MINING LEARNING SERIES

Mineral Processing & Metallurgy

From crushed ore to a valuable, responsible product

Prepared by FundaWay Team

How to Use This Study Note

Read one section at a time, write down unfamiliar terms, explain each process in your own words and then complete the revision questions without looking back.

LEARNING OUTCOMES

After studying this guide, you should be able to: describe the main stages in a processing plant; compare separation methods; calculate simple recovery and mass pull; explain responsible water and tailings management; identify study and career pathways.

QUIZ PREPARATION

The matching FundaWay topic quiz contains 20 questions. Focus on understanding cause and effect, safe practice, calculations and correct technical vocabulary.

1. From Ore to Product

Mineral processing separates valuable minerals from waste rock after extraction. The aim is to produce a concentrate or final product that meets a required quality while using energy, water and reagents responsibly.

- Crushing reduces large rocks to smaller pieces.
- Grinding liberates valuable mineral grains from gangue.
- Separation concentrates the valuable mineral.
- Dewatering removes water from concentrate and tailings.
- Smelting or refining may produce a purer metal.

KEY IDEA

A processing plant adds value by increasing the proportion of valuable mineral in the product; it does not create the mineral.

2. Comminution: Crushing and Grinding

Comminution is the controlled reduction of particle size. Primary crushers accept run-of-mine rock, while secondary and tertiary stages make it smaller. Mills then grind material until valuable grains are sufficiently liberated.

Stage	Purpose	Typical equipment
Primary crushing	Break large feed	Jaw or gyratory crusher
Secondary crushing	Reduce size further	Cone crusher
Grinding	Liberate mineral grains	Ball or SAG mill

ENERGY CHECK

Over-grinding wastes energy and can make separation harder. The target size must balance liberation, recovery and cost.

3. Separation Methods

The correct separation method depends on differences between the valuable mineral and gangue.

Method	Property used	Example
Gravity	Density	Heavy minerals separated from lighter rock
Magnetic	Magnetism	Magnetite recovered with magnets
Flotation	Surface chemistry	Selected particles attach to air bubbles
Leaching	Solubility	A reagent dissolves a target metal

PROCESS CHOICE

A test-work programme determines which method gives an acceptable recovery and product grade safely and economically.

4. Flotation and Reagents

In froth flotation, ground ore is mixed with water and carefully selected reagents. Air bubbles rise through the slurry. Hydrophobic mineral particles attach to bubbles and form a froth that can be collected.

- Collectors help selected minerals attach to bubbles.
- Frothers create stable bubbles.
- Modifiers adjust conditions such as pH or depress unwanted minerals.
- Operators monitor dosage, air flow, level and particle size.

> **SAFETY**
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> Reagents must be labelled, stored, handled and disposed of according to their safety data sheets and site procedures.

5. Recovery, Grade and Mass Pull

Recovery measures how much of the valuable material in the feed reaches the concentrate. Grade measures how concentrated that valuable material is. Improving one can sometimes reduce the other, so plants seek a practical balance.

Measure	Formula	Meaning
Recovery (%)	valuable material in concentrate / valuable material in feed x 100	How much value was captured
Mass pull (%)	concentrate mass / feed mass x 100	How much feed became concentrate

EXAMPLE

If feed contains 100 kg of copper and concentrate contains 85 kg, recovery = 85/100 x 100 = 85%.

6. Water, Tailings and Responsible Processing

Tailings are the finely ground material left after valuable minerals are recovered. They may still contain water, reagents and minerals. Responsible management is essential throughout operation and long after closure.

- Recover and reuse water where practical.
- Monitor tailings facilities and water quality.
- Prevent uncontrolled seepage, erosion and dust.
- Plan for closure, rehabilitation and long-term stability.
- Use alarms, inspections and emergency plans.

> **RESPONSIBILITY**
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> Production targets never justify bypassing environmental controls or tailings safety procedures.

7. Metallurgy Careers and Study Pathways

Metallurgists and mineral-processing engineers design, operate and improve plants. Process controllers, laboratory technicians, artisans, chemical engineers and environmental teams also contribute.

- Useful school subjects: Mathematics, Physical Sciences and technical subjects.
- Study routes can include university degrees, university-of-technology diplomas and TVET artisan programmes.
- Important skills: calculations, chemistry, data interpretation, teamwork, communication and safety discipline.

CAREER TIP

Compare current entry requirements directly with each institution before applying.

Key Terms

Term	Meaning
Gangue	Unwanted minerals or rock associated with the valuable mineral.
Liberation	Freeing valuable mineral grains from gangue by crushing and grinding.
Concentrate	A product containing a higher proportion of valuable mineral.
Recovery	The percentage of valuable material captured in the product.
Grade	The concentration of valuable material in a stream or product.
Tailings	Material remaining after valuable minerals are recovered.
Flotation	A separation method using surface chemistry and air bubbles.
Leaching	Dissolving a target component using a suitable solution.

Revision Questions

Answer in full sentences before checking the memorandum.

- 1. Why is grinding performed after crushing?
- 2. Name two mineral-separation properties.
- 3. What is the difference between grade and recovery?
- 4. Calculate recovery when 80 kg of valuable metal reaches concentrate from 100 kg in the feed.
- 5. Why must tailings and water be managed after production stops?
- 6. Name two careers linked to processing plants.

Answer Guide

- 1. Grinding makes particles smaller so valuable grains are liberated.
- 2. Any two: density, magnetism, surface chemistry or solubility.
- 3. Grade is concentration; recovery is the proportion of available value captured.
- 4. 80/100 x 100 = 80%.
- 5. They can create long-term stability, pollution and community risks.
- 6. Examples include metallurgist, mineral-processing engineer, laboratory technician, process controller or artisan.

READY FOR THE QUIZ?

You are ready when you can explain the key terms, apply the process steps to a new situation and justify safe or responsible choices without copying the notes.

References and Further Learning

These notes provide learner-friendly educational guidance. Mining technology and operating procedures change, so always verify current requirements with official institutions, employers, equipment manuals and regulators.

- South African Qualifications Authority - qualification information
- Council for Geoscience - mineral and geoscience learning
- Department of Mineral and Petroleum Resources - minerals-sector information
- Official university, university-of-technology and TVET programme pages

> **IMPORTANT**
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> This is a non-accredited learning resource. It does not replace mine-specific induction, legal training, professional advice or an official qualification.