Lecture 14 - 2.28

Tuesday, February 28, 2023 9:33 AM

- Changing Forces
- Crooked paths

$$W = \int_a^b F(s) \cdot ds$$

- Constant Forces
- Straight paths

$$W = F \cdot s$$

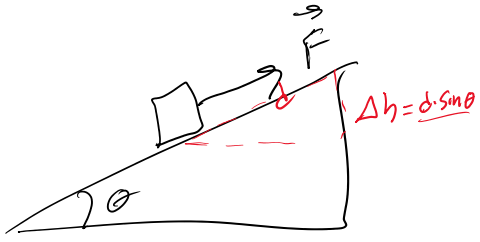
- Work is energy transferred to or from an object.
- Energy is the ability of an object to do work.

Work - Energy Theorem

$W = F \cdot d$

Pushed up, work is done, but kinetic Energy doesn't change

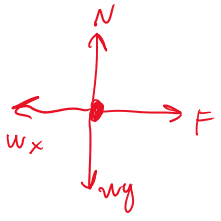
Frictionless ramp



a) How much work?

b) where does it go? Gravitational Potential (GPE / E_{pot})

c) Can you get it back? Yes, it can be converted to kinetic Energy.



$\Sigma F_x = 0 \Rightarrow w_x = F = w \cdot \sin\theta = m \cdot g \cdot \sin\theta$

$W = mg \cdot \Delta h$

Gravitational Potential Energy (GPE / E_{pot})

Potential Energy helps us store work

Power → work done in a given time.

$$\text{Power} = \frac{\text{work}}{\text{time}} \quad / \quad P = W/t$$

GPE

- Energy is always relative to a system. We usually measure this in an object - Earth system, but we can specify.

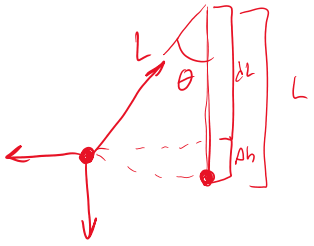
- There is no absolute Potential Energy, only relative.

- GPE = $m \cdot g \cdot y$

  y is dependent on your system. Δh

Pendelum

To get GPE, $= m \cdot g \cdot y = m \cdot g \cdot L - \cos\theta L$



$\Delta l = L\cos\theta$

$\Delta h = L - \cos\theta L$

Recap

$K = \frac{1}{2} mv^2$ $\quad U_{grav} = m \cdot g \cdot h$

- E got stored in object somehow
- Kinetic E always pos(+)
- GE can be + or −, depending on reference height
- For physics probs, we usually only care about Δ GPE

Elevator Quiz

1) Forces Balance

2) (100 kg mum, 1000 kg elevator)

Tension is same

Tension is same

$T = m \cdot g$

3) GPE increases

4) $P = w/t$

$w = m \cdot g \cdot \Delta h$

$P = \frac{m \cdot g \cdot h}{t}$

$T = m \cdot g$

$w = F \cdot h \Rightarrow m \cdot g \cdot h$

$P = \frac{w \cdot h}{t} = T \cdot v$

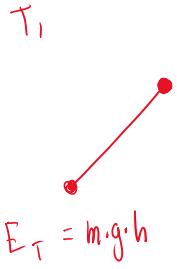
a, b, c all true

Noether Theorem: Every Symmetry yields a conserved quantity

- Laws of Phsics don't change w/ time → Symmetry
- Total Energy is always the same → This is a conserved quantity

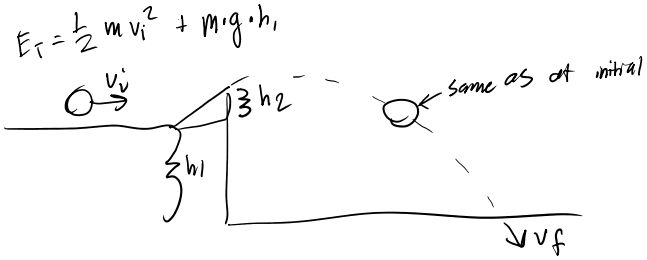
Conservation of Energy

Total Energy is always the same, as a sum of KE and U_{grav}



$\Rightarrow m \cdot g \cdot h = \frac{1}{2} m v^2 \Rightarrow v = \sqrt{2gh}$

- Set energies equal to each other



$h_1 = 5m$

$h_2 = 2m$

$m = 1{,}000\ kg$

$v_i = 10 m/s$

$E_T = E_T$

$E_T = \frac{1}{2} m v_f^2$

$$\frac{1}{2} m v_i^2 + m g h_1 = \frac{1}{2} m v_f^2 \Rightarrow v_f = \sqrt{v_i^2 + 2gh} \approx \sqrt{200}\ m/s$$

$$\approx 14\ m/s$$