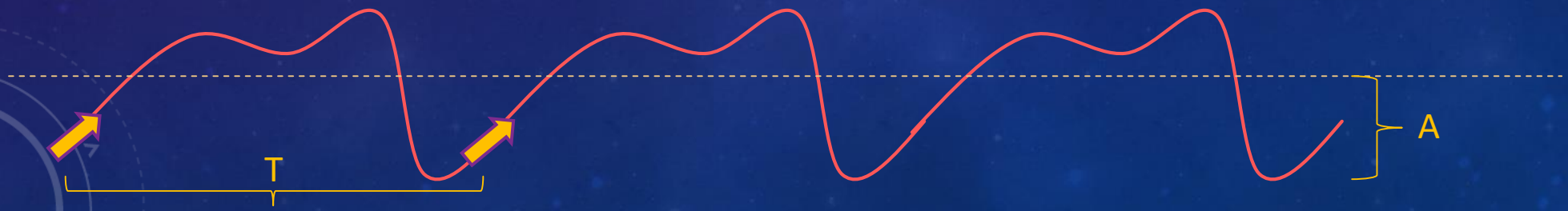
PERIODIC MOTION

PES 1000 – PHYSICS IN EVERYDAY LIFE

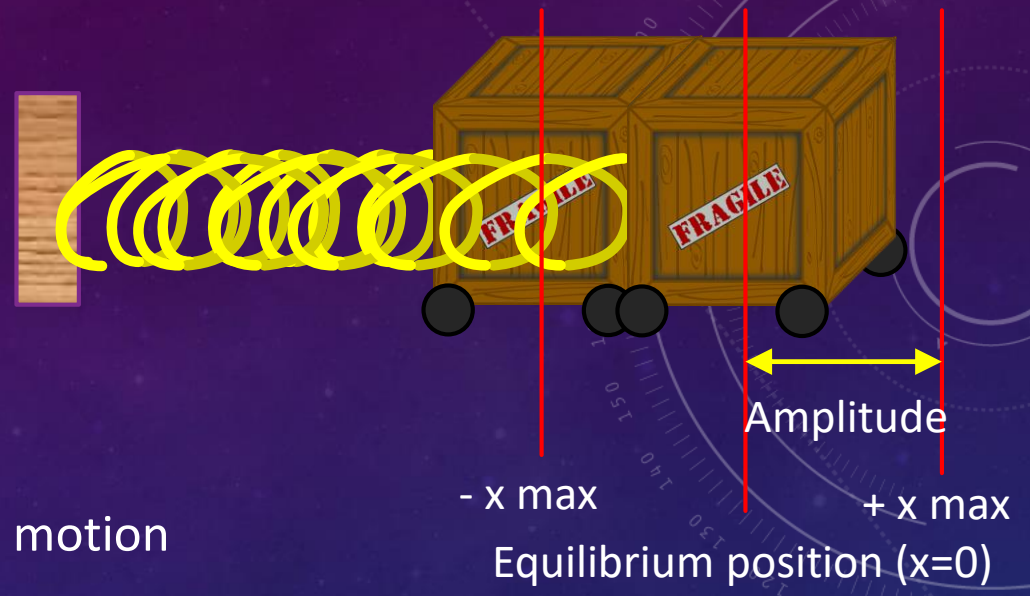
DEFINITIONS & UNITS

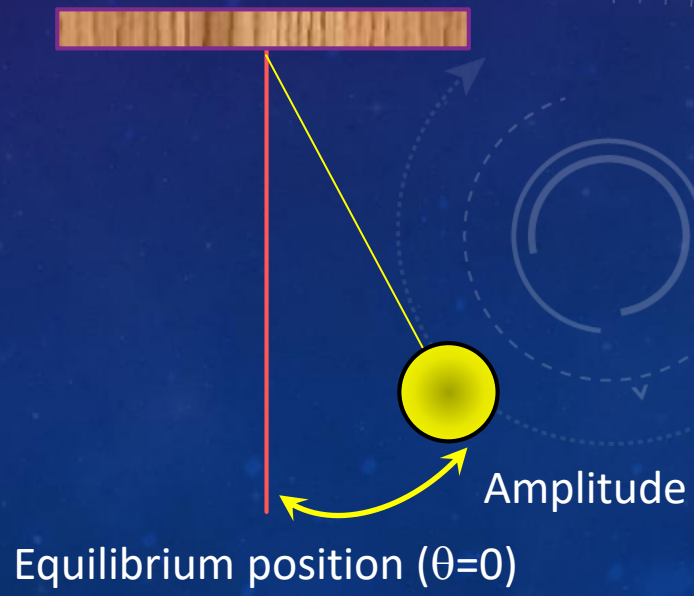
- If an object starts with a particular position and velocity and returns to that same position and velocity, it will continue to repeat its motion. This is called periodic motion.
  - The time it takes to complete one cycle is called the period. Period is measured in seconds, and the variable used for period is usually T.
  - The value called frequency is related to the period and measures how many cycles occur per second. The units are Hertz (abbreviated Hz) and sometimes written 1/s or s^{-1}. The variable used for frequency is usually f.
    - Frequency is related to period by the simple equation $f = 1/T$.
- The distance that the object moves from its resting position is called its amplitude. The SI units for amplitude are meters, and the variable used is often A or sometimes x_{max}.



EXAMPLES

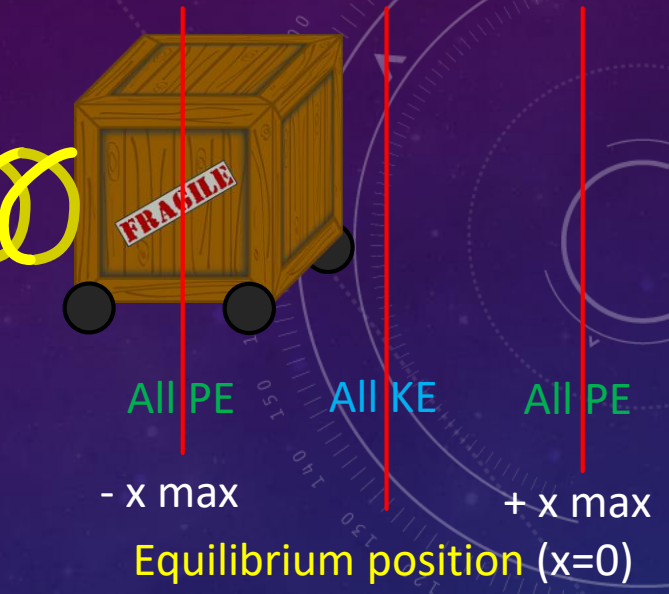
- Box and spring
  - We ignore drag and friction
  - The equilibrium position is where the box sits before motion begins.
  - The amplitude is the maximum distance from equilibrium
- Pendulum
  - We ignore drag
  - Equilibrium is the lowest point of the arc
  - Amplitude is the largest angle the string moves from equilibrium
- In this example, one cycle (full swing) takes 2 seconds, so the period, T=2 s, and the frequency, f = 1/T = 1/2 Hz.

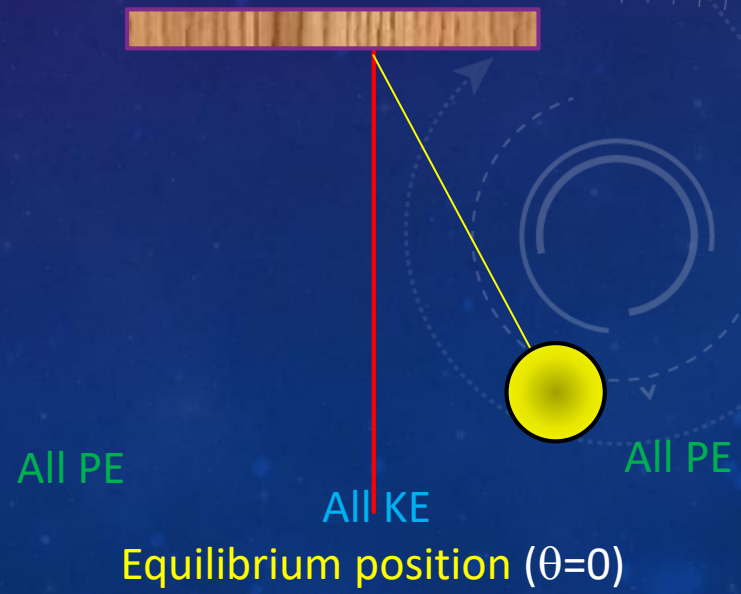




ENERGY APPROACH

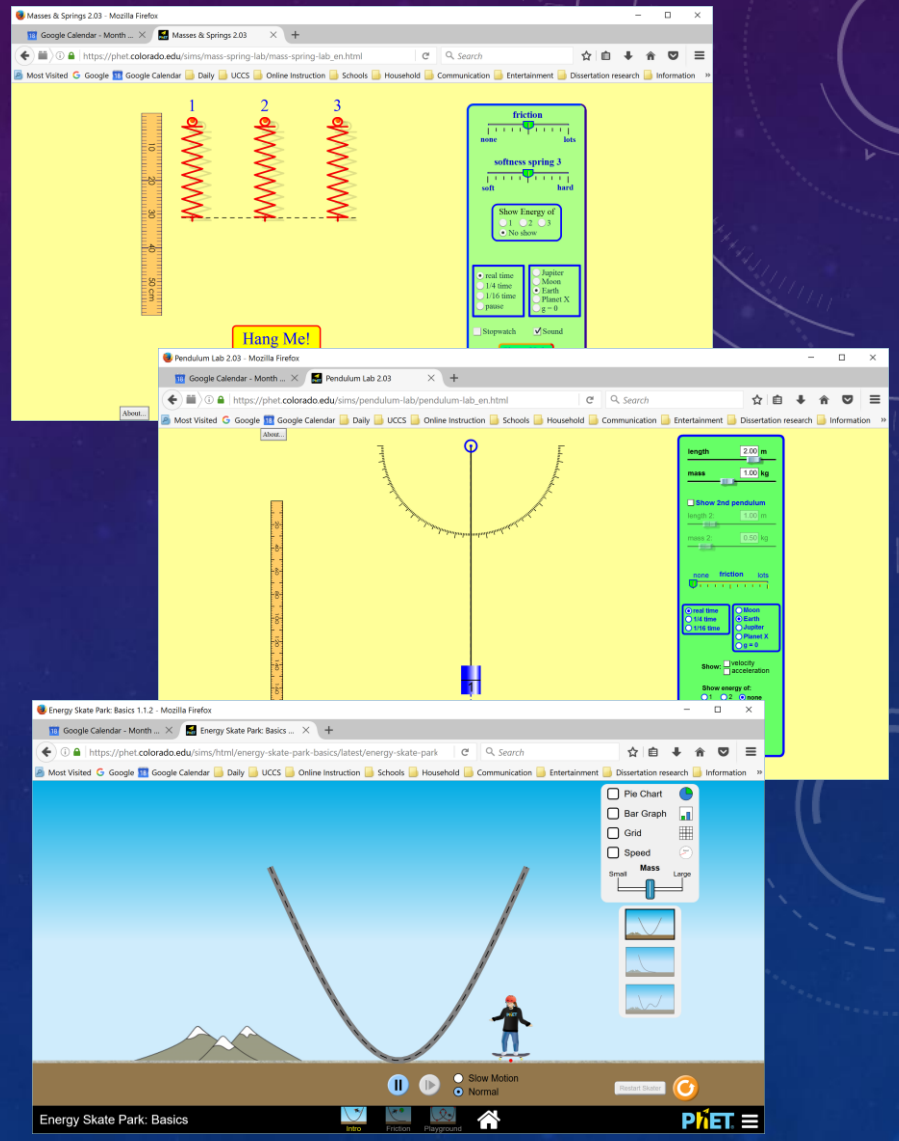
- Let's examine the periodic motion of the box and spring using an energy approach.
  - When the spring is compressed, it contains potential energy.
  - The energy transfers this energy into the kinetic energy of the box as it moves through equilibrium.
  - Inertia carries the box past equilibrium, and the spring slows it down, storing the energy again as potential energy.
  - The process then reverses. If no energy is lost, this cycle will continue indefinitely.
- Applying the energy approach to the pendulum:
  - At the top of the arc, energy is stored as gravitational potential energy.
  - At the bottom of the swing, the energy has transferred into kinetic energy.
  - Inertia carries the pendulum back up to the top of the arc on the other side, and the process repeats.





PERIODIC MOTION SIMULATION

- Link to box and spring simulation:
  - https://phet.colorado.edu/en/simulation/legacy/mass-spring-lab
    - Try this: Select the 'Show Energy' box. Turn off friction and gravity (g=0). Hang a weight on spring 1. Observe the energy graph.
- Link to pendulum simulation:
  - https://phet.colorado.edu/sims/pendulum-lab/pendulum-lab_en.html
    - Try this: Select the 'Show Energy of 1' box. Move the pendulum to the side and let it go. Observe the energy graph.
- Link to skate park simulation:
  - https://phet.colorado.edu/en/simulation/energy-skate-park-basics
    - Try this: Select 'Intro'. Put the skater on the track and let him go. Observe the energy graph. Try changing the shape of the track.



CONCLUSIONS

- Periodic motion is any motion that goes through a cycle that repeats.
  - Examples are a box & spring, a mass hanging from a spring, a pendulum, a marble in a bowl, etc.
- Important quantities:
  - Period is how long it takes to go through one cycle.
  - Frequency is how many cycles it goes through in one second. It is the reciprocal of period.
  - Amplitude is the maximum distance from the equilibrium or rest point.
- During periodic motion, energy transfers between potential energy and kinetic energy.