Fri: HW by 5pm

Mon: Cover 6.6

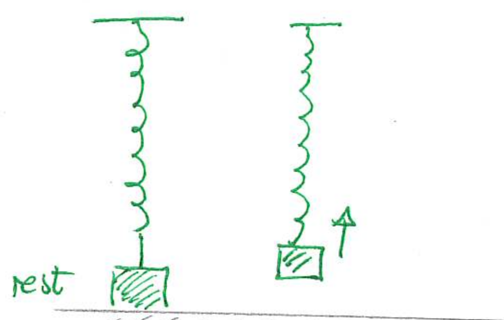
Weds: HW by 5pm

Energy conservation

For certain systems, the total energy is constructed as:

Total energy = kinetic energy + potential energy

and as time passes, this stays constant (depending on whether certain requirements, checked by considering forces). These constraints will not always be satisfied and we ask whether the ideas of energy can be broadened. We can consider a spring/mass system. Suppose that the mass is pulled extending the spring and the mass is released from rest at ground level. If we start with energy as



$$E = KE + PE$$

will this be conserved.

Quiz 1 50% - 50%

	KE	PE	E = KE + PE
release	0	0	0
moments after	positive	positive	not zero

The example shows that we cannot just use kinetic and potential energy and expect their sum to be constant.

Luckily we can analyze this using physics and the result is that we require a third type of energy to describe the springs effects. This is

> Elastic Potential Energy ⇝ describes energy stored in the spring when the spring is stretched or compressed.
>
> E_{elas}

The formula for this refers to the amount by which the spring is stretched or compressed

Quiz 2 90%

The elastic potential energy clearly depends on:

* the amount by which the spring is stretched/compressed
* the type of spring.

In more sophisticated treatments we can derive an expression:

$$E_{elastic} = \frac{1}{2} \times (\text{spring constant}) \times \left(\begin{array}{c}\text{distance by which spring} \\ \text{is stretched/compressed}\end{array}\right)^2$$

spring constant: describes stiffness of spring ⇝ depends on spring

distance measured in meters

One can then show that

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

Conservation of Energy

DEMO: PhET Mass + Springs – Energy Tab
– Damping = none

* ~~Show~~

* With small spring constant, release from ground
* Observe bar graph

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	0 J +	0 J +	60 J =	60 J
At halfway	35 J +	20 J +	5.0 J =	60 J
At max height	0 J +	40 J +	20 J =	60 J

same

Answer: a) $KE = \frac{1}{2} \times mass \times speed^2 = \frac{1}{2} \times 4.0kg \times (0 m/s)^2 = 0J$

$PE = mass \times 9.8 \times height = 4.0kg \times 9.8 \times 0m = 0J$

b) Stops ⇒ speed = 0 m/s ⇒ KE = 0 J

$KE + PE + E_{elas} = 60J$ ⇒ $0J + E_{elas} + 20J = 60J$

c) $KE + 20J + 0.5J = 60J$ ⇒ $KE = 35J$

$$speed = \sqrt{\frac{2 \times KE}{mass}} = \sqrt{\frac{2 \times 35J}{4.0kg}} = \sqrt{17.5 J/kg}$$

$= 4.2 m/s$

Quiz 3

DEMO: Dropped slinky