Processing: Chemical Reactions

Lab Manual – Gr. 4-6

Part 1: Sort a Mixture

Materials:

- Soil sample
- Sifters
- Vinegar dropper bottle
- Water
- Glass container

Personal Protective Equipment:

- Goggles
- Gloves

You have a soil sample which contains waste, called tailings, from a mine site which is extracting limestone. Large slabs of limestone can be sold, but in order to reduce waste, smaller samples of limestone are going to be extracted from the tailings and processed into lime. That lime will be used to restore the soil when we move on from this mine site.

Your first task is to sort the limestone from the tailings.

1. What safety equipment do you need to wear?

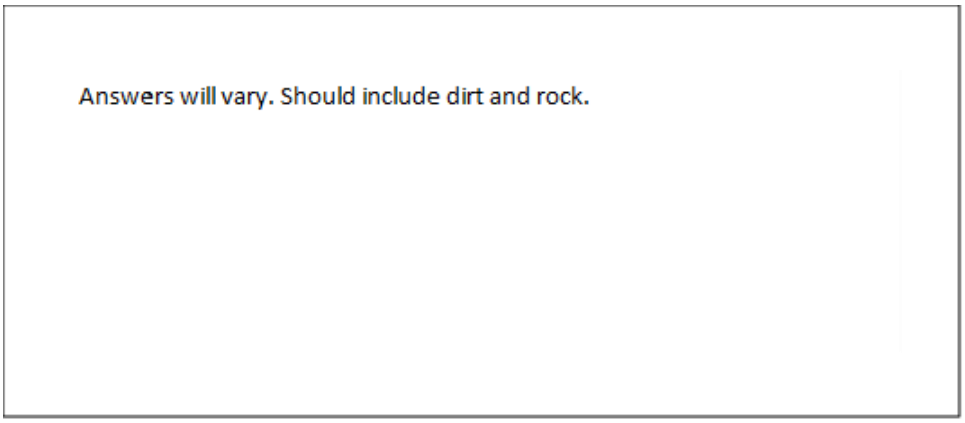
   Goggles, gloves

2. What state of matter is your soil sample? Solid

Steps:

A. Put your sifter over your container.
B. Pour your soil sample into the sifter.
C. Wiggle and bounce your sifter until the soil has all been sifted out.

3. What do you observe in your sifter? Draw your observations.



D. Discard your soil in the compost.
E. Rinse your container clean.
F. Put your remaining rock sample in the class container and rinse them clean.

We need to figure out which rock is limestone, and which is just rock. Limestone is usually:

- Grey, white, yellow, or brown
- Soft (can be scratched easily)
- Reacts with acid

G. Scratch rocks against each other to test their softness.
H. Separate the ones you think are limestone.
I. On each pebble you predict to be limestone, drop a single droplet from your vinegar dropper bottle.

4. In what state of matter are your reagents?
    a. Vinegar: Liquid
    b. Stone Sample: Solid

J. Test each pebble. If it reacts with the vinegar, it is limestone.
K. Sort your limestone and your pebbles into two separate piles.
L. Discard the pebbles outdoors.

5. What happens when vinegar touches limestone?

Bubbles appear

6. Does this reaction cause a change in state? yes / no

7. If yes, describe what states are changing.

Despite the appearance of a gas, it is a new substance, not a change in state for the vinegar or the stone.

8. Is this a chemical or a physical reaction? Chemical

Part 2: Refine the Product

Materials:

- Vinegar
- Glass container
- Limestone sample
- Stir stick
- Indicator

Personal Protective Equipment:

- Goggles
- Gloves

We still need to process our limestone into lime. We already know that limestone reacts with vinegar. That reaction produces carbon dioxide (CO_2), water (H_2O), and lime ($Ca(CH_3COO)_2$).

The carbon dioxide escapes as the bubbles we see in that reaction. What is left will be a lime solution.

Steps:

A. Put a pebble of limestone into your glass container.
B. Fill the glass container with enough vinegar to cover your pebble.

C. Stir until the limestone dissolves.

1. Do you observe a change in state? yes / no

2. If yes, describe any changes:

The solid limestone dissolves into a liquid state.

3. Is this a chemical or a physical reaction? Physical

D. Use your indicator to test the acidity of your sample.
E. Add and dissolve limestone until your sample is neutral.

Part 3: Isolate the Product

Materials:

- Glass container
- Hot plate
- Lime solution

Personal Protective Equipment:

- Goggles
- Gloves

The lime has been refined from limestone, but it is still in solution, which means it is dissolved in water. We want our lime to be in a solid state. That means there is one step still left in the processing phase.

Steps:

A. Plug in and turn on the hot plate.
B. Put your glass container with the lime solution in it on the hot plate.

C. Bring your lime solution to a boil.
D. Let it boil until there is a thick slurry in the container.

4. Do you observe a change in state? yes / no

5. If yes, describe any changes:

The water is changing from liquid to gas. Students will likely be unable to get their lime completely solid.

6. Is this a chemical or a physical reaction? Physical

Without more specialized equipment, we cannot completely dry the lime solution. The final step would be to put our slurry in a dehydrator for many, many hours. At that stage, we would have a fine powder.

Congratulations! We have produced lime powder which our mine can use in order to restore the soil when our operations are done.

Processing: Chemical Reactions

Lab Manual – Gr. 7-8

Part 1: Sort a Mixture

Materials:

- Soil sample
- Sifters
- Vinegar dropper bottle
- Water
- Glass container

Personal Protective Equipment:

- Goggles
- Gloves

You have a soil sample which contains waste, called tailings, from a mine site which is extracting limestone. Large slabs of limestone can be sold, but in order to reduce waste, smaller samples of limestone are going to be extracted from the tailings and processed into lime. That lime will be used to restore the soil when we move on from this mine site.

Your first task is to sort the limestone from the tailings.

1. What safety equipment do you need to wear?

   Goggles, gloves

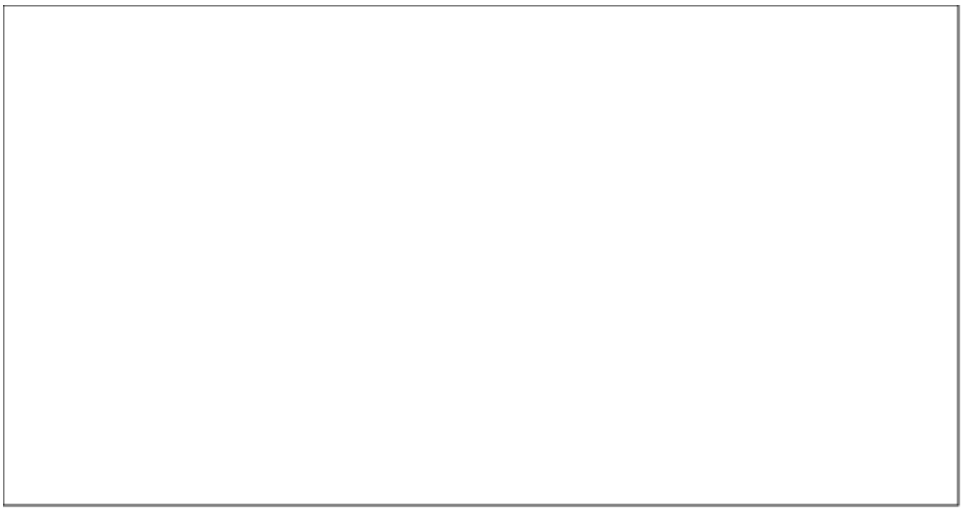
2. Is your soil sample a pure substance or a mixture?

   Mixture

3. Is your soil sample a heterogeneous or homogeneous mixture?

   Heterogeneous

4. Draw a diagram of your mixture, labelling what you see in it to the best of your ability.



Steps:

5. Given the materials available to you, how could you separate this mixture? Explain your reasoning.

   Answers will vary. This is a mixture which can be physically sorted. The smaller particles of soil can fall through small holes in the sifter, while the stone will remain. The stones can be sorted using their physical and chemical properties.

A. Put your sifter over your container.
B. Pour your soil sample into the sifter.
C. Wiggle and bounce your sifter until the soil has all been sifted out.

6. What do you observe in your sifter? Draw your observations.

7. Have you completely separated this mixture? How can you tell?

   There are still soil particles stuck to the rock, and there is more than one type of rock together. This is still a mixture.

D. Discard your soil in the compost.
E. Rinse your container clean.
F. Put your remaining rock sample in the class container and rinse them clean.

8. What is left in this mixture?

   Limestone and pebbles

We need to figure out which rock is limestone, and which is just rock. Limestone is usually:

- Grey, white, yellow, or brown
- Soft (can be scratched easily)
- Reacts with acid

G. Scratch rocks against each other to test their softness.
H. Separate the ones you think are limestone.
I. On each pebble you predict to be limestone, drop a single droplet from your vinegar dropper bottle.
J. Test each pebble. If it reacts with the vinegar, it is limestone.
K. Sort your limestone and your pebbles into two separate piles.

L. Discard the pebbles outdoors.

9. What happens when vinegar touches limestone?

   Bubbles appear

Part 2: Refine the Product

Materials:

- Vinegar
- Glass container
- Limestone sample
- Stir stick
- Indicator

Personal Protective Equipment:

- Goggles
- Gloves

We still need to process our limestone into lime. We already know that limestone reacts with vinegar. That reaction produces carbon dioxide (CO_2), water (H_2O), and lime ($Ca(CH_3COO)_2$).

1. Define a solution.

   A solution is a small particle dissolved in another substance.

2. Which products of this reaction do you predict will form a solution?

   Water and lime

Steps:

A. Put a pebble of limestone into your glass container.
B. Fill the glass container with enough vinegar to cover your pebble.
C. Stir until the limestone dissolves.

D. Use your indicator to test the acidity of your sample.
E. Add and dissolve limestone until your sample is neutral.

3. Was your prediction accurate? How can you tell?

   Answers will vary

Part 3: Isolate the Product

Materials:

- Glass container
- Hot plate
- Lime solution

Personal Protective Equipment:

- Goggles
- Gloves

The lime has been refined from limestone, but it is still in solution, which means it is dissolved in water. We want our lime to be in a solid state. That means there is one step still left in the processing phase.

1. How might a substance be taken out of solution? Explain your reasoning.

   The water can be boiled off, or so much substance can be added that it forms a substrate when the water can no longer dissolve any more.

Steps:

A. Plug in and turn on the hot plate.
B. Put your glass container with the lime solution in it on the hot plate.
C. Bring your lime solution to a boil.
D. Let it boil until there is a thick slurry in the container.

Without more specialized equipment, we cannot completely dry the lime solution. The final step would be to put our slurry in a dehydrator for many, many hours. At that stage, we would have a fine powder.

2. What might some intended and unintended consequences be of the ways mixtures are separated in the mining industry?

   In this reaction, carbon dioxide is released. Carbon dioxide is a greenhouse gas; on a large scale, this could contribute to climate change.

   Students may research other answers.

Congratulations! We have produced lime powder which our mine can use in order to restore the soil when our operations are done.

Processing: Chemical Reactions

Lab Manual – Gr. 9

Part 1: Sort a Mixture

Materials:

- Soil sample
- Sifters
- Vinegar dropper bottle
- Water
- Glass container

Personal Protective Equipment:

- Goggles
- Gloves

You have a soil sample which contains waste, called tailings, from a mine site which is extracting limestone. Large slabs of limestone can be sold, but in order to reduce waste, smaller samples of limestone are going to be extracted from the tailings and processed into lime. That lime will be used to restore the soil when we move on from this mine site.

Your first task is to sort the limestone from the tailings.

1. What safety equipment do you need to wear?

   Goggles, gloves

Steps:

A. Put your sifter over your container.
B. Pour your soil sample into the sifter.
C. Wiggle and bounce your sifter until the soil has all been sifted out.

2. What do you observe in your sifter? Draw your observations.

3. Describe the physical properties of the remaining sample.

   Colour descriptions will vary depending on the sample. It is solid. The stones are not malleable, but the limestone is soft. Answers will vary.

D. Discard your soil in the compost.
E. Rinse your container clean.
F. Put your remaining rock sample in the class container and rinse them clean.

We need to figure out which rock is limestone, and which is just rock. Limestone is usually:

- Grey, white, yellow, or brown
- Soft (can be scratched easily)
- Reacts with acid

4. Which of the described properties are physical properties?

   Colour, hardness

5. Which of the described properties are chemical properties?

   Reactiveness with acid

6. What other physical properties can you use to describe each of your reagents?
   a. Vinegar: Sharp, sour scent; clear, colourless liquid

b. Rock: fracture shape, brittleness when dropped, no scent
c. Limestone: Fracture shape, brittleness when dropped, no scent

G. Scratch rocks against each other to test their softness.
H. Separate the ones you think are limestone.
I. On each pebble you predict to be limestone, drop a single droplet from your vinegar dropper bottle.
J. Test each pebble. If it reacts with the vinegar, it is limestone.
K. Sort your limestone and your pebbles into two separate piles.
L. Discard the pebbles outdoors.

7. What happens when vinegar touches limestone?

   It bubbles

8. Is each reaction physical or chemical? How can you tell?
   a. Scratching rocks: Physical; it is not altered and nothing new is created
   b. Vinegar and rocks: Chemical; the presence of bubbles suggests a chemical reaction

Part 2: Refine the Product

Materials:

- Vinegar
- Glass container
- Limestone sample
- Stir stick
- Indicator

Personal Protective Equipment:

- Goggles
- Gloves

We still need to process our limestone into lime. We already know that limestone reacts with vinegar. That reaction produces carbon dioxide (CO_2), water (H_2O), and lime ($Ca(CH_3COO)_2$).

The carbon dioxide escapes as the bubbles we see in that reaction. What is left will be a lime solution.

Steps:

A. Put a pebble of limestone into your glass container.
B. Fill the glass container with enough vinegar to cover your pebble.
C. Stir until the limestone dissolves.

1. Describe some physical properties of the product:

   White opaque liquid

2. Is this a chemical or a physical reaction? How can you tell?

Physical; the lime and water do not react, the lime just dissolves, which is a change in state.

D. Use your indicator to test the acidity of your sample.
E. Add and dissolve limestone until your sample is neutral.

3. Is each of these substances an acid or a base?
   a. Vinegar: acid / base
   b. Lime: acid / base

Part 3: Isolate the Product

Materials:

- Glass container
- Hot plate
- Lime solution

Personal Protective Equipment:

- Goggles
- Gloves

The lime has been refined from limestone, but it is still in solution, which means it is dissolved in water. We want our lime to be in a solid state. That means there is one step still left in the processing phase.

Steps:

A. Plug in and turn on the hot plate.
B. Put your glass container with the lime solution in it on the hot plate.
C. Bring your lime solution to a boil.
D. Let it boil until there is a thick slurry in the container.

4. How do the physical properties of the solution change from beginning to end?

It becomes more viscous, thicker

5. Is this a chemical or a physical reaction? How can you tell?

Physical; this is the water changing state.

Without more specialized equipment, we cannot completely dry the lime solution. The final step would be to put our slurry in a dehydrator for many, many hours. At that stage, we would have a fine powder.

Congratulations! We have produced lime powder which our mine can use in order to restore the soil when our operations are done.

Processing: Chemical Reactions

Lab Manual – Gr. 10

Part 1: Sort a Mixture

Materials:

- Soil sample
- Sifters
- Vinegar dropper bottle
- Water
- Glass container

Personal Protective Equipment:

- Goggles
- Gloves

You have a soil sample which contains waste, called tailings, from a mine site which is extracting limestone. Large slabs of limestone can be sold, but in order to reduce waste, smaller samples of limestone are going to be extracted from the tailings and processed into lime. That lime will be used to restore the soil when we move on from this mine site.

Your first task is to sort the limestone from the tailings.

1. What safety equipment do you need to wear?

   Goggles, gloves

Steps:

A. Put your sifter over your container.
B. Pour your soil sample into the sifter.
C. Wiggle and bounce your sifter until the soil has all been sifted out.

2. What do you observe in your sifter? Draw your observations.

D. Discard your soil in the compost.
E. Rinse your container clean.
F. Put your remaining rock sample in the class container and rinse them clean.

We need to figure out which rock is limestone, and which is just rock. Limestone is usually:

- Grey, white, yellow, or brown
- Soft (can be scratched easily)
- Reacts with acid

G. Scratch rocks against each other to test their softness.
H. Separate the ones you think are limestone.
I. On each pebble you predict to be limestone, drop a single droplet from your vinegar dropper bottle.
J. Test each pebble. If it reacts with the vinegar, it is limestone.
K. Sort your limestone and your pebbles into two separate piles.
L. Discard the pebbles outdoors.

3. What happens when vinegar touches limestone?

It bubbles

4. Is each reaction physical or chemical? How can you tell?
    a. Scratching rocks: Physical; nothing new is created and nothing is fundamentally changed.
    b. Vinegar and rocks: Chemical; the presence of bubbles suggests a chemical reaction.

Part 2: Refine the Product

Materials:

- Vinegar
- Glass container
- Limestone sample
- Stir stick
- Indicator

Personal Protective Equipment:

- Goggles
- Gloves

We still need to process our limestone into lime. We already know that limestone reacts with vinegar.

The chemical formula for vinegar is CH_3COOH. The chemical formula for limestone is $CaCO_3$.

This reaction creates water, carbon dioxide, and lime. The chemical formula for water is H_2O. The chemical formula for carbon dioxide is CO_2. The chemical formula for lime is $Ca(CH_3COO)_2$.

1. What is the unbalanced equation for this reaction?

    $CH_3COOH + CaCO_3 \rightarrow H_2O + CO_2 + Ca(CH_3COO)_2$

2. How many of each element are on the left hand side of the equation?
    a. Carbon: 3
    b. Hydrogen: 4
    c. Oxygen: 5
    d. Calcium: 1

3. How many of each element are on the right hand side of the equation?
    a. Carbon: 5
    b. Hydrogen: 8
    c. Oxygen: 7
    d. Calcium: 1

4. What is the balanced equation for this reaction?

    $2CH_3COOH + CaCO_3 \rightarrow H_2O + CO_2 + Ca(CH_3COO)_2$

The carbon dioxide escapes as the bubbles we see in that reaction. What is left will be a lime solution.

<u>Steps:</u>

A. Put a pebble of limestone into your glass container.
B. Fill the glass container with enough vinegar to cover your pebble.
C. Stir until the limestone dissolves.

5. Is this a chemical or a physical reaction? How can you tell?

Physical; dissolving is a change in state.

D. Use your indicator to test the acidity of your sample.
E. Add and dissolve limestone until your sample is neutral.

6. Is each of these substances an acid or a base?
    a. Vinegar: acid / base
    b. Lime: acid / base

Part 3: Isolate the Product

Materials:

- Glass container
- Hot plate
- Lime solution

Personal Protective Equipment:

- Goggles
- Gloves

The lime has been refined from limestone, but it is still in solution, which means it is dissolved in water. We want our lime to be in a solid state. That means there is one step still left in the processing phase.

Steps:

A. Plug in and turn on the hot plate.
B. Put your glass container with the lime solution in it on the hot plate.
C. Bring your lime solution to a boil.
D. Let it boil until there is a thick slurry in the container.

7. Is this a chemical or a physical reaction? How can you tell?

Physical; the water is changing state from liquid to gas.

Without more specialized equipment, we cannot completely dry the lime solution. The final step would be to put our slurry in a dehydrator for many, many hours. At that stage, we would have a fine powder.

Congratulations! We have produced lime powder which our mine can use in order to restore the soil when our operations are done.

1. Is the final product neutral, acidic, or basic? How do you know?

   Neutral. Adding an acid and a base together makes a neutral substance.

2. What would the environmental impact of this process by on a large scale?

   This process releases Carbon Dioxide, which is a greenhouse gas which contributes to climate change.

3. Lime can be used to restore acidic soil, making it an important substance for environmental remediation. However, its production releases CO_2 into the atmosphere. What other processes do we currently need to help the environment which also come at a cost?

   Many minerals and metals are needed for electric vehicles, solar panels, etc., but are impactful to mine. Students may research different answers.