## **SI Units:**

* Kilo:
* Mega:
* Giga:
* (Tera: )

# **Oscillations:**

"Physics" = "nature"

Same equation for every type of oscillation!

Period:

* length of time for one complete oscillation
* cosine wave (with time)
* The smaller the period, the faster it oscillates

Frequency:

* (context: sound has a frequency ranging from a few Hertz to 10kHz)

Relation between Period and Frequency:

* Period is related inversely to frequency

Periodic (Harmonic) motion:

* sinusoidal motion
* Amplitude
* angular frequency
* phase (starting point)
* so
* requires a stable equilibrium (i.e. a spot with lower potential energy than surrounding area)
  + an unstable equilibrium has all surrounding points with lower potential energy

## **Simple Harmonic Oscillators**

Anything (like atoms) with a potential energy graph that resembles a parabola (even w/ small x) is a SHO

Restoring force:

* Must have a restoring force except at equilibrium
* Hooke’s Law:

  + (i.e. restoring force is proportional to displacement)
  + This restoring force *must* be negatively proportional for it to be a SHO
* Solutions to the differential equation () with Hooke’s Law and
* When substituted back, we find that
* does not depend on amplitude!
* Larger (spring constant) oscillates **faster**
* Smaller (mass) oscillates **faster**

Energy conservation:

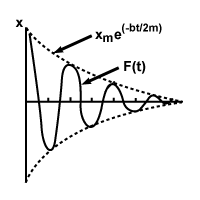
* Spring Potential Energy:
* Mass Kintetic energy:
* Not correct!

Oscillating Pendulum

* Simple Harmonic Oscillator only for very small values of x
* only difference from a spring is that a pendulum is driven by gravity
* Radius is constant, of string
* decompose gravity into:
  + force along string
  + force along path: **restoring force**:
* displacement is arc length
* , does not depend on mass
* Simple Pendulum:
  + Period is independent of the angle at which the pendulum is released!
* Real pendulum:

## **Damped Harmonic Oscillation**

* Friction slows down the harmonic oscillation
* Still a cosine graph, but the amplitude changes as a function of time
  + Amplitude decreases exponentially
  + (Frictional force depends on velocity, as the velocity gets lower, there is less friction)



* where b is the damping constant
* Wave Function
* Solution to wave function: (where )
* Frequency changes as
* “Critically Damped” is the fastway to equilibrium without oscillation ()
* “Over Damped” still has no oscillation, and
* amplitude decreases exponentially, and frequency changes!

## **Forced Oscillations**

* If you apply a force to an object on its own frequency, the amplitude gets larger
* where is the driving frequency.
  + All oscillators will eventually oscillate at the applied driving frequency: “**steady state**”
* Cases:
  + If (driving frequency is the same as the object’s frequency), the Amplitude gets higher (to infinity)
    - This is the maximum amplitude increase!
    - **Resonance**
      * larger resonance frequency range of damped oscillations, but smaller peak
  + If (b is damping),
  + If , the amplitude is limited by a peak value: “resonance peak”
  + If is large, nothing will happen (the object can’t respond in time)
* IMPORTANT:
  + *Large Damping = wide resonance peak*
  + *Large Damping = small resonance peak*
  + *Position of resonance peak depends on damping*
  + *Driven oscillator oscillates at drive frequency*