Mystery science

Anchor Layer Teacher Guide

A curriculum companion for Anchor Layer users

Grade 5

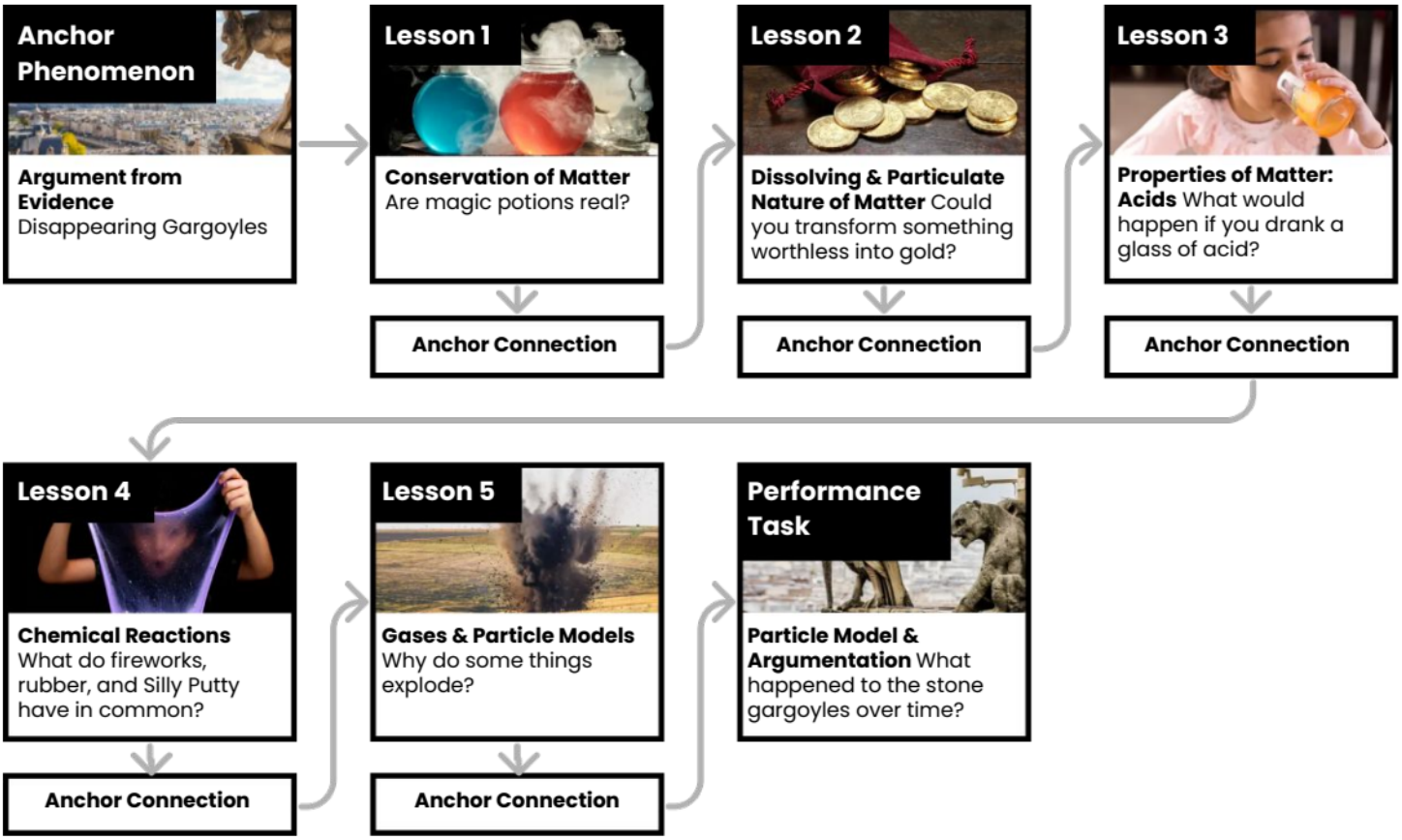
Chemical Reactions & Properties of Matter

Unit Web Link • Pacing Guide • Other Units

Unit Summary

In this unit, students investigate the properties of matter by dissolving everyday chemicals to make solutions and by exploring simple yet surprising chemical reactions. Through these investigations, students begin to build conceptual models for the particulate nature of matter.

Performance Expectations	Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• 5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen. • 5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. • 5-PS1-3. Make observations and measurements to identify materials based on their properties. • 5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.	• Planning and Carrying Out Investigations • Constructing Explanations and Designing Solutions • Using Mathematics and Computational Thinking • Analyzing and Interpreting Data • Developing and Using Models	• PS1.A: Structure and Properties of Matter • PS1.B: Chemical Reactions	• Cause and Effect • Scale, Proportion, and Quantity • Energy and Matter



Anchor Phenomenon Background

What's happening with the gargoyles? Why do they slowly seem to disappear over time?

The answer was not obvious--it took careful observation before anyone discovered the truth. The gargoyles are carved from a type of rock called "limestone." Even though it is solid rock, it turns out that limestone is similar in many ways to baking soda. When any acid is placed on limestone, the limestone fizzes and creates bubbles. But it's not like the gargoyles ever get acid on them...right?

Well, as you might know, rain water is not pure water. It contains impurities from the air around us. Some of those impurities actually make rain water very slightly acidic. Not enough to harm your skin. The rain water acts like an acid on the gargoyles.

Key:

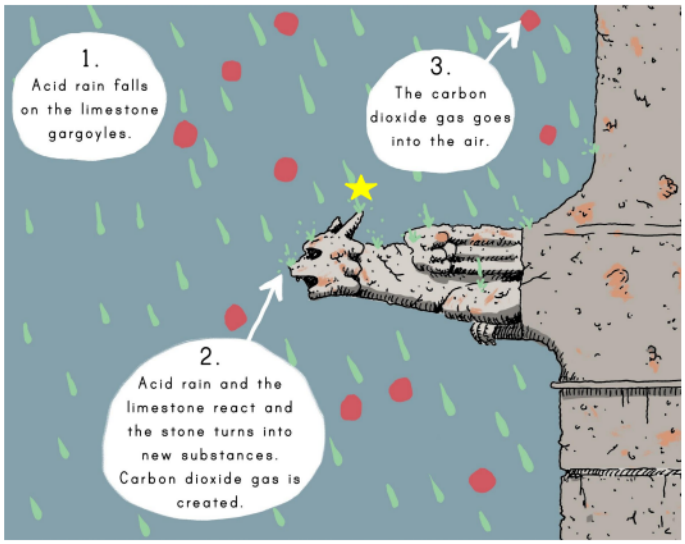
= gas particles

= acid rain

= chemical reaction

Just like baking soda and vinegar, the limestone and rainwater are taking part in a chemical reaction: the limestone and acid are reacting to form new substances. One of those substances is a gas, carbon dioxide, which is released into the air. (Those fizzy bubbles you see are carbon dioxide!) The other substances are water and calcium acetate.

So even though it may seem like the stone is disappearing, in fact, it's only changing...reacting with acid to form carbon dioxide that goes into the air.



Anchor Phenomenon: Disappearing Gargoyles
Argument from Evidence

Anchor Phenomenon
13 mins

Guided Inquiry
20 mins

Hands-On Activity
25 mins

Wrap-Up
2 mins

Anchor Phenomenon Lesson Overview

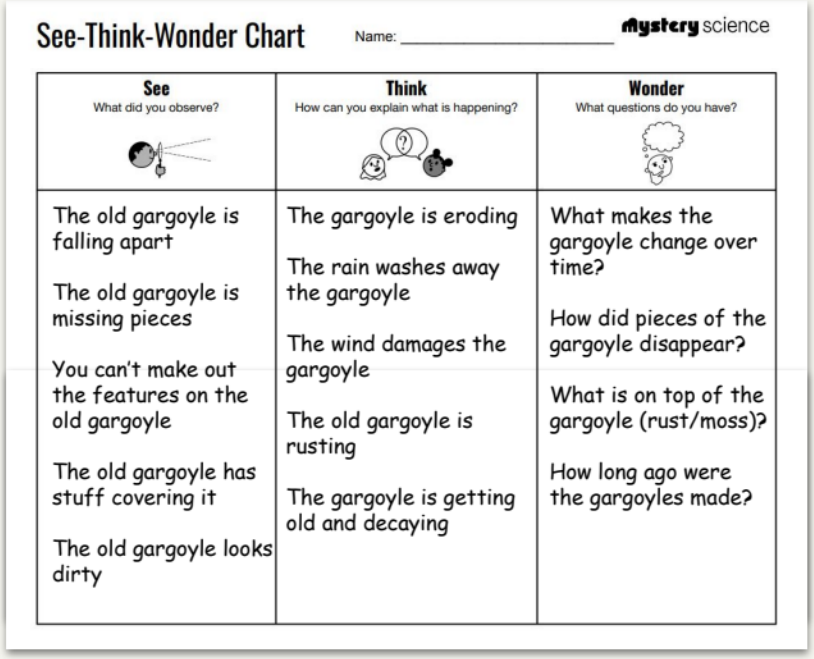
Note: This lesson is part of this unit's Anchor Layer. If you have the Anchor Layer turned on, we recommend teaching all lessons in the remainder of this unit in order.

The anchor phenomenon for this unit is the process of stone gargoyles changing over time. In the activity, they write an argument supporting the alchemist's claim about why the gargoyles change over time that they most agree with. Students will gather evidence after each Mystery to help them revise their argument at the end of the unit.

Student Work Samples & Notes

It is important to encourage students to recognize that even if they don't know the perfect answer yet, they are going to learn a lot throughout the unit and have an opportunity to change or add to their first argument.

Choose 4 separate spots in your classroom to hang the Alchemist Claim posters.



See-Think-Wonder Chart Name: _____ Mystery science

See What did you observe?	Think How can you explain what is happening?	Wonder What questions do you have?
The old gargoyle is falling apart The old gargoyle is missing pieces You can't make out the features on the old gargoyle The old gargoyle has stuff covering it The old gargoyle looks dirty	The gargoyle is eroding The rain washes away the gargoyle The wind damages the gargoyle The old gargoyle is rusting The gargoyle is getting old and decaying	What makes the gargoyle change over time? How did pieces of the gargoyle disappear? What is on top of the gargoyle (rust/moss)? How long ago were the gargoyles made?

Lesson 1: Are magic potions real? (pg 1 of 2)
Conservation of Matter

Exploration
15 mins

Hands-On Activity
25 mins

Wrap-Up
15 mins

Anchor Connection
20 mins

Assessment
25 mins

Overview

In this lesson, students meet the alchemists, a historic group that used "potions" to try to transform materials.

In the activity, Test Like An Alchemist, students test liquids to see which ones will clean the tarnish off a penny. Then, when one penny changes from dark and dirty to bright and shiny, they'll have a chance to think about where the tarnish went.

If you are planning on teaching Lesson 2: "Could you transform something worthless into gold?" Students will need their completed "Alchemist's Potion, Part 1" printouts. At the end of this lesson, you'll dump all the pennies into the Salt & Vinegar to soak overnight.

After students have left class, we recommend that you put a nail into the Salt & Vinegar solution with the pennies — but don't tell your students you're doing it. You'll find out why in the next lesson, when your students will discover that the solution the pennies soaked in can change steel in a surprising way.

Activity Notes

We suggest students work in groups of four. You will need access to water and old, tarnished pennies for this activity. You must use pennies dating from BEFORE 1982, when they were made from 95% copper. (Pennies made after 1982 are copper-plated zinc, which won't work for this activity.)

For suggestions on gathering pre-1982 pennies and more detailed prep instructions for preparing your liquids, see the lesson page.

Anchor Connection on Next Page

Lesson 1: Are magic potions real? (pg 2 of 2)
Conservation of Matter

Exploration
15 mins

Hands-On Activity
25 mins

Wrap-Up
15 mins

Anchor Connection
20 mins

Assessment
25 mins

Anchor Connection

Substances can change other substances. The salt and vinegar solution turned a dull copper penny shiny, so perhaps some substance is changing the gargoyles, too.

Students revisit the evidence sheet that they worked on during the Anchor Phenomenon. They should understand that another substance may have caused the gargoyles to disappear over time.

Students can update their evidence sheet to include:

- Substances can be changed by other substances

Connecting Storyline Question

What type of substance could cause the pieces of the gargoyles to disappear over time?

Lesson 2: Could you transform something worthless into gold?

Dissolving & Particulate Nature of Matter (pg 1 of 2)

Exploration
20 mins

Hands-On Activity
25 mins

Wrap-Up
10 mins

Anchor Connection
20 mins

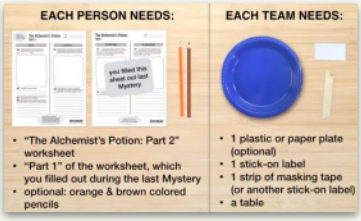
Assessment
25 mins

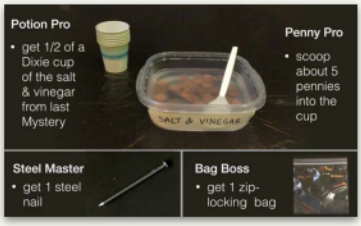
Overview

In this lesson, students investigate the alchemists' claim of transforming ordinary metals into gold.

In the activity, The King's Sword, students use the vinegar, salt, and penny solution that they created in Lesson 1 to copper plate a steel nail. Students then create a conceptual model of how particles from the pennies are the same ones that eventually coat the nail in copper.

To do this activity, you must have completed the activity in Lesson 1. At the end of the last lesson, you put all the pennies in the Salt & Vinegar solution, added a steel nail when students were gone, and then left the solution overnight. To prepare for this activity, check on that solution before class and look at the nail you put in. All or part of the nail should now be covered by a layer of copper.





Activity Notes

We suggest students work in groups of four. Take the nail out of the solution you used from lesson 1, rinse it off, and set it aside to show your students during the last video. Save the penny-filled solution for students to use in this activity.

If conditions are just right, copper forms on the steel quickly. But in many cases, students may need to leave their experiments for a few hours or even overnight to see results.

For more detailed prep instructions, tips on how to organize supplies around your classroom, and tips on storing solutions overnight, see the lesson page.

Anchor Connection on Next Page

Lesson 2: Could you transform something worthless into gold?

Dissolving & Particulate Nature of Matter (pg 2 of 2)

Exploration
20 mins

Hands-On Activity
25 mins

Wrap-Up
10 mins

Anchor Connection
20 mins

Assessment
25 mins

Anchor Connection

Large objects can be broken down into particles too small to be seen, but they still exist even though we can't see them. The salt and vinegar solution removed the corrosion on the dull penny. The particles did not disappear but dissolved into the salt and vinegar solution. We know they are still there because when the nail was placed in the solution it was coated with the particles and turned copper. Perhaps the stone gargoyles are being broken down by something, too.

Students revisit the evidence sheet that they worked on during the Anchor Phenomenon. They should understand that the stone from the gargoyles could have been dissolved by another substance.

Students can update their evidence sheet to include:

- Substances can be broken down into smaller pieces.
- Even though it looks like those pieces cease to exist, that isn't what happens. The substances still exist even when they are broken into pieces too small to be seen.

Connecting Storyline Question

If another substance changed the gargoyles, what happened to the pieces that "disappeared"?

Lesson 3: What would happen if you drank a glass of acid?
Properties of Matter: Acids (pg 1 of 3)

Exploration
12 mins

Hands-On Activity
40 mins

Wrap-Up
3 mins

Anchor Connection
35 mins

Assessment
25 mins

Overview
In this lesson, students are introduced to acids, a group of substances with a reputation for being reactive.

In the activity, Acid Test, students discover two ways to detect acids: they use baking soda, which fizzes when mixed with acids, or a special liquid that changes color when mixed with acids. Then, students use those methods to identify common foods that are acidic.

Teacher Background
The purple liquid that you prepare from the cabbage (or black beans) is called an indicator. There's a pigment in purple cabbage and black beans that changes color when it reacts with an acid or base. You and your students should notice that the color of the liquid changes to a reddish/pink when you add it to any of the acids (e.g. vinegar). You can then use this information to test unknown liquids. If the liquid turns pink, then it's an acid.

You and your students will also notice that when baking soda is mixed with vinegar, there is fizzing that indicates an acid-base reaction. But baking soda does not fizz when mixed with water, making it a good acid indicator. Baking powder will also fizz with vinegar. But you will notice that baking powder will also slightly fizz when water is added. This is because baking powder is actually a mixture of baking soda (base) and cream of tartar (acid). This is why it reacts with both water and vinegar. So baking powder is not a good indicator because it fizzes when any liquid is added.

Activity Notes on Next Page

Lesson 3: What would happen if you drank a glass of acid?
Properties of Matter: Acids (pg 2 of 3)

Exploration
12 mins

Hands-On Activity
40 mins

Wrap-Up
3 mins

Anchor Connection
35 mins

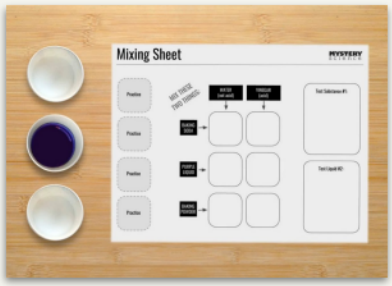
Assessment
25 mins

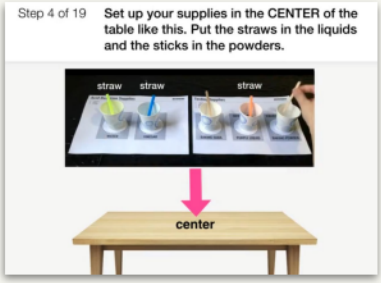
Activity Notes

ou will need access to water for this activity. We suggest students work in pairs and two pairs of students share supplies at the same table group.

If you're using purple cabbage, put 2 cups of chopped cabbage in 1½ cups of water. Leave it for at least an hour, stirring occasionally. The cabbage will turn the water purple. Drain the chopped cabbage and reserve the purplish-pink liquid. If you're using black beans, put 1 cup of beans into 2 cups of water and leave them for at least an hour. The beans will soak up some water and turn the rest purplish brown. Drain the beans and reserve the purplish-brown liquid.

For more detailed instructions on preparing the straws, testing & acid reaction supplies, as well as for tips on setting up the classroom see the lesson page.





Anchor Connection on Next Page

Lesson 3: What would happen if you drank a glass of acid?
Properties of Matter: Acids (pg 3 of 3)

Exploration
12 mins

Hands-On Activity
40 mins

Wrap-Up
3 mins

Anchor Connection
35 mins

Assessment
25 mins

Anchor Connection
Be sure to complete the readings linked within the anchor connection slides. Acids are very reactive substances. Acid rain is so reactive that it can even wear away at stone.

Findings from this investigation suggest that an acid (acid rain) could have reacted with the gargoyle stone.

Students can update their evidence sheet to include:

- Acids can cause stone to break down into smaller pieces.

Connecting Storyline Question
What effects could acid rain have on a stone gargoyle when they come in contact with one another?

Lesson 4: What do fireworks, rubber, and Silly Putty have in common?

Chemical Reactions (pg 1 of 2)

Exploration
12 mins

Hands-On Activity
45 mins

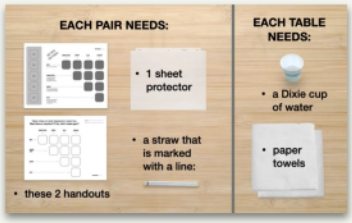
Anchor Connection
20 mins

Assessment
25 mins

Overview

This lesson develops the idea that chemical reactions create new materials that have useful and interesting properties.

The Great Goo Experiment is a two-part activity. In Part 1, students experiment by combining different substances and watching for reactions. In Part 2, students mix glue and borax solution in clear plastic bags to observe the reaction, which creates "Mystery Goo."



Activity Notes

You may want to divide this activity into two sessions. Part 1 (testing substances) takes 15 to 20 minutes. Part 2 (creating goo) takes another 15 minutes, and begins at Step 12.

You will need access to water for this activity. We suggest students work in pairs and two pairs of students share supplies at a group table.

For detailed instructions on preparing your solutions, preparing the straws, tips for separating the supplies into two different sessions, and tips for setting up supply stations, see the lesson page.

Anchor Connection on Next Page

Lesson 4: What do fireworks, rubber, and Silly Putty have in common?

Chemical Reactions (pg 2 of 2)

Exploration
12 mins

Hands-On Activity
45 mins

Anchor Connection
20 mins

Assessment
25 mins

Anchor Connection

Gargoyles are made of limestone which contains calcium carbonate. The acid rain reacts with calcium carbonate. This reaction changes the stone and forms new substances.

Evidence suggests that the acid rain and stone (calcium carbonate) can react to create new substances.

Students can update their evidence sheet to include:

- The stone was very solid, but when it reacts to form new substances, those new substances have completely different properties.
- The new substances don't stay together in a solid. This is why the gargoyle appears to be wearing away.

Connecting Storyline Question

What evidence can we see to know if a chemical reaction takes place between acid rain and a stone gargoyle?

Lesson 5: Why do some things explode? (pg 1 of 2)
Gases & Particle Models

Exploration
11 mins

Hands-On Activity
30 mins

Wrap-Up
4 mins

Anchor Connection
20 mins

Assessment
25 mins

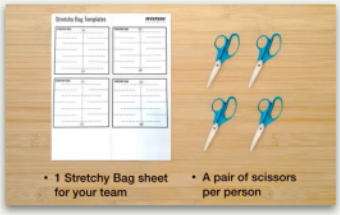
Overview

In this lesson, students investigate and model how gases cause explosions.

In the activity, Bag of Bubbles, students experiment by combining baking soda and vinegar inside a sealed bag and observe how the gas bubbles produced cause the bag to inflate–and sometimes pop!

First activity

Second activity



Activity Notes

We strongly recommend that students wear eye protection for this activity. We suggest students work in pairs for the first activity, and in groups of four for the second activity.

Prepare the vinegar and baking soda. Divide your plastic cups (or plastic containers) in half. For each of the cups in one of the piles, pour about ½ cup of vinegar. For the other cups, pour about ½ cup of baking soda into each.

Separate supplies for each activity for easy distribution.

Anchor Connection on Next Page

Lesson 5: Why do some things explode? (pg 1 of 2)
Gases & Particle Models

Exploration
11 mins

Hands-On Activity
30 mins

Wrap-Up
4 mins

Anchor Connection
20 mins

Assessment
25 mins

Anchor Connection

Gases are made of particles too small to be seen. When baking soda (a base) and vinegar (an acid) have a chemical reaction, it produced gas (carbon dioxide). The gas particles are too small to be seen and spread out into the air. This same type of reaction happens with the gargoyles.

This experiment suggests that one of the substances created in the reaction between acid rain and stone (calcium carbonate) was a gas that expanded into the atmosphere.

Students can update their evidence sheet to include:

- One of the new substances created in the reaction between the stone gargoyle and the acid rain is a gas.
- The gas created spreads out into the air.

Connecting Storyline Question

If parts of the gargoyle didn't "disappear," where did any new substances created from a chemical reaction between acid rain and the stone go?

Performance Task: How can you tell time at night?
Night Sky

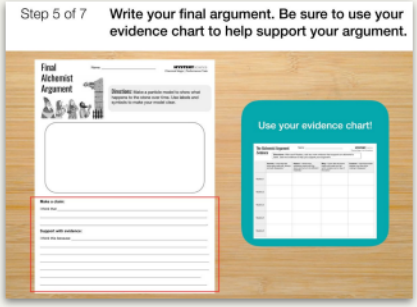
Unit Review
15 mins

Hands-On Activity
40 mins

Wrap-Up
5 mins

Overview

In this performance task, students use their evidence chart to revise their final argument about what happens to the stone gargoyles over time. They create a particle model to show what is happening in the reaction between acid rain and the stone gargoyles to support their argument. If you have time to extend the performance task, there is a hands-on investigation in the Extensions.



Performance Task Notes

Students will need their completed The Alchemist Argument Evidence Chart that they have been adding to after each Mystery.

Students will also need their first The Alchemist Argument worksheet that they completed during the introduction to the anchor phenomenon.

Crosscutting Concepts

Cause and Effect: Cause and effect relationships are used to explain change. Chemical reactions result in a substance changing into new substances.

Scale, Proportion, & Quantity: Phenomena and natural objects exist from the very small (microscopic) to the very large (macroscopic). Particles too small to be seen make up macroscopic objects and phenomena.