Intro Physics
Day 10

Today

I last time

II Relative Motion

III Addition of velocities

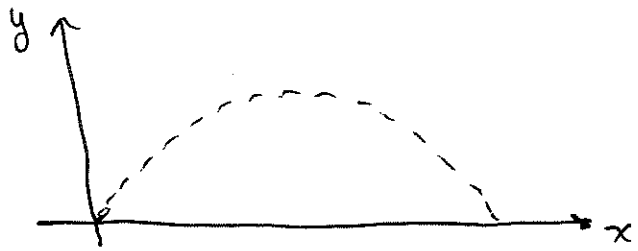
I • Quiz on projectile motion – more varied than previous quizzes.
- Independence of x and y motions
- x motion is const. speed
- y motion is const. accel.

• Studied Uniform circular motion

Uniform = constant speed, but velocity is not constant. It is always tangent to the circle. Acceleration acts to change the direction of the velocity. It is always towards the center of the circle with Magnitude

$$a = v^2/r$$

II We've been studying projectile motion and have found



But we also found in 1D const. accel

$$y - y_0 = v_{0y}t - \frac{1}{2}gt^2$$

The reason, of course, is that

$$x = x_0 + v_{ox}t$$

i.e. $x - x_0 \propto v_{ox}t$, so they
(proportional to)
behave exactly like one another here.
But, these motions can be seen
as similar for another reason too

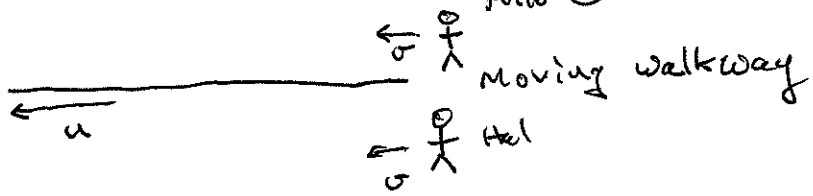
you Cannot! I still find it
completely remarkable that our Solar
System is moving at

$$230\ {}^{km}/_{s}\ \left(= 143\ {}^{mi}/_{s} = 514{,}000\ mph\right)$$

around the galactic center.

III Galileo realized that all we can
pin down is the relative motion of
two objects: a clear example is

From the perspective of
the moving observer, this
is just 1D const. accel.
motion in the y-direction
This insight led Galileo to
the question: How can you
tell if something is in
motion? His surprising and
profound answer was that
the airport walk way



Both u and v are specified
with respect to (w.r.t) the ground.
A useful convention:

v_{AB} = velocity of A w.r.t. B

Let

M = Milo, H = Hal

G = ground

W = walkway

Then

$v_{HG} = v$

$v_{WG} = u$

$v_{MW} = v$

the speed of two objects with respect to one common frame, frame B in this formula, you can figure out their speeds with respect to one another.

Ex: Two space shuttles, one Russian and one American are moving as shown with respect to a space station

What is Milo's speed with respect to the ground?

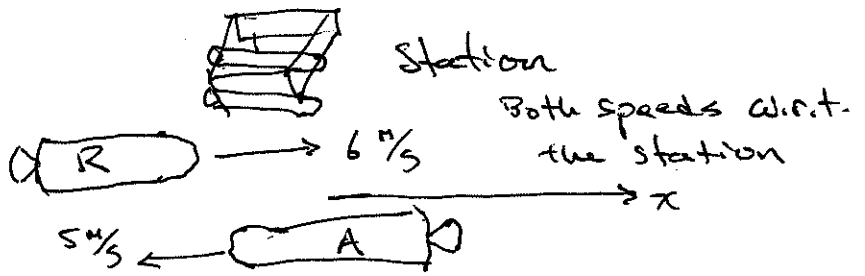
$$v_{MG} = v_{MW} + v_{WG}$$

$$= v + u$$

In general Galileo posited

$$v_{AC} = v_{AB} + v_{BC}$$

This says that whenever you know



What is v_{RA} (Russians w.r.t. Americans)?

$$v_{RA} = v_{RS} + v_{SA}$$ (Space station w.r.t. Americans)

$$= v_{RS} - v_{AS}$$ (Americans w.r.t. station)

$$= 6\ m/s - (-5\ m/s) = \boxed{11\ m/s}$$

What about v_{AR}? Well,

$$v_{AR} = v_{AS} + v_{SR} = v_{AS} - v_{RS}$$

$$= -5\,m/s - (6\,m/s) = -11\,m/s$$

This confirms that

$$v_{AR} = -v_{RA} \checkmark$$

Notice that the signs (as always) are determined by my choice of coordinates.