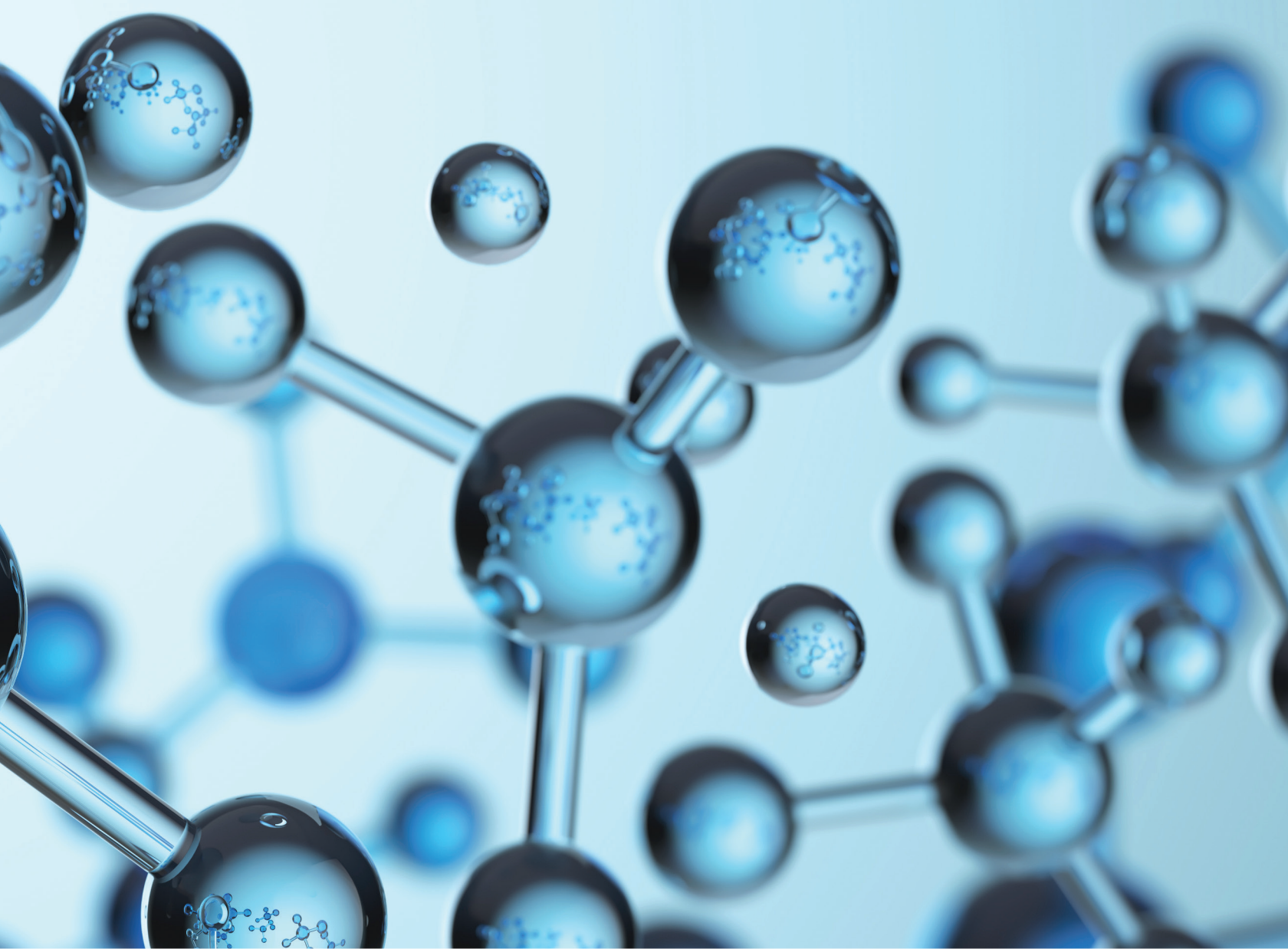
HANDS-ON physics



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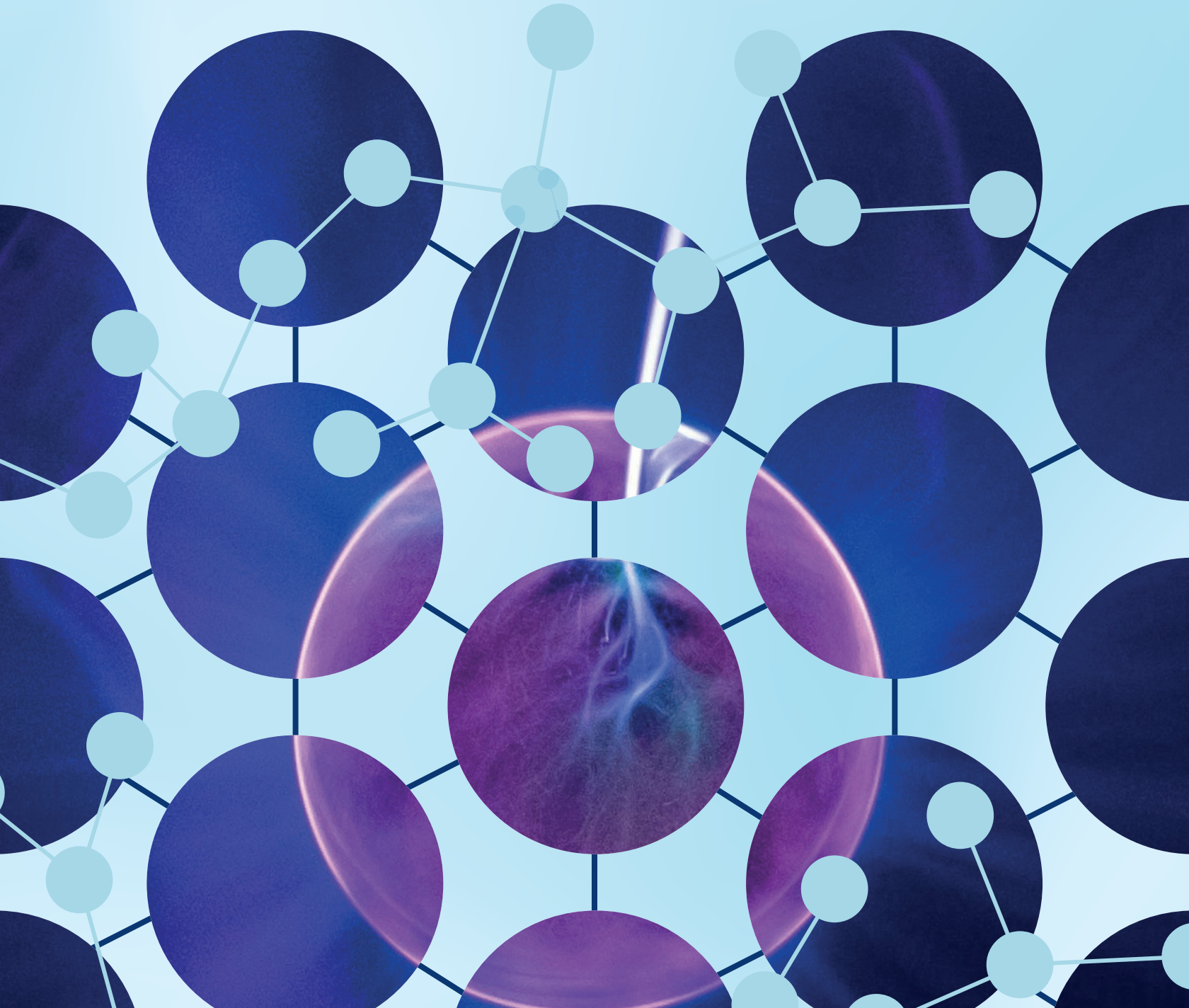


MATTER AND ENERGY

Ever stopped to think about the world around you? Everything you can think of, including rocks, sunlight, and even the food in your fridge, can be divided into just two categories: matter and energy. They're the fundamental building blocks that make up everything you see, touch, and feel. But what do these words really mean, and how do they shape our world? Let's dive in and find out!

MATTER

Let's begin by exploring matter. Matter is everything around you – the books you read, the toys you play with, and even the air you breathe. It's anything that takes up space and has **mass**.

But what exactly is mass? Mass is a measure of how much matter is packed inside an object. A big rock has more mass than a small pebble because it contains more matter. That's why it feels heavier.

However, it's important not to confuse mass and weight. Imagine a backpack filled with books. The mass of your backpack is like the total number of books inside. Now, when you hold that backpack on Earth, it feels heavy because gravity pulls it down. That feeling of heaviness is what we call weight. But if you were to take that same backpack to the moon, where gravity is weaker, it would feel lighter even though it still contains the same number of books. So, while the mass (which is the number of books) stays the same, the weight (which is the feeling of heaviness) can change depending on where you are.

A big stone has more mass than a little pebble.

ENERGY

Now, let's talk about energy. Energy is the ability to do work, or the power that makes things happen or change. It's what makes things move, get warm, or create light and sound. Basically, everything around you needs energy to work, whether it's turning on a light, playing with your gadgets, or making a sandwich.

Now let's dive into the two main types of energy: **potential** and **kinetic**.

You need energy for everything, even making sandwiches.

POTENTIAL ENERGY

Potential energy is stored energy, which is energy that's waiting to be used. Imagine a parked bike or a ball sitting at the top of a hill. They both have potential energy because they're not moving or doing any work, but they're ready to go. Another example is a stretched rubber band. It's not actively doing anything, but it's ready to snap back into shape.

Words to Know

1. Matter - anything that has mass and takes up space
2. Energy - the ability to do work
3. Mass - the amount of matter or substance that makes up an object
4. Potential energy - the stored energy in an object due to its position, properties, and forces acting on it
5. Kinetic energy - a form of energy that an object or particle has by reason of its motion

KINETIC ENERGY

Kinetic energy is the energy of motion. When objects move, they have kinetic energy. A bike speeding along the road, a ball rolling down a hill, and a rubber band snapping back into shape are all examples of kinetic energy in action.

Two factors decide how much kinetic energy an object has. The first factor is speed. The faster something moves, the more kinetic energy it has. For example, if you give a ball a gentle push, it won't roll very far because it's lacking this energy. But if you give it a big push, it will zoom farther and faster because it's got more kinetic energy.

The second factor is mass. The bigger the mass, the more kinetic energy an object has, even if it's moving at the same speed as something smaller. That's why a large truck, for example, has more kinetic energy than a small car traveling just as fast.

FORMS OF ENERGY

There are many different forms of energy. Let's take a look at some of them.

- **Thermal Energy:** This is the energy that makes things warm. When you're by a fire or drinking hot cocoa, you're feeling thermal energy in action.
- **Chemical Energy:** This is the energy stored in **atoms** and **molecules** (tiny particles that make up everything in the world).
- **Electrical Energy:** This is the energy that powers electronic devices, like phones and computers. When you plug something in, it uses electrical energy to work.
- **Sound Energy:** Sound energy is produced when something makes noise. When you put on some music or clap your hands, you're creating sound energy.

A campfire produces thermal energy.

- **Light Energy:** Light energy comes from sources like the sun, lamps, or flashlights. It's what allows you to see everything around you.

- **Nuclear Energy:** This is the energy found in atoms. It's what makes things like power plants and even the sun work.

Nuclear energy makes power plants work.

RENEWABLE AND NON-RENEWABLE ENERGY

Let's now explore where our energy comes from. There are two sources of energy: renewable and non-renewable.

Renewable energy is generated by sources that naturally replace themselves over time, like the sun, wind, and water. These energy sources are great because they won't run out and they're better for the environment. Renewable energy is like having a snack that refills itself every time you take a bite. It's as if enjoying your favorite treat without ever having to worry about it running out.

On the flip side, **non-renewable energy** comes from sources like coal, oil, and natural gas, which can't be replaced once they're used up. These fuels take a long time to form and are limited. Once they're used, they're gone for good. It's similar to eating your favorite snack too quickly. It's doesn't last long, and you have to be careful with how much you use.

Solar panels harness renewable energy from the sun.

VOCABULARY:

RENEWABLE ENERGY	_____	1. energy of motion
MATTER	_____	2. the ability to do work
NON-RENEWABLE ENERGY	_____	3. tiny particles that make up everything in the world
MASS	_____	4. anything that takes up space and has mass
KINETIC ENERGY	_____	5. energy sources that can't be replaced once they're used up
ATOMS	_____	6. stored energy
ENERGY	_____	7. energy sources that are naturally replaced over time
POTENTIAL ENERGY	_____	8. the amount of matter inside an object

QUESTIONS

1. **What is the difference between mass and weight?**

_____

_____

2. **Can you think of an object not mentioned above that has both potential and kinetic energy?**

_____

_____

3. **List three examples of things that use either thermal energy or sound energy.**

_____

_____

4. **If renewable energy is considered better, why do you think non-renewable energy is still used?**

_____

_____

SCIENTIFIC LAWS

Ever wonder why clouds form in the sky or why your hot chocolate loses its warmth over time? Scientists investigate these questions and others to understand how things work. When they find consistent patterns explained by simple rules, these become scientific **laws**. These laws help us understand how different parts of the world work. Just like traffic laws keep cars moving safely and in an orderly way, scientific laws explain and predict how everything in the world behaves.

There's one important law that explains how energy moves and changes, affecting everything we do. Let's dive into the fascinating world of the law of conservation of energy!

There are laws explaining how everything in the world works, even clouds.

The light energy in a flashlight is converted from its battery's electrical energy.

LAW OF CONSERVATION OF ENERGY

The **law of conservation of energy** tells us that energy can't be created or destroyed, only changed from one form to another.[1] In other words, energy can't magically appear out of nowhere or just vanish into thin air. It's always there, just transforming from one type to another.

When you turn on a flashlight, for example, the electrical energy from the batteries is converted into light, making it shine. When you turn it off, that energy doesn't disappear; it just goes back to being stored in the batteries as electrical energy.

1 It's called the law of conservation of energy because it describes how energy is conserved, or stays the same, within a system.

CLOSED SYSTEM

The law of conservation of energy also tells us that in a closed system, the total amount of energy always stays the same. A closed system is like a sealed container where nothing can come in or go out, but energy can still move inside. Even though the energy might change from one form to another, like from light to heat, the total energy inside the system remains the same.

Let's say you're playing with a toy car inside a closed box. When the car slows down, the total energy inside the box stays the same, even if the car's energy changes form (like from kinetic to heat). But if you play with the car outside the box, some of its energy can escape to the air and ground around it.

Words to Know

1. Law of conservation of energy - a law stating that energy can neither be created nor destroyed
2. Closed system - a system in which only the exchange of energy is allowed, but the exchange of matter is not allowed
3. Friction - the force felt between two surfaces when one attempts to slide against the other
4. Mechanical energy - the energy of either an object in motion or the energy that is stored in objects by their position
5. Gravity - an invisible force that pulls objects toward each other

FRICTION

Ever wondered why your hands feel warm after rubbing them together really fast? That's because of **friction**!

But what's friction, and why does it make things warm? Friction is a force that happens when two things rub against each other, like car wheels on the ground or shoes on a floor.[2] This rubbing always slows down or stops the movements of the objects, which might seem like energy is disappearing. But remember, energy doesn't vanish; it just changes forms. So, when you rub your hands, the kinetic energy from your movements is transformed into heat energy, giving your hands that warm feeling.

When a car tire slows down because of friction with the road, its kinetic energy changes into thermal energy.

MECHANICAL ENERGY

Imagine you're making a cake. When you mix ingredients like flour, sugar, and eggs together, you get something delicious! Similarly, potential and kinetic energy are like ingredients. Potential energy is the stored energy, like a toy car sitting at the top of the hill, ready to go. Kinetic energy is the energy of motion, like when the car starts rolling down the hill, moving faster and faster. When you combine the potential energy with the kinetic energy, you get **mechanical energy**. In simple terms, mechanical energy is the total energy of an object's motion (kinetic energy) and its position (potential energy).

2 Friction can be helpful or unhelpful. It helps a bike stop with its brakes but makes it hard to push a heavy box on the floor.

POSITION AND SHAPE

When you lift a ball or stretch a rubber band, they gain potential energy because they're ready to move. Essentially, potential energy is all about an object's position and its shape. Even though there are many types of potential energy, they all come down to these two factors. Let's explore two forms of potential energy you often come across.

GRAVITATIONAL POTENTIAL ENERGY

The higher the ball is lifted, the more gravitational potential energy it has.

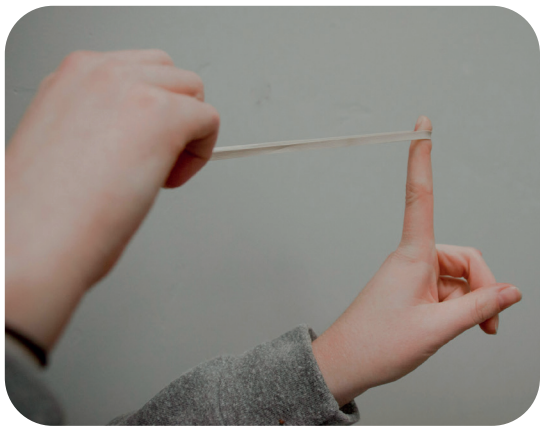
If you've ever put money in the bank, you know that the more you put in, the more you have saved up. **Gravitational potential energy** works in a similar way. The higher you lift an object and the heavier it is, the more of this energy it has saved up.

This is because when you lift an object, you're working against **gravity**, the force that pulls things down. Just like you can add money to your savings, lifting an object higher increases its gravitational potential energy. And the heavier the object, the more effort it takes to lift it, resulting in even more stored energy.

ELASTIC POTENTIAL ENERGY

Elastic potential energy is the energy stored in something when you push, pull, or force it out of shape. This energy is released when the object returns to its original shape or position.

For example, when you stretch a rubber band, you're doing work to change its shape. This work gets stored as elastic potential energy. When you let go, the stored energy is released, and the rubber band snaps back. Similarly, when you squeeze a spring, you're storing energy in it as elastic potential energy. When you release the spring, it bounces back to its original shape, releasing the stored energy.



A stretched rubber band has elastic potential energy.

VOCABULARY:

GRAVITY _____

MECHANICAL ENERGY _____

ELASTIC POTENTIAL ENERGY _____

SCIENTIFIC LAWS _____

GRAVITATIONAL POTENTIAL ENERGY _____

CLOSED SYSTEM _____

LAW OF CONSERVATION OF ENERGY _____

FRICTION _____

1. energy stored in objects when pushed, pulled, or forced out of shape
2. a system where energy can't enter or leave
3. rules that describe how everything in the world works
4. the force that pulls things down
5. when two things rub against each other
6. energy stored in an object because of its position above the ground
7. total energy of an object's motion and position
8. rule stating that energy can't be created or destroyed; it can only change forms

QUESTIONS

1. **What does it mean for energy to change forms?**

2. **How does energy behave inside a closed system compared to outside of it?**

3. **What is friction, and how does it affect the movement of objects?**

4. **What kind of energy does a ball have when you're holding it before you throw it? When it's moving through the air?**

STUDENT EXERCISE

	Balloon Circumference	Distance Traveled
Trial 1	30 mm	
Trial 2	50 mm	
Trial 3	75 mm	
Trial 4	100 mm	
Trial 5	125 mm	
Trial 6	150 mm	