.5)]) × 100 = (136.3 ÷ 138.4) × 100 = 98.5 %

i) Mass of H_2 produced:
Moles H_2 = 0.0250 mol, Mass = 0.0250 × 2.0 = 0.0500 g