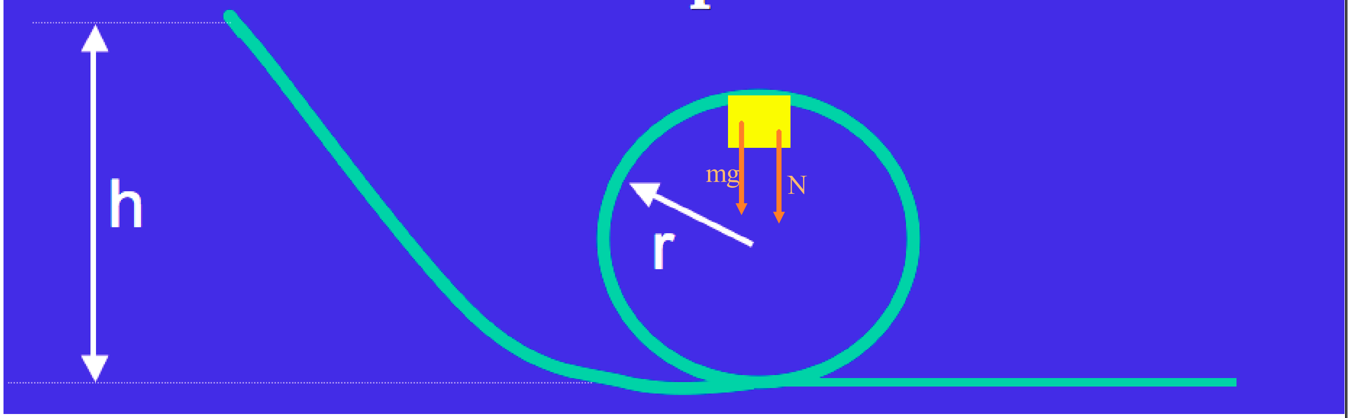
Reminders 10-29-07:
-Next Homework Due 11/1!!!
-Circular Motion Questions due Wednesday 10/31.
-Bring Chapter 9 Notes to Lab this week.
-Chapter 7 Conceptual Quiz Next Monday.
-**Students need a 50% average in lab to pass this course. Presently there are 5 people with a lab average under 50%. If those averages remain under 50% at the end of the semester the course grade is automatically F!!!**

Objectives:
-Centripetal Force Examples
-Gravitation and Satellites

- A small mass is sliding without friction along a looped apparatus The loop has a radius r. The mass always remains on the loop.



To find minimum height h so that it makes it around loop we need:
1. free body diagram at top of loop
2. speed at top of loop
3. to realize that the normal force of loop goes to zero at top of loop when object loses contact with loop.

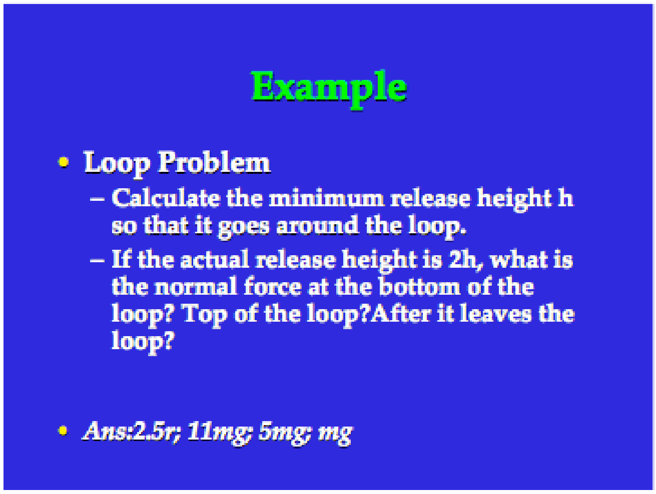
Forces

$-N-mg=-mv^2/r$

$N=(mv^2/r)-mg$: it can barely make it around loop if N slightly greater than zero. If N=0, then $mg=(mv^2/r)$ and $v_{top}=\sqrt{gR}$

Energy Conservation:

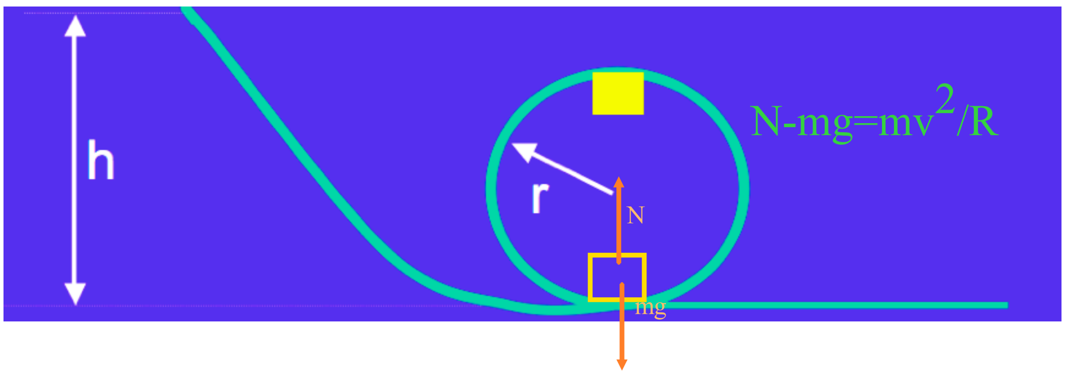
$mgh=0.5mv^2+mg2R$
$mgh=0.5mgR+mg2R$
$mgh=2.5mgR$
$h=2.5R$



If initial height is 2h=5R, we need to find speed at bottom of loop to find N at bottom.
Conserve Energy:

$mg5R=0.5mv^2$

$v^2=10gR$



$N-mg=mv^2/R$

$N=mv^2/R+mg=m(10gR)/R+mg=11mg$ at bottom

<u>Find N at top when initial height is 5R.</u>

At the top $N=mv^2/R-mg$ (see previous slide)

Now conserve energy to find speed at top.

$mg5R=0.5mv^2+mg2R$

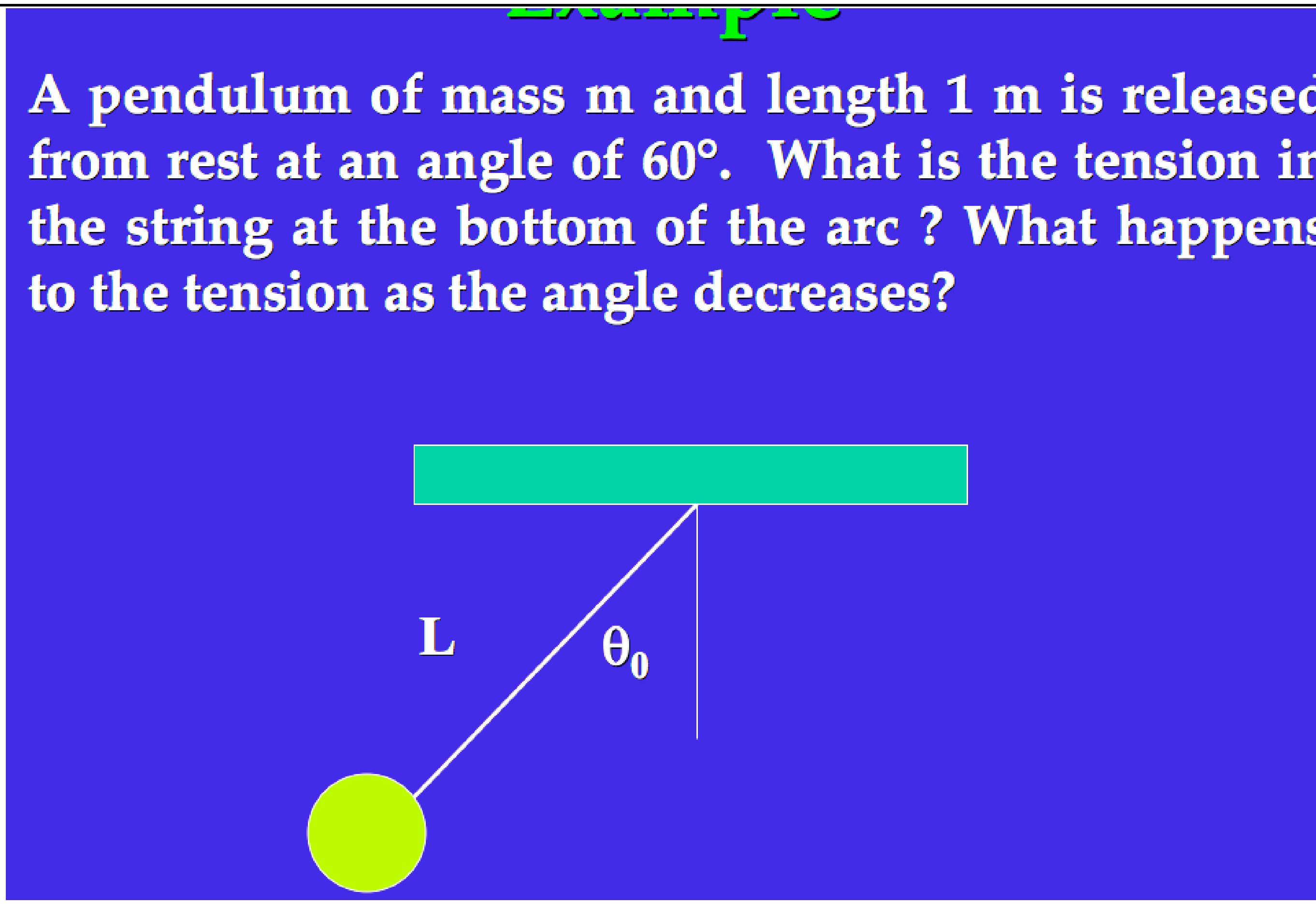
$mg3R=0.5mv^2$

$v^2=6gR$

so

$N=m(6gR)/R-mg=5mg$

When it leaves the loop then N=mg, since $a_c=0$.



Summing forces at bottom of swing yields

$T-mg=mv^2/L.$

We need v. Conserve energy.

$mgL(1-\cos60)=0.5mv^2$

$v^2=2gL(1-\cos60)=gL$

$T=mg+mgL/L=2mg$

What if the final angle is not 0 degrees?

- The Earth revolves around the Sun in a circular orbit (approximately). If the mass of the Sun is 1.99×10^{30} kg and the distance from the Earth to the Sun is 1.5×10^{11} meters, calculate the period of the Earth's orbit around the Sun. Remember,

$$\frac{GM_s M_e}{r_{es}^2} = \frac{M_e v^2}{r_{es}}$$

$$v = \frac{2\pi r_{es}}{T}$$

- *Ans*: 3.17×10^7 s: 365 days

$$\frac{GM_S M_E}{r_{es}^2} = \frac{M_E v^2}{r_{es}} \Rightarrow \frac{GM_S}{r_{es}^2} = \frac{v^2}{r_{es}} = \left(\frac{2\pi r_{es}}{T}\right)^2 \frac{1}{r_{es}}$$

$$\frac{GM_S}{r_{es}^2} = \frac{4\pi^2 r_{es}}{T^2}$$

$$\frac{T^2}{r_{es}^3} = \frac{4\pi^2}{GM_S} = constant \Rightarrow T^2 = \frac{4\pi^2}{GM_S} r_{es}^3$$

$$T = \sqrt{\frac{4\pi^2}{GM_S} r_{es}^3} = 365 days$$

- If the orbital radius of a satellite is decreased by a factor of four what happens
  - to its speed?
  - to its orbital period?
- Does work have to be done to the satellite to accomplish this feat?