

# Physics Reference: Manifestations of Energy

## *Kinetic energies – based on the motion of matter*

- **Kinetic** – the motion of a single object
  - calculated as  $KE = \frac{1}{2} \cdot m \cdot v^2$
  - the faster or more massive something is, the more kinetic energy it has
- **Thermal** – thermal energy is the random motion of tiny particles (informally, “heat”)
- **Sound** – the energy of sound waves causes tiny particles to vibrate
- **Electrical** – electric current (like from a wall socket) is really just a stream of moving electrons

## *Potential energies – based on arrangements of matter and fields*

- **Gravitational** – causes gravitational attraction
  - calculated as  $GPE = m \cdot g \cdot y$  ( $y$  = height above your reference point)
- **Elastic** \* – causes the stretching or deforming of a solid object
  - springs and rubber bands are the most common examples
  - anything that *returns to its original shape* after you bend, compress, or stretch it is storing elastic potential energy
  - usually calculated as  $EPE = \frac{1}{2} \cdot k \cdot \Delta x^2$  ( $k$  = spring constant,  $\Delta x$  = stretch/compression)
- **Radiant** \* – visible light and other electromagnetic radiation/waves
  - radiation *isn't matter*, so it's not a kinetic energy even though it moves
  - radio, microwaves, infrared, visible light, ultraviolet, x-rays, and gamma rays
- **Phase** \* – based on the “phase” or “state” of matter, representing the closeness of its particles
  - solids have the least, liquids have a little, and gases have a lot
- **Chemical** \* – based on the arrangements of individual atoms into different molecules
  - food and fuels like coal or gasoline have a lot of chemical potential energy stored in them
- **Electromagnetic** – based on the fields that cause electric and magnetic attraction/repulsion
  - different from the energy of an electrical current!! this is more like “static electricity”
  - \* the four starred energies above are all based on electric and magnetic fields and their interactions with tiny particles, so they can be considered electromagnetic too!
- **Nuclear** – based on the arrangements of particles inside an atomic nucleus
  - stars, nuclear power plants, and nuclear bombs make use of this energy type
- **Matter/mass** – matter itself is a form of energy! that's what  $E = m \cdot c^2$  means!

## *Conservation of energy*

- A system (set) of objects can have any combination of energy types at any time!
  - $E = KE + GPE + EPE + \dots$  (just add up all the types that are present!)
- The total energy in a system stays the same unless an outside force does work to change it:
  - $E_f = E_i + W$
- All energy eventually ends up as thermal energy thanks to friction.

## *Measuring energy*

- The SI unit for work and energy is the Joule (J).
- $1 \text{ J} = 1 \text{ kg} \cdot \text{m}^2 / \text{s}^2$