

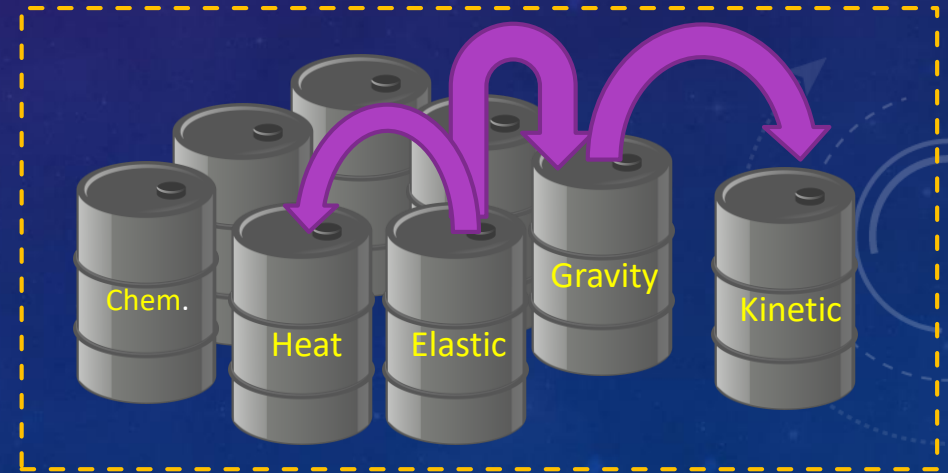
The background features a dark blue gradient with a starry pattern. On the left side, there are several overlapping circular elements. A prominent one is a large scale with tick marks and numbers ranging from 140 to 260. Other circles contain curved lines and arrows, suggesting motion or energy flow.

CONSERVATION OF ENERGY

PES 1000 – PHYSICS IN EVERYDAY LIFE

CONSERVATION OF ENERGY

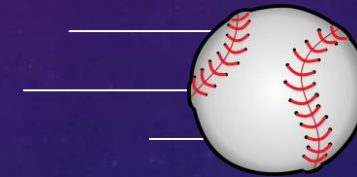
- If you are very careful to account for all forms of energy, you'll find that in a system that is isolated from energy losses or gains, the sum of all the energy does not change.
- This is the fundamental concept of the **Law of Conservation of Energy: In an isolated system, the total energy is constant**
- An alternative statement is: **Energy can neither be created or destroyed. It can only change form.**
- Although it is always true, it is not always easy to apply since some energies are difficult to measure



ENERGY FORMULAS

Here are some relationship formulas for some of the more common situations we'll encounter

- **Kinetic Energy** – Depends on an object's mass and speed



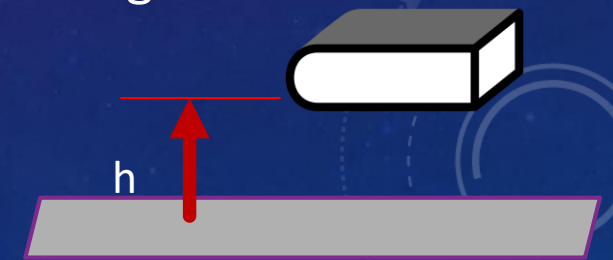
- $KE = \frac{1}{2} \text{mass} * (\text{speed squared}) = \frac{1}{2} m * v^2$

- The energy an observer measures depends on his own speed relative to the object

- **Gravitational Potential Energy** – Depends on an object's weight and how high it is

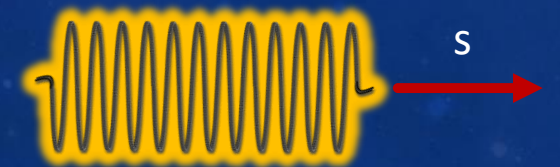
- $P_{\text{gravity}} = \text{weight} * \text{height} = m * g * h$

- The book itself doesn't contain this energy. It is in the book-Earth system.



- **Elastic Potential Energy** – Depends on the spring constant and how much it is stretched/compressed

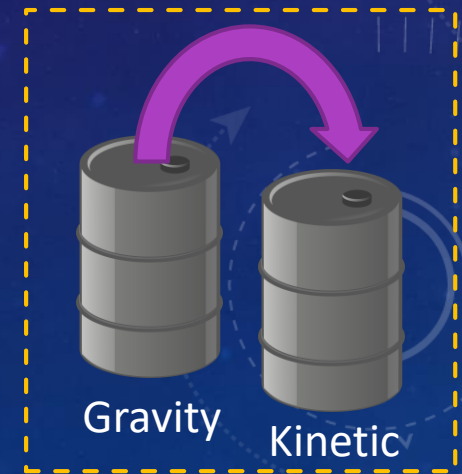
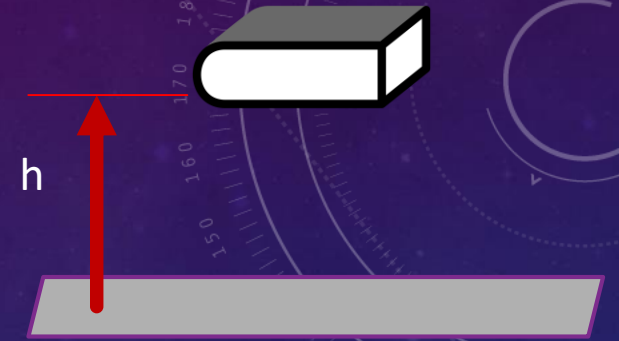
- $P_{\text{spring}} = \frac{1}{2} (\text{spring constant}) * (\text{stretch squared}) = \frac{1}{2} k * s^2$



APPLYING CONSERVATION OF ENERGY

Let's apply the **Law of Conservation of Energy** to an example:

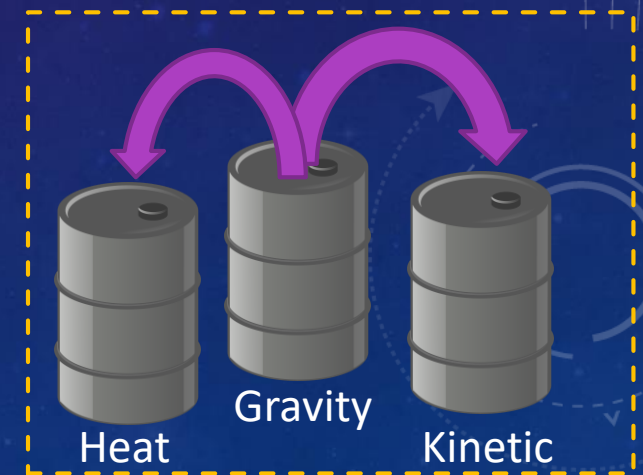
- We drop a book from a certain height above the floor.
 - Between when we have released it and right before it reaches the ground, only **gravity** and **drag** affect it.
 - **Drag force** is very small, so we can ignore it.
 - This means that the **gravitational potential energy** that the book started with is entirely converted into **kinetic energy** as it approaches the floor.
- Conservation of Energy says **$PE_{\text{gravity}} = \text{Kinetic Energy}$** , or
 - ~~$m \cdot g \cdot h = \frac{1}{2} m \cdot v^2$~~
 - Notice that mass appears on both sides of the equation, so it cancels out. This means that the speed does not depend on the mass of the object, and **all objects fall at the same rate** if drag is ignored.



APPLYING CONSERVATION OF ENERGY

Let's apply the Law of Conservation of Energy to another example:

- The same book slides down a rough wooden slope from the same height as before.
 - We will ignore air drag again, but the friction is not ignorable
 - **Friction** turns some of the energy into **thermal energy**: the book and the slope are slightly warmer, but this is very difficult to measure.
- Conservation of Energy says $PE_{\text{gravity}} = \text{Thermal Energy} + \text{Kinetic Energy}$, or
 - The book has less energy in the form of kinetic energy, so it is moving slower than if it was simply dropped
 - We know its initial **gravitational energy** and we can measure its **kinetic energy** at the bottom. Conservation tells us that the

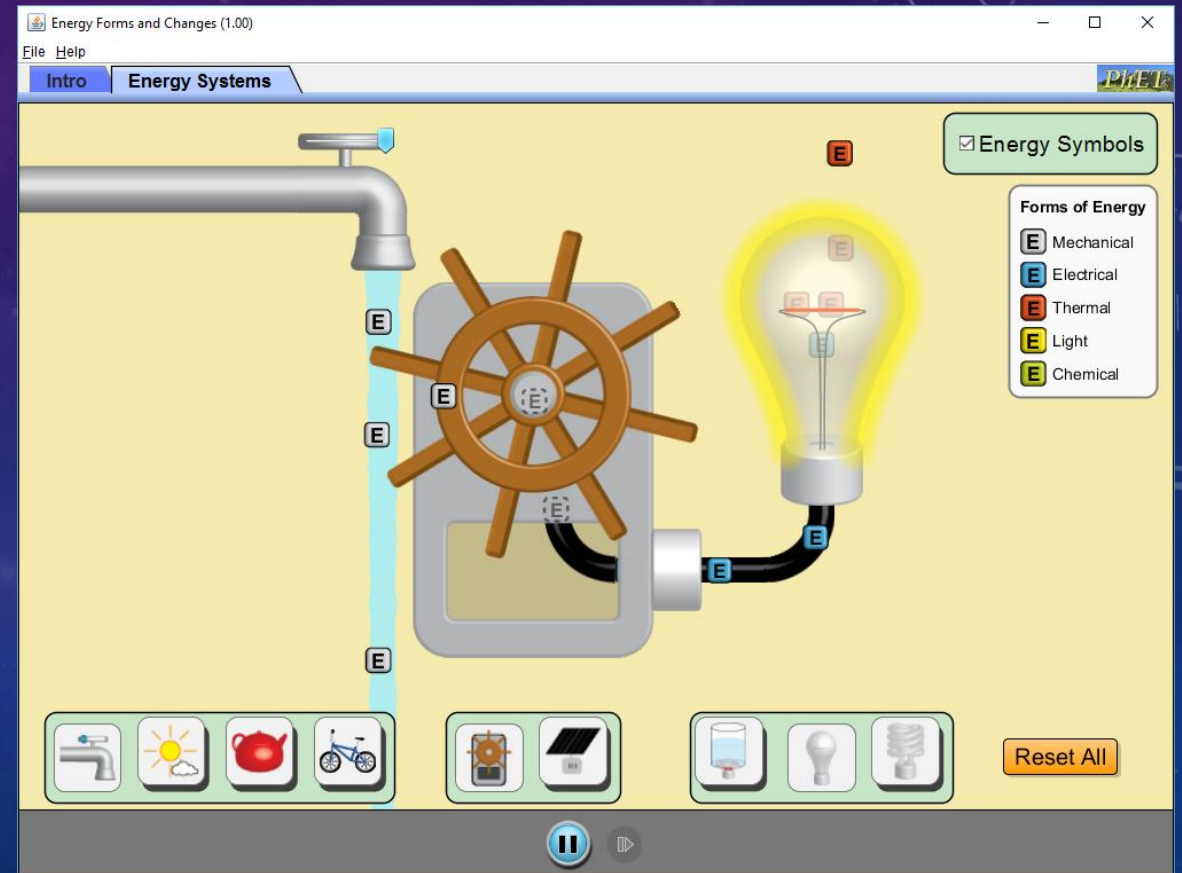


ENERGY TRANSFER SIMULATION

Link to simulation: <https://phet.colorado.edu/en/simulation/legacy/energy-forms-and-changes>

Things to try:

- Select the 'Energy Systems' box.
- Check the 'Energy Symbols' box
- Turn on the water at the handle.
- Try different types of:
 - **Energy Sources** (water, sun, steam, bike)
 - **Energy Transfer** devices (water wheel, solar panel)
 - **Energy Consumption** devices (water, light bulbs)



CONCLUSION

- The **Law of Conservation of Energy** is a fundamental principle of nature.
- **In an isolated system, the total energy is constant.**
- This law has **never** been observed to have been violated in **any** branch of science.
- While the Law of Conservation of Energy is **always true**, it is **not always easy to apply**.
- We will be encountering **other important conservation laws** as we explore physics further.