Today: HW due.

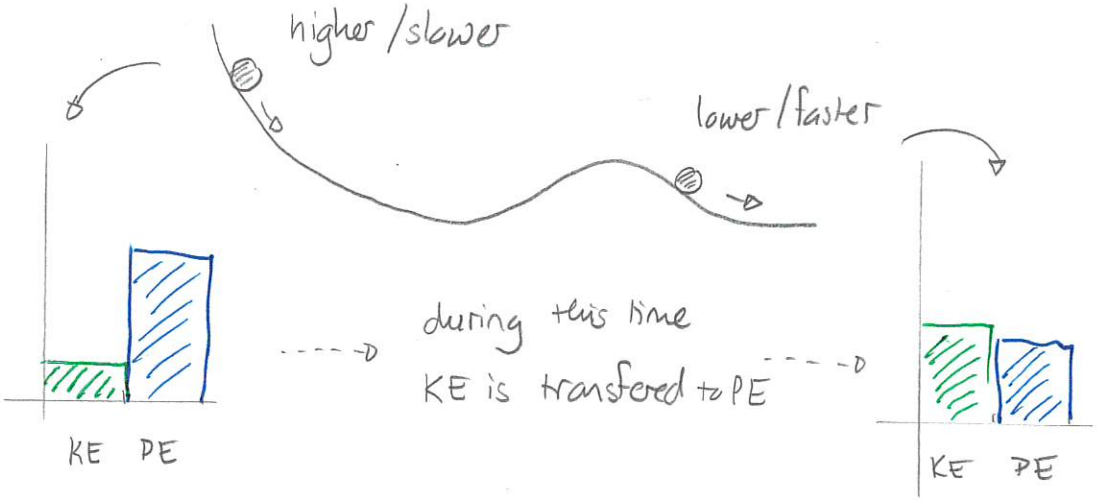
Monday: Read

## Energy conservation and energy transfer

We have seen that for some systems, the total energy

$$\text{Energy} = \text{Kinetic Energy} + \text{Potential Energy}$$

remains constant as time passes. At various moments the energy is apportioned differently and we can view this via a bar diagram




Energy is then converted from one type to another. We can imagine that energy is constantly transfered between the forms. This is analogous to transfering money between various bank accounts:

checking account ~> money easily used (useful) ~> kinetic energy

savings account ~> money stored to be used later ~> potential energy

potentially useful

Quiz 1 100%

Quiz 2 70% - 100%

Quiz 3 90%

DEMO: PhET ESP (Basics)

- show bar graphs

## Springs and energy

Will the total energy constructed in the form

energy = kinetic energy + potential energy

always be constant? Consider a mass attached to a spring.

Quiz 4 5%

DEMO: Spring / mass

If we only consider the potential energy and kinetic energy and the block is released from rest then

$$E = KE + PE$$

is not constant. A detailed analysis of the physics of springs shows that we can associate a new type of potential energy, called elastic potential energy with the spring. This is calculated via

| Instant | KE | PE | E |
|---|---|---|---|
| release | 0 | 0 | 0 |
| A little after release | positive | positive | not zero |

$$E_{elastic} = \frac{1}{2} \times (\text{spring constant}) \times (\text{stretch/compression of spring})^2$$

* describes stiffness of spring
* depends on spring

mmm: relaxed

mmm: stretched

stretch.

Then one can show:

> If the only forces that change the object's speed are gravity and the spring force then the total energy
>
> Energy = Kinetic Energy + Potential Energy + Elastic Energy
>
> $E = KE + PE + E_{elastic}$
>
> stays constant throughout the motion

This is the conservation of energy for the spring/mass system.

DEMO: PhET Masses + Springs

* Show stretched spring PAUSE.

Quiz 5

DEMO: PhET Masses + Springs

* Show energy - remove damping
  - release from floor
  - observe bar graph

DEMO: Dropped slinky.

# Concepts of Physics: Class 20

6 October 2023

## 1 Block and spring

A 4.0 kg block is suspended from a spring. The block is pulled to the ground, stretching the spring. The block is held at rest in this position and then released.

a) Determine the potential, kinetic, elastic and total energies of the block at the lowest point of its swing.

b) Determine the potential, kinetic, elastic and total energies of the block at the instant at which it reaches its highest point.

c) Determine the speed of the block at the halfway point.

| Instant | KE | PE | $E_{elastic}$ | Energy |
|---|---|---|---|---|
| At release | 0J | + 0J | + 60 J | = 60J |
| At halfway | 35J | + 20 J | + 5.0 J | = 60J |
| At max height | 0J | + 40J | + 20 J | = 60J |

c) $(\text{speed})^2 = \frac{2 \times KE}{\text{mass}} = \frac{70\ J}{4.0 kg} = 17.5$

$\text{speed} = \sqrt{17.5} = 4.2 m/s.$