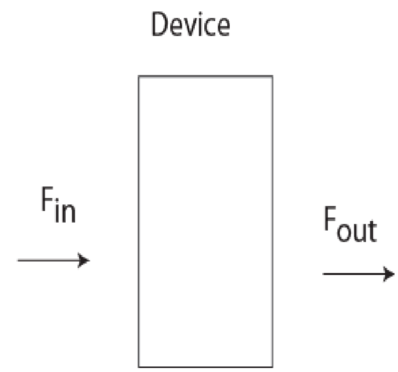
PHY2004 Lectures 13-15

Simple machines (Chap. 16)

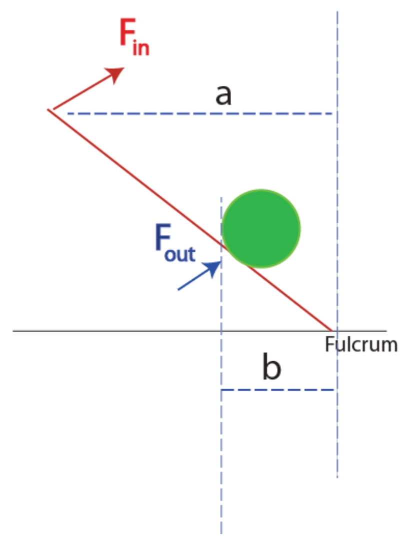


Force in = F_{in}

Force out = F_{out}

Actual Mechanical Advantage = Fout/Fin

Consider **lever**:



If in equilibrium (ideal case)

F_{in} a = F_{out} b. (Equilibrium of torques about fulcrum)

HENCE

IDEAL Mechanical Advantage = a/b

(can be large)

If perfect, no losses

IDEAL Mechanical Advantage = $F_{out}^{\ ideal}/F_{in}^{\ ideal}$

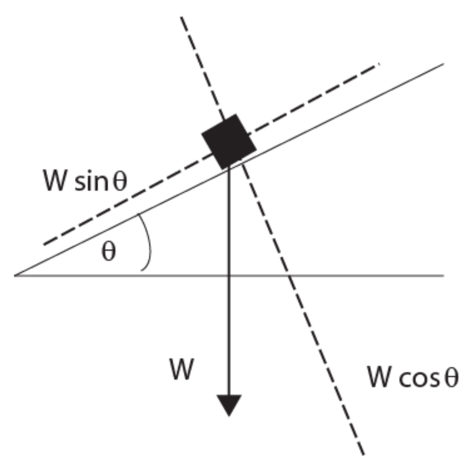
determined by geometry or design of machine

Inclined plane

If just θmoving up plane

$F_{in}^{\ ideal}$ = W sinθ and

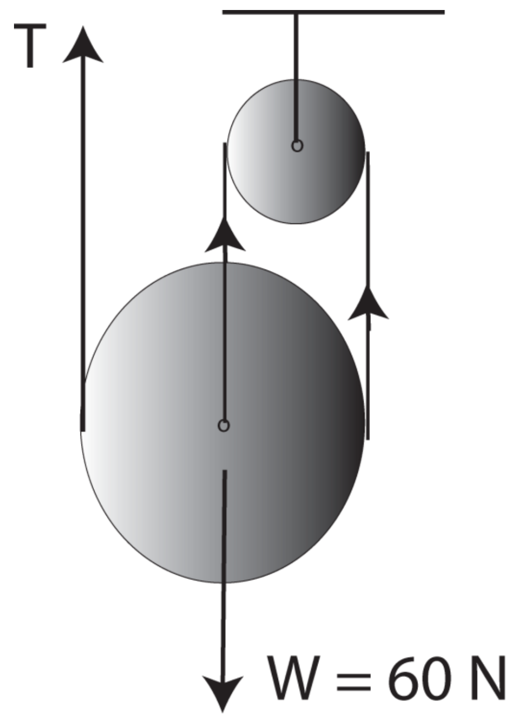
$F_{out}^{\ ideal}$ = W cosθ



IDEAL MECHANICAL ADVANTAGE

IMA = 1/sinθ

Pulleys



Pulley rope is continuous so tension T in the rope is the same

EVERYWHERE

Equilibrium $3T = W$

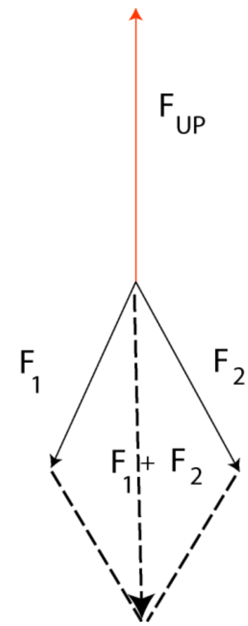
$F_{in} = T$

$F_{out} = W$

IDEAL Mechanical Advantage = W/T = 3

PHY 2004 LECTURES 10-12

EQUILIBRIUM Chapter 8.

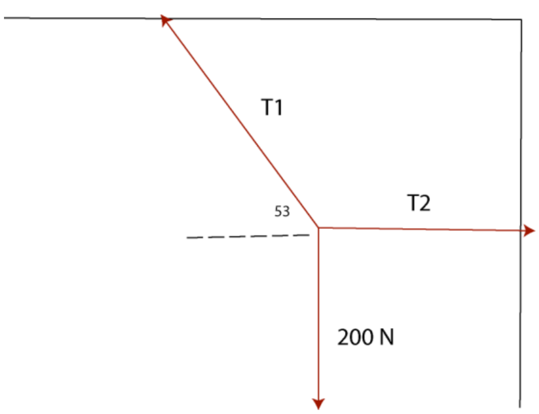


No motion (OR constant motion i.e. no acceleration)

Vector sum of forces =0

I.e. in figure to right $F_1 + F_2 = F_{UP}$

In figure below,



Equilibrium requires

For horizontal direction;

T1 = T2 cos 53 = 0.6T2

For vertical direction;

T2 sin53 =2 00, OR 0.8T2 =200

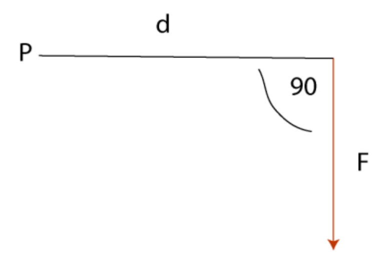
Solve T1= 150 N

Turning effect

Measure of turning or twisting (rotational or angular) motion

Torques must cancel

Torque



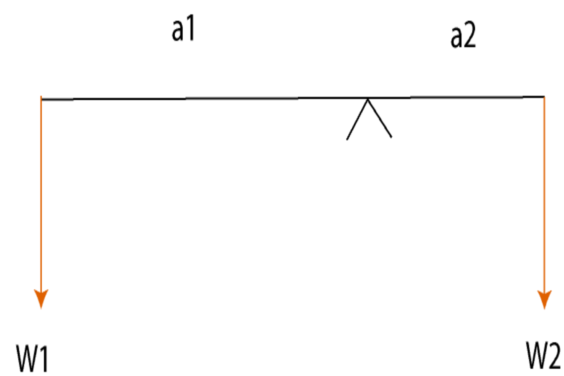
τ = d * perpendicular component of force to axis d

= dF

Has a sense of rotation about P: clockwise (+) or anticlockwise (-)

Equilibrium:

Sum of all torques about ANY point in system must =0



E.g seesaw

Sum of torques =0

W1 *a1 +W2*a2 =0

PHY 2004, Lectures 8-9

ENERGY, WORK

Work

$W = FxD.$

D =distance in the same direction as the force

Work by gravity

$F=mg$ If move against gravity do positive work

$W =mgh$

This energy is stored, e.g placing a mass on a shelf at height h

Can recover this POTENTIAL energy

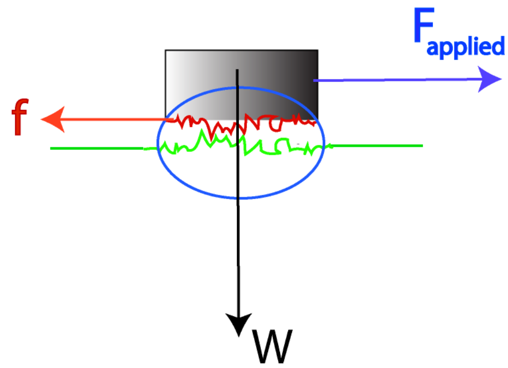
Knock mass off shelf. Object gains KINETIC energy

Use $V_F^2 = 2gh$

to show final kinetic energy $K =(1/2)mV^2$

LECTURE 7 PHY 2004

FRICTION

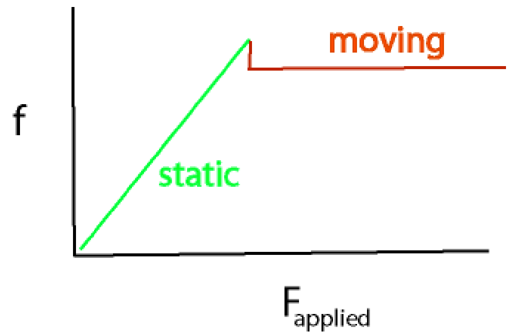


Force of friction proportional
to force NORMAL to motion

μ = coefficient of friction $f = \mu W$

Rubber on concrete	$\mu \approx 0.8$
Steel on steel	0.07
Skater on ice	0.02

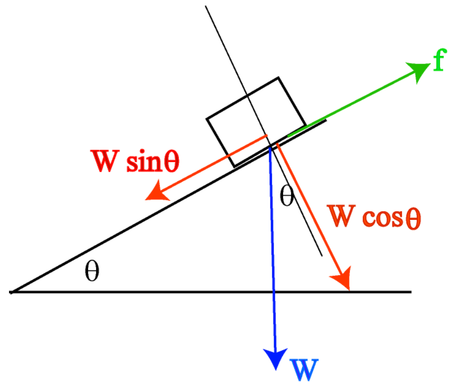
Static versus sliding friction



Object does not move until

$F_{applied}$ overcomes static friction

Inclined plane



Force normal to plane

$F = W\cos\theta$

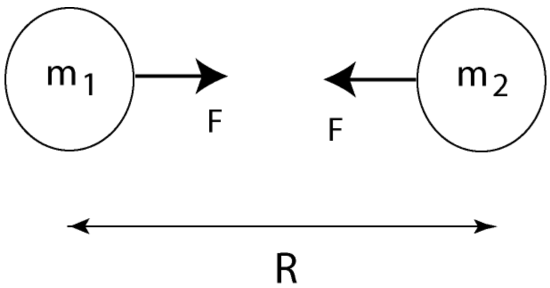
Friction $f = \mu W\cos\theta$

SLIDES when $W\sin\theta = f$

OR $\tan\theta = \mu$

LECTURE 6 PHY 2004

Gravity



Force

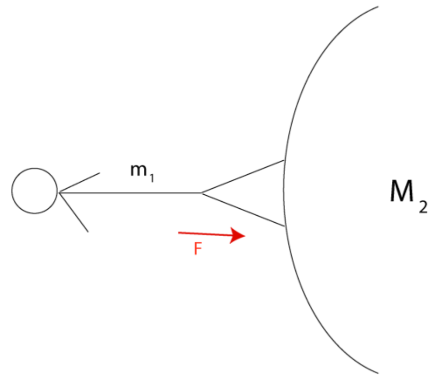
$$F = \frac{Gm_1m_2}{R^2}$$

G is universal constant

(same everywhere)

Weight

$$F = m_1 g = \frac{Gm_1 m_2}{R^2}$$



Thus

$$g = \frac{Gm_2}{R^2}$$ **for mass on surface of planet M_2**

Problem 3.41

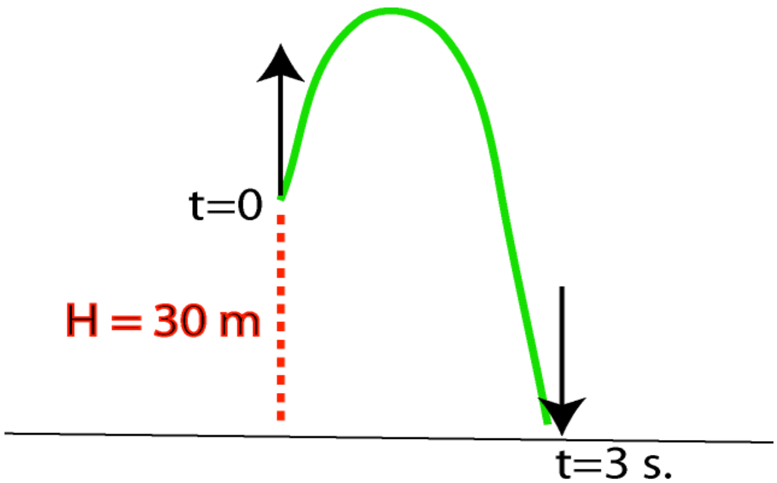
g(moon) =1.6m/s2

Weight on moon = 1.6(4) = 6.4 N

Weight on Earth = 9.8(4) 39.2 N

LECTURE 5 PHY 2004

Chap. 2 #43



$Y = V_i t + (1/2)at^2$ ……………………………………………………… (1)

At end Y = -30 m (below origin)

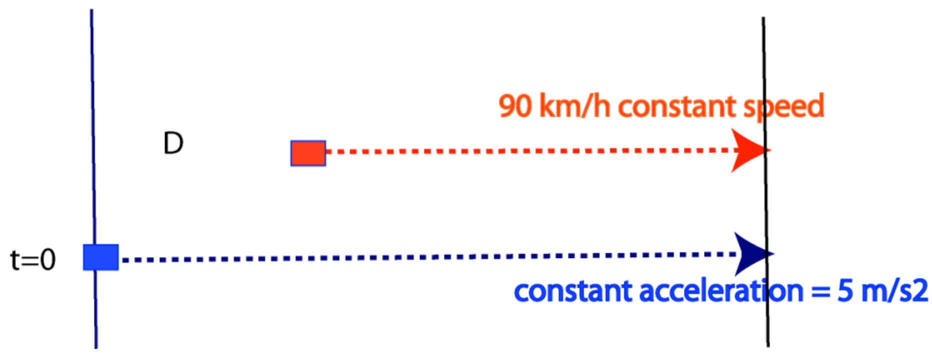
acceleration a = -g= -9.8m/s2

Put in Eq'n (1)

$-30 = V_i\, 3 - (1/2)(9.8)\, 9$

$V_i = (4.9)3 = 4.7$ m/s

Chap 2. # 35



Red speed constant = 90 km/h = 25 m/s

Blue does not start until 5 seconds after red passes, D=(5)(250)=125 m

Need to find t, then calculate distances

NOTE: $X_{blue} = X_{red} + 125$ ....Eq'n (1)

$X_{red} = 25\ t$

$X_{blue} = (1/2)\ at^2 = (1/2)5t^2 = 2.5t^2$

Use Eq'n (1)

$2.5\ t^2 = 25t + 125$, or

$t^2 = 10t + 50$,

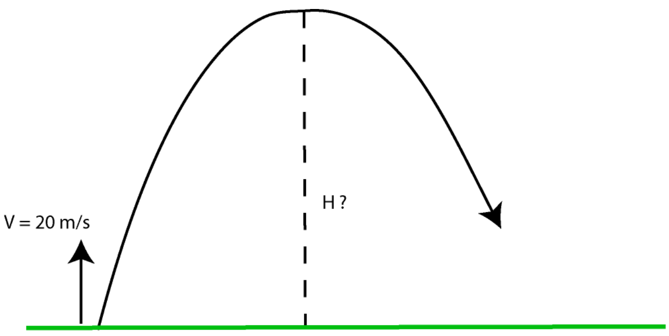
or $t=5 \pm \sqrt{(75)}$ (-ve sign non-physical)=5 +8.7 = 13.7s

$X_{red} = 25\ t = 341.5\ m$

$X_{blue} = 466.5\ m$

LECTURE 3 PHY 2004

Gravity constant at Earth's surface (always "down")



Typical problem

Throw ball up at 20 m/s. How high will it go?

$V_F^2 = V_i^2 + 2aH$

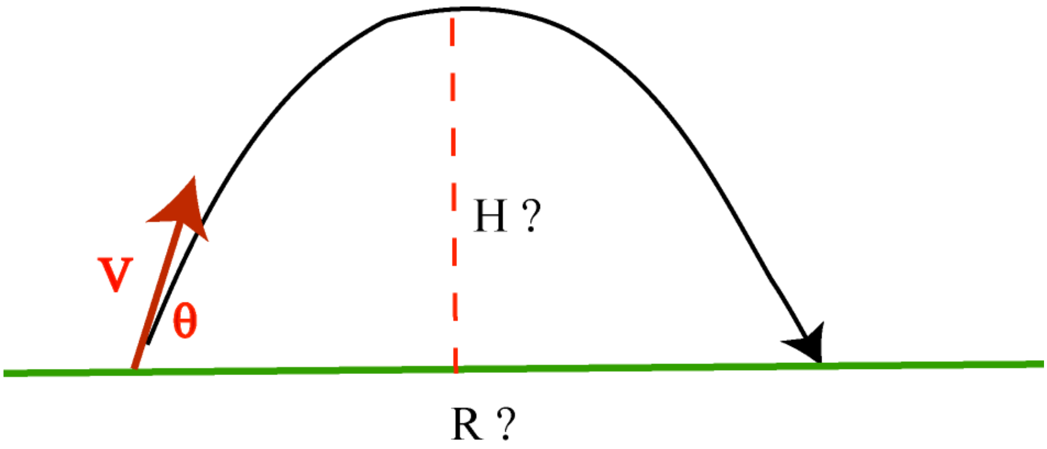
$a = -\ 9.8\ m/s^2$ (gravity **DOWN** deceleration)

$V_F = 0$

$0 = 202 - 2(9.8)H$

$H = 400/19.6 = 20.4\ m$

Projectile Motion



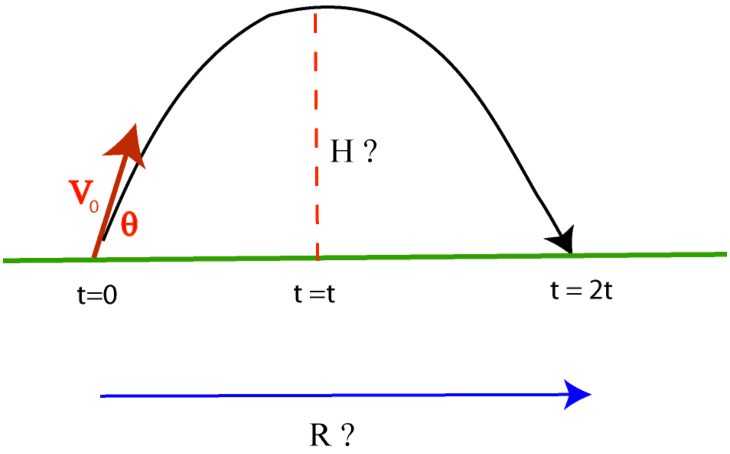
Initial velocity V at angle θ to horizontal

Calculate R

Calculate θ

LECTURE 4 PHY 2004

Continuing the above problem from lecture 3.



Key point to remember, the x and y motions are independent.

Resolve V into x and y motions

$V_X = V_0 \cos\theta$

$V_Y = V_0 \sin\theta$

Consider vertical motion. $V_y = 0$ **at top where** $y = H$

V_{avg} (y-direction) $= (1/2)\, V_0 \sin\theta$

At top use $V_F = V_i + at$, **or** $0 = V_0\sin\theta - gt$ **which gives** $t = (V_0\sin\theta)/g$

$H = V_{avg}.t = (1/2)V_0 \sin\theta.(V_0\sin\theta/g)$ **No need to memorize this formulae,**

just remember simple red equations

$R =$ (total time) $V_x = 2t\, V_0\cos\theta$

PHY 2004: *Applied Physics in our world today*

Neil S. Sullivan *Fall 2010*

NPB Rm 2235

Email: **sullivan@phys.ufl.edu**

Tel. 352-846-3137

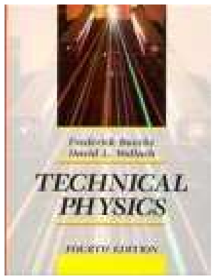
Class meets: **M W F (Period 8) 3:00 -3:50 PM**

NPB 1001

Office Hours: **M W F (Period 4) 10:40 – 11:30 AM**

NPB 2235

Textbook:



Technical Physics

F. Bueche & D. Wallach

(4th ed., J. Wiley & Sons, 1994)

PHY 2004

GENERAL POINTS

Reference materials, important dates: **CHECK** **course web site**

Course Goals

General introduction to use of physics in **everyday life**

Simple applications, useful in professional careers

Emphasis on principles (not lengthy calculations)

Exams:

Some problems in exams will be from problems

discussed in class and in in-class quizzes (clicker responses)

Make-up exams (date TBD) Need SIGNED documentation

from Dr. coach teacher etc.

HITT:

Have remotes by September 7 (to have in-class quizzes recorded)

PHY 2004 Exams Fall 2010

All here in NPB 1001

Mid-term: Best two 30 points each

1. **Sept. 20 Pd 8 (3-3:50 PM)**
2. **Oct. 20 Pd 8 (3-3:50 PM)**
3. **Nov. 19 Pd 8 (3-3:50 PM)**
4.

Final Dec. 13 (3-5 PM) 40 points

unless third midterm better than final in which case

final =30 points and other mid-term=10 points)

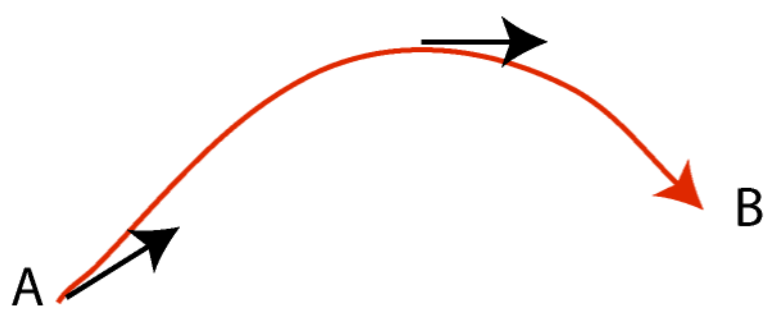
In class questions = bonus of 5 %

LECTURE 2 PHY 2004

MOTION

Speed (scalar) distance per unit time meters/sec

Velocity (vector) speed + direction



Direction different at different points

Average velocity = displacement vector AB/time

Acceleration (vector)

Rate of change of velocity

$a = (V_F - V_I)/t$ OR $V_F = V_I + at$

Uniform acceleration (typical in this class)

e.g. gravity, rockets

$X = V_{avg}\, t$ where V_{avg} is average velocity $V_{avg} = (V_I + V_F)/2$

THUS $X = (V_F^2 - V_I^2/2a)$ OR $V_F^2 = V_I^2 + 2aX$

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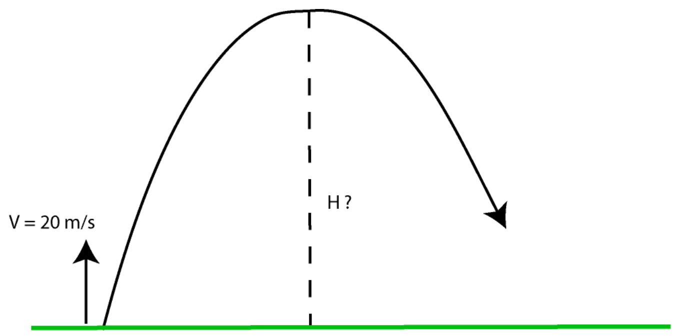

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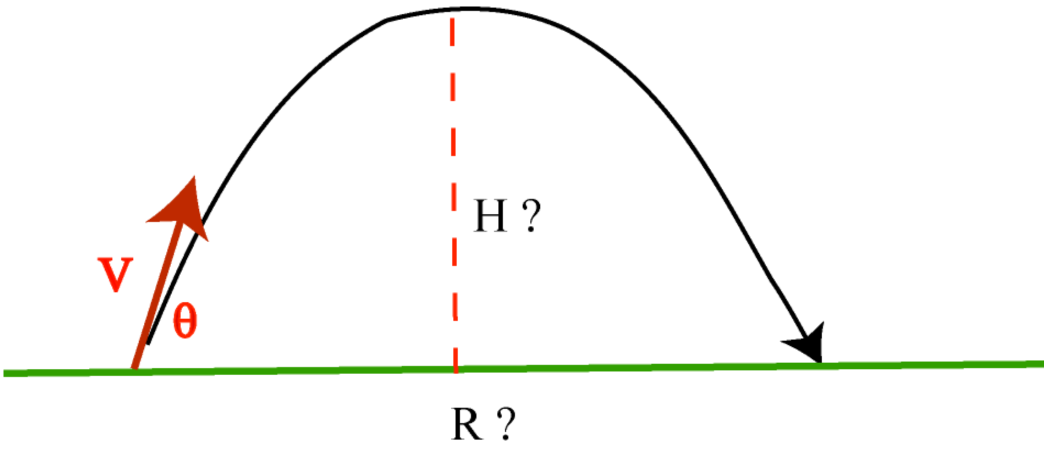

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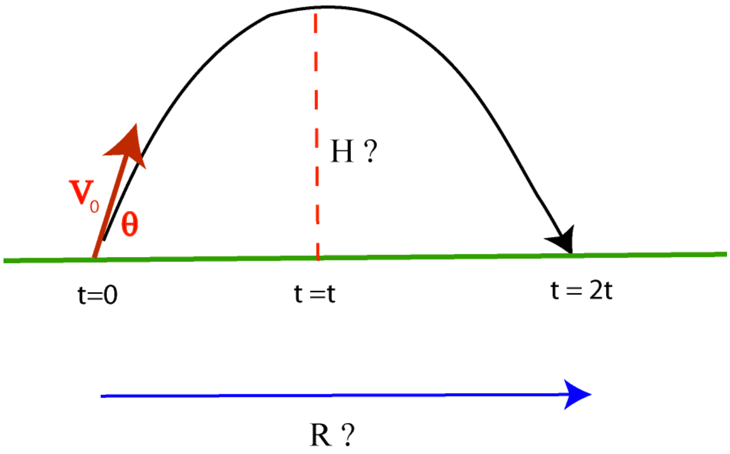

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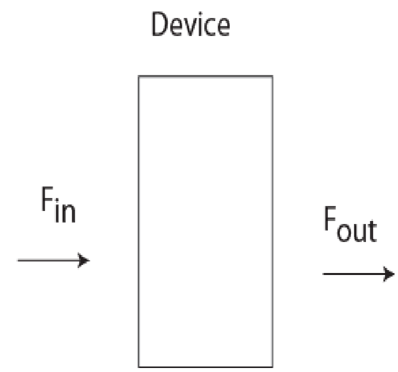

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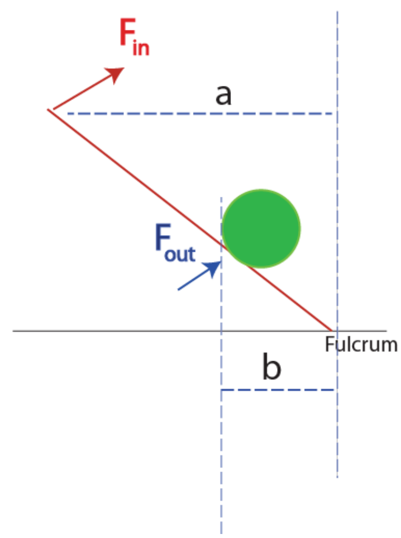

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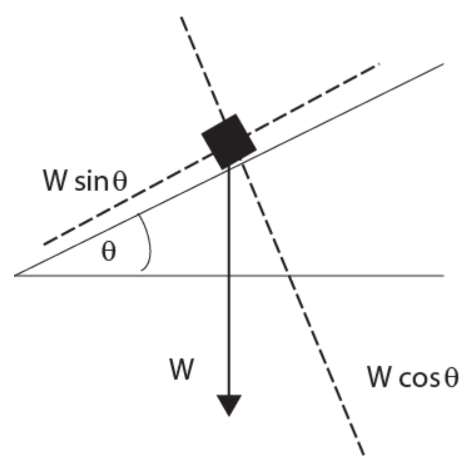

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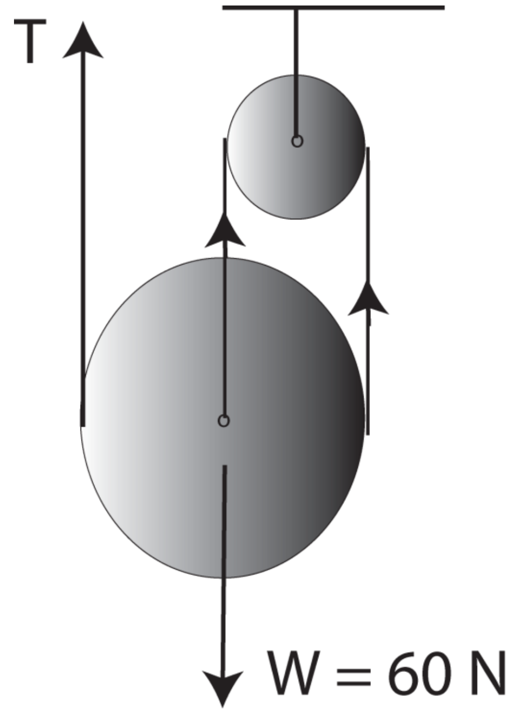

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