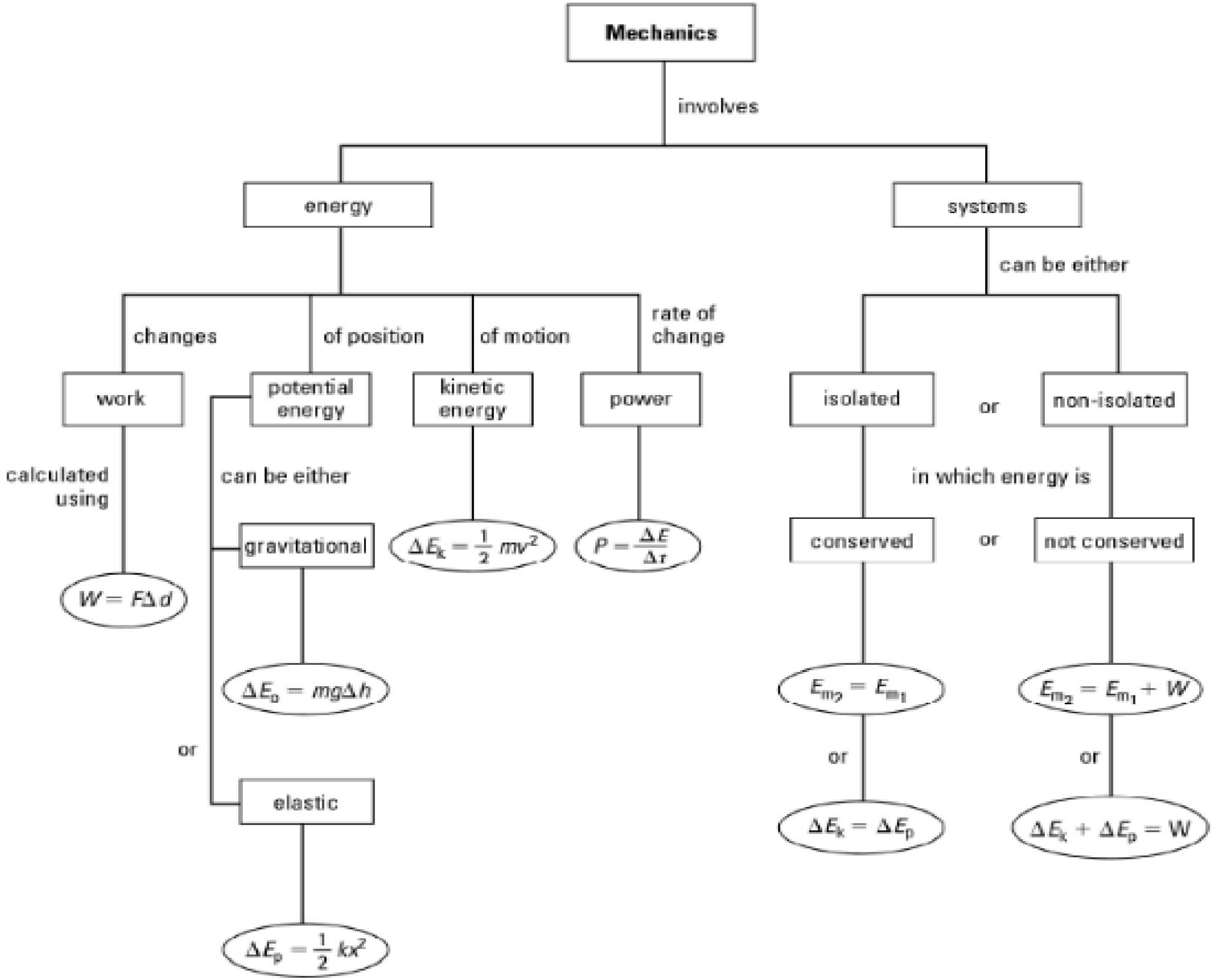
Work and Energy Review


Mechanics
involves
energy
systems
changes
of position
of motion
rate of change
can be either
work
potential energy
kinetic energy
power
isolated
or
non-isolated
calculated using
can be either
in which energy is
gravitational
$\Delta E_k = \frac{1}{2} mv^2$
$P = \frac{\Delta E}{\Delta t}$
conserved
or
not conserved
$W = F\Delta d$
$\Delta E_p = mg\Delta h$
$E_{m_2} = E_{m_1}$
$E_{m_2} = E_{m_1} + W$
or
or
or
elastic
$\Delta E_k = \Delta E_p$
$\Delta E_k + \Delta E_p = W$
$\Delta E_p = \frac{1}{2} kx^2$

Work

- a change in energy
- a force exerted over a displacement
- force and displacement must be in same direction for work to take place

$$W = \vec{F}\vec{d}$$

To find work (N) done by exerting a force parallel to a displacement.

or

$$W = \vec{F}\cos\theta\vec{d}$$

To find work done by the parallel component of a force if force is not parallel to displacement (θ is the angle between the force and displacement).

ex) What is the change in kinetic energy if a net force of 3.80×10^3 N [0°] acts on a mass while it undergoes a displacement of 95.0 m [335°]?

Ans: 3.27×10^5 J

Gravitational Potential Energy

- one of several types of potential energy
- energy by virtue of height
- reference points can vary

$$PE = m\vec{g}\vec{h}$$

Where the height is measured in reference to some point.

Kinetic Energy

- energy by virtue of speed/motion
- notice the squared term!

$$KE = 1/2m\vec{v}^2$$

Don't forget to square the velocity! (Or square root if solving for velocity.)

Elastic Potential Energy

- Comes from Hooke's law for elastic/springs:

$$\vec{F}_{spring} = k\vec{x}$$

where:
k = spring constant (unique to each spring)
$\vec{x}$ = stretch or compression displacement

- Found by taking the area under a force vs. position graph of a spring (A = 1/2LW, W = 1/2Fd)

$$PE = 1/2k\vec{x}^2$$

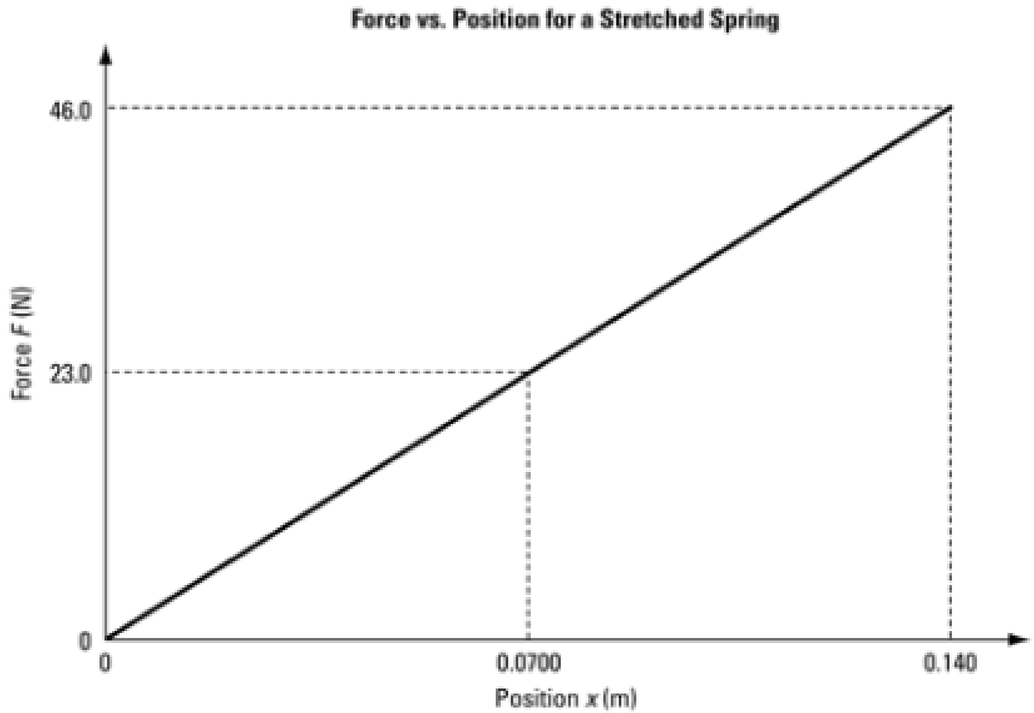
(Recall: Graph on Handout)

Elastic Potential Energy

The following graph shows how a force causes change in position as it stretches a spring. □
Note that the force is acting parallel to the change in position.

(a) Calculate the energy stored in the spring when the force is 46.0 N.

(b) Compare the energy when the force is 46.0 N to the energy stored in the spring when its position is 7.00 cm.



Mechanical Energy

- the sum of kinetic and potential energies acting on an object.

- this energy can be thought of as a change in energy, which leads into the

Work-Energy Theorem

$$W = \Delta KE + \Delta PE$$

- the work done on a system is equal to the change in mechanical energy (sum of the KE and PE).

This also leads into...

The Law of Conservation of Energy

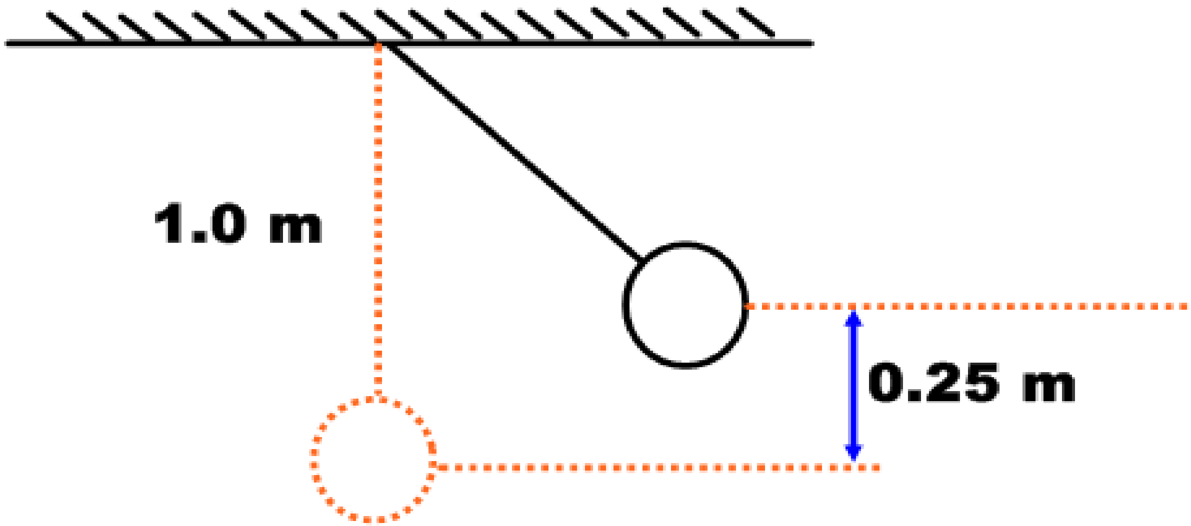
- in an isolated system, energy is not gained or lost, only changed in form

All of these ideas are used to solve problems where we let PE = KE or W = PE + KE or some combination thereof.

ex) Caitlin drops a water balloon on Lori. The balloon is dropped from 12.0 m above Lori's head. What is the speed of the balloon as it hits Lori?

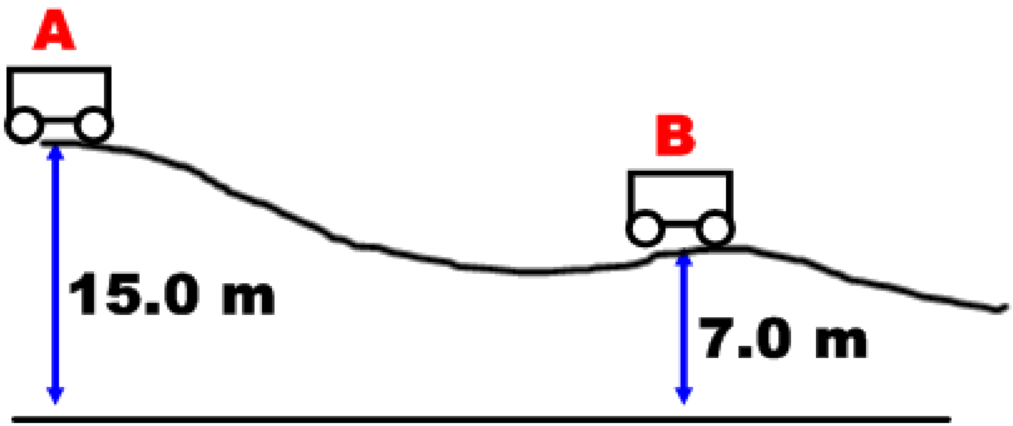
Ans: 15.3 m/s

ex) A pendulum is dropped from the position as shown 0.25 m above equilibrium. What is the speed of the bob as it passes through the equilibrium position?



Ans: 2.2 m/s

ex) A roller coaster is traveling on a frictionless track as shown. If the speed of the coaster at A is 3.0 m/s, what is the speed at B?



Ans: 13 m/s