Percentage Yield — Worksheet

Relative atomic masses (Ar) to use:

H=1, C=12, O=16, N=14, Na=23, Cl=35.5, Ca=40, Mg=24, S=32, Al=27, K=39, P=31, Fe=56

For each question:
• The balanced equation is shown.
• The named reactant is the limiting reagent; other reagents are in excess.
• Use the mass of the limiting reagent and the actual mass of the desired product to calculate the percentage yield to 1 decimal place.

Question 1

A reaction is carried out to make CaO. The balanced equation is given below. You start with 20.8 g of CaCO3 (the limiting reagent), and obtain 8.3 g of CaO. Calculate the percentage yield of CaO to 1 decimal place.

$$CaCO_3 \rightarrow CaO + CO_2$$

Question 2

A reaction is carried out to make CaCl2. The balanced equation is given below. You start with 29.4 g of Ca(OH)2 (the limiting reagent), and obtain 37.8 g of CaCl2. Calculate the percentage yield of CaCl2 to 1 decimal place.

$$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$$

Question 3

A reaction is carried out to make NaCl. The balanced equation is given below. You start with 22.9 g of Na (the limiting reagent), and obtain 39.1 g of NaCl. Calculate the percentage yield of NaCl to 1 decimal place.

$$2Na + Cl_2 \rightarrow 2NaCl$$

Question 4

A reaction is carried out to make SO3. The balanced equation is given below. You start with 17.2 g of SO2 (the limiting reagent), and obtain 14.6 g of SO3. Calculate the percentage yield of SO3 to 1 decimal place.

$$2SO_2 + O_2 \rightarrow 2SO_3$$

Question 5

A reaction is carried out to make NaCl. The balanced equation is given below. You start with 8.5 g of Na2CO3 (the limiting reagent), and obtain 8.1 g of NaCl. Calculate the percentage yield of NaCl to 1 decimal place.

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$$

Question 6

A reaction is carried out to make NH3. The balanced equation is given below. You start with 27.5 g of N2 (the limiting reagent), and obtain 23.2 g of NH3. Calculate the percentage yield of NH3 to 1 decimal place.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Question 7

A reaction is carried out to make NH3. The balanced equation is given below. You start with 13.5 g of N2 (the limiting reagent), and obtain 12.3 g of NH3. Calculate the percentage yield of NH3 to 1 decimal place.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Question 8

A reaction is carried out to make CaCl2. The balanced equation is given below. You start with 38.2 g of Ca(OH)2 (the limiting reagent), and obtain 49.0 g of CaCl2. Calculate the percentage yield of CaCl2 to 1 decimal place.

$$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$$

Question 9

A reaction is carried out to make CaCl2. The balanced equation is given below. You start with 16.5 g of Ca(OH)2 (the limiting reagent), and obtain 17.6 g of CaCl2. Calculate the percentage yield of CaCl2 to 1 decimal place.

$$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$$

Question 10

A reaction is carried out to make MgO. The balanced equation is given below. You start with 26.0 g of Mg (the limiting reagent), and obtain 30.5 g of MgO. Calculate the percentage yield of MgO to 1 decimal place.

$$2Mg + O_2 \rightarrow 2MgO$$

Question 11

A reaction is carried out to make H2O. The balanced equation is given below. You start with 29.7 g of H2 (the limiting reagent), and obtain 218.7 g of H2O. Calculate the percentage yield of H2O to 1 decimal place.

$$2H_2 + O_2 \rightarrow 2H_2O$$

Question 12

A reaction is carried out to make NaCl. The balanced equation is given below. You start with 9.4 g of Na2CO3 (the limiting reagent), and obtain 7.1 g of NaCl. Calculate the percentage yield of NaCl to 1 decimal place.

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$$

Percentage Yield — Answers & Worked Solutions

Relative atomic masses (Ar) to use:

H=1, C=12, O=16, N=14, Na=23, Cl=35.5, Ca=40, Mg=24, S=32, Al=27, K=39, P=31, Fe=56

Question 1

$$CaCO_3 \rightarrow CaO + CO_2$$

Working:

1) Moles of CaCO3 = mass ÷ Mr = 20.8 ÷ 100.0 = 0.21 mol

2) Stoichiometric ratio CaCO3 → CaO = 1:1 ⇒ moles of CaO (theoretical) = 0.21 × (1/1) = 0.21 mol

3) Theoretical mass of CaO = moles × Mr = 0.21 × 56.0 = 11.6 g

4) % yield = (actual ÷ theoretical) × 100 = (8.3 ÷ 11.6) × 100 = 71.2%

Question 2

$$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$$

Working:

1) Moles of Ca(OH)2 = mass ÷ Mr = 29.4 ÷ 74.0 = 0.40 mol

2) Stoichiometric ratio Ca(OH)2 → CaCl2 = 1:1 ⇒ moles of CaCl2 (theoretical) = 0.40 × (1/1) = 0.40 mol

3) Theoretical mass of CaCl2 = moles × Mr = 0.40 × 111.0 = 44.1 g

4) % yield = (actual ÷ theoretical) × 100 = (37.8 ÷ 44.1) × 100 = 85.7%

Question 3

$$2Na + Cl_2 \rightarrow 2NaCl$$

Working:

1) Moles of Na = mass ÷ Mr = 22.9 ÷ 23.0 = 1.00 mol

2) Stoichiometric ratio Na → NaCl = 2:2 ⇒ moles of NaCl (theoretical) = 1.00 × (2/2) = 1.00 mol

3) Theoretical mass of NaCl = moles × Mr = 1.00 × 58.5 = 58.2 g

4) % yield = (actual ÷ theoretical) × 100 = (39.1 ÷ 58.2) × 100 = 67.1%

Question 4

$$2SO_2 + O_2 \rightarrow 2SO_3$$

Working:

1) Moles of SO2 = mass ÷ Mr = 17.2 ÷ 64.0 = 0.27 mol

2) Stoichiometric ratio SO2 → SO3 = 2:2 ⇒ moles of SO3 (theoretical) = 0.27 × (2/2) = 0.27 mol

3) Theoretical mass of SO3 = moles × Mr = 0.27 × 80.0 = 21.5 g

4) % yield = (actual ÷ theoretical) × 100 = (14.6 ÷ 21.5) × 100 = 67.8%

Question 5

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$$

Working:

1) Moles of Na2CO3 = mass ÷ Mr = 8.5 ÷ 106.0 = 0.08 mol

2) Stoichiometric ratio Na2CO3 → NaCl = 1:2 ⇒ moles of NaCl (theoretical) = 0.08 × (2/1) = 0.16 mol

3) Theoretical mass of NaCl = moles × Mr = 0.16 × 58.5 = 9.4 g

4) % yield = (actual ÷ theoretical) × 100 = (8.1 ÷ 9.4) × 100 = 86.2%

Question 6

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Working:

1) Moles of N2 = mass ÷ Mr = 27.5 ÷ 28.0 = 0.98 mol

2) Stoichiometric ratio N2 → NH3 = 1:2 ⇒ moles of NH3 (theoretical) = 0.98 × (2/1) = 1.96 mol

3) Theoretical mass of NH3 = moles × Mr = 1.96 × 17.0 = 33.4 g

4) % yield = (actual ÷ theoretical) × 100 = (23.2 ÷ 33.4) × 100 = 69.5%

Question 7

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Working:

1) Moles of N2 = mass ÷ Mr = 13.5 ÷ 28.0 = 0.48 mol

2) Stoichiometric ratio N2 → NH3 = 1:2 ⇒ moles of NH3 (theoretical) = 0.48 × (2/1) = 0.96 mol

3) Theoretical mass of NH3 = moles × Mr = 0.96 × 17.0 = 16.4 g

4) % yield = (actual ÷ theoretical) × 100 = (12.3 ÷ 16.4) × 100 = 75.2%

Question 8

$$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$$

Working:

1) Moles of Ca(OH)2 = mass ÷ Mr = 38.2 ÷ 74.0 = 0.52 mol

2) Stoichiometric ratio Ca(OH)2 → CaCl2 = 1:1 ⇒ moles of CaCl2 (theoretical) = 0.52 × (1/1) = 0.52 mol

3) Theoretical mass of CaCl2 = moles × Mr = 0.52 × 111.0 = 57.3 g

4) % yield = (actual ÷ theoretical) × 100 = (49.0 ÷ 57.3) × 100 = 85.5%

Question 9

$$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$$

Working:

1) Moles of Ca(OH)2 = mass ÷ Mr = 16.5 ÷ 74.0 = 0.22 mol

2) Stoichiometric ratio Ca(OH)2 → CaCl2 = 1:1 ⇒ moles of CaCl2 (theoretical) = 0.22 × (1/1) = 0.22 mol

3) Theoretical mass of CaCl2 = moles × Mr = 0.22 × 111.0 = 24.8 g

4) % yield = (actual ÷ theoretical) × 100 = (17.6 ÷ 24.8) × 100 = 71.1%

Question 10

$$2Mg + O_2 \rightarrow 2MgO$$

Working:

1) Moles of Mg = mass ÷ Mr = 26.0 ÷ 24.0 = 1.08 mol

2) Stoichiometric ratio Mg → MgO = 2:2 ⇒ moles of MgO (theoretical) = 1.08 × (2/2) = 1.08 mol

3) Theoretical mass of MgO = moles × Mr = 1.08 × 40.0 = 43.3 g

4) % yield = (actual ÷ theoretical) × 100 = (30.5 ÷ 43.3) × 100 = 70.4%

Question 11

$$2H_2 + O_2 \rightarrow 2H_2O$$

Working:

1) Moles of H2 = mass ÷ Mr = 29.7 ÷ 2.0 = 14.85 mol

2) Stoichiometric ratio H2 → H2O = 2:2 ⇒ moles of H2O (theoretical) = 14.85 × (2/2) = 14.85 mol

3) Theoretical mass of H2O = moles × Mr = 14.85 × 18.0 = 267.3 g

4) % yield = (actual ÷ theoretical) × 100 = (218.7 ÷ 267.3) × 100 = 81.8%

Question 12

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$$

Working:

1) Moles of Na2CO3 = mass ÷ Mr = 9.4 ÷ 106.0 = 0.09 mol

2) Stoichiometric ratio Na2CO3 → NaCl = 1:2 ⇒ moles of NaCl (theoretical) = 0.09 × (2/1) = 0.18 mol

3) Theoretical mass of NaCl = moles × Mr = 0.18 × 58.5 = 10.4 g

4) % yield = (actual ÷ theoretical) × 100 = (7.1 ÷ 10.4) × 100 = 68.8%