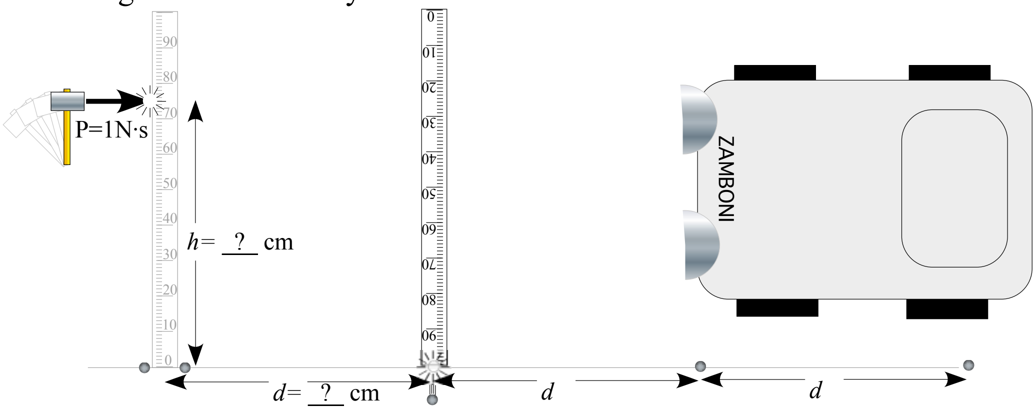
10/30/19 *Assignment 9 - CMwBANG!* Unit 2-2.9. Unit 3-3.8. - Lect.16-18 p.73-74 & p.102-110 Due Wed Nov. 6

An icy cycloid problem

Ex.1 (a) A *1kg*. meter stick lies on a smooth icy hockey rink surface with two marbles sitting at its end on either side of the 0.0cm mark. (See top-view figure) Assume frictionless ice rink.
A hammer give impulse **P**=$(1\text{N}\cdot\text{s})\mathbf{e_x}$ to the 1kg stick at the *h*-cm. mark.
What height *h* is *least* likely to disturb the marbles.



(b) Now assume *h*-value from (a) and friction-free "icy" surface. At what distances *d, 2d, 3d, …* along *x*-axis should the *3rd, 4th, 5th,…*marbles be placed so they are most likely to be knocked below the axis. Draw 6 equal time Δt interval snapshots of the stick as it flips by 180° and then to 360°. What is Δt for the 1kg stick?
(c) Compare path of stick if it struck with the same impulse at *h+10cm.* and if it struck at *h-10cm.*

Electromagnetic cycloids

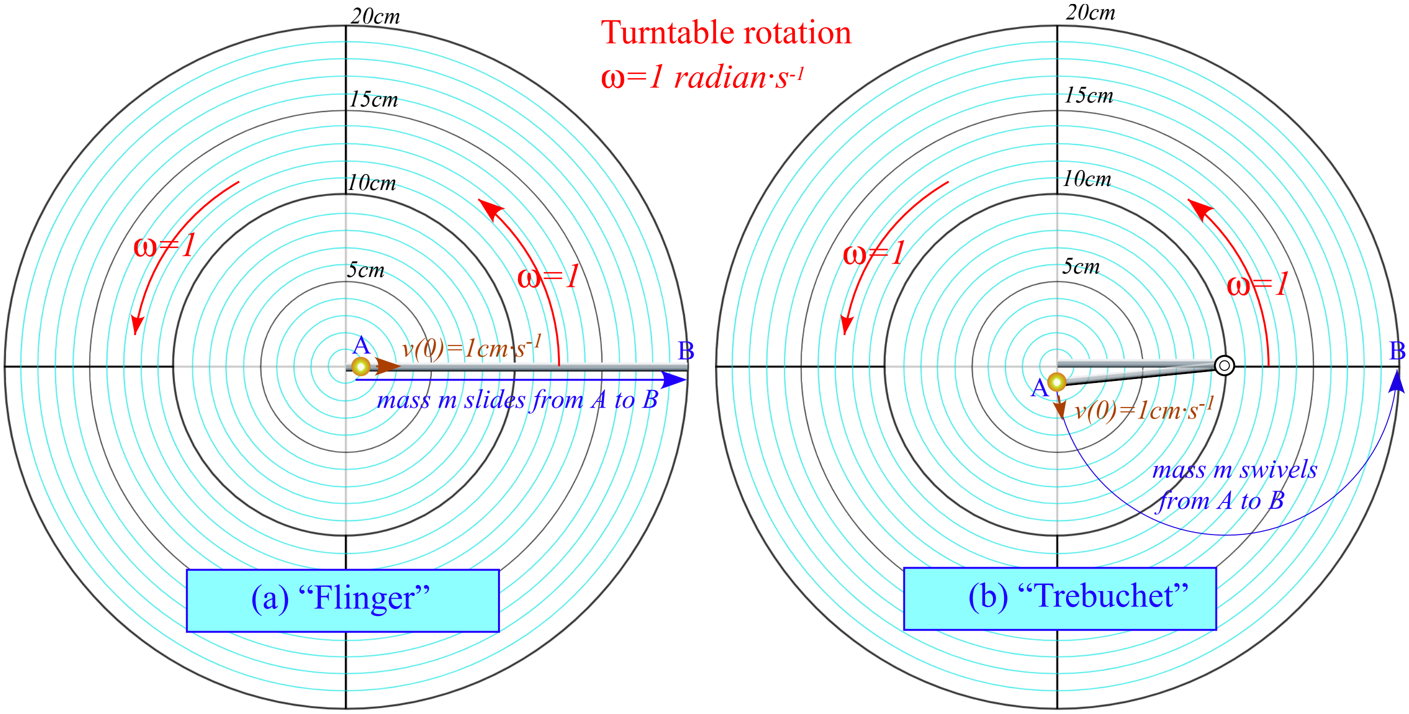
Ex.2 A unit mass *m=1 kg* and charge *Q=1 Coul.* (Dangerous!) starts at ($x=0=y$) on a frictionless (x,y)-surface in vertical Earth gravity (Say $g_y=-10m/s^2$) and in a strong *z*-axial magnetic field $\mathbf{B}_z=(0,0,B_z)$ normal to surface.
(a) What field B_z (in *Tesla*) has a mass with zero initial velocity $(v_x(0),v_y(0))=(0,0)$ follow a cycloid of 1 meter wheel diameter rolling along -*x* axis? What *x*-axis points does it hit? Are these hit points different for different **v**(0)?
(b) What initial **v**(0) would cause the mass to fly a straight line along the -*x*-axis? … along the +*x*-axis?
(c) Describe and plot the resulting trajectory if instead the mass is thrown down with $(v_x(0),v_y(0))=(0,-2m/s)$.

Flinger vs. Trebuchet on turntable (geometric version)

Ex.3. Compare dynamics of mass m on a "Flinger" (Fig. (a)) to what it does on a "Trebuchet" (Fig. (b)).
Both begin at point A of radius $r(0)=1cm.$ from the center of a turntable rotating at $\omega=1(radian)s^{-1}$. Both have an initial speed of $v(0)=1cm\cdot s^{-1}$ and move from that point A to a final point B relative to turntable having radius $r(t_r)=20cm$ where we assume m is then released into the laboratory.

In Fig. (a) m slides $19cm$ along a rod of length $\ell=20cm$. (The $20cm$ rod is fixed to turntable.)

In Fig. (b) m swivels on a rod of length $\ell=10cm$ around a point fixed to turntable at $r=10cm$ radius.



(1a) Relative to turntable…
Find m release speed for "Flinger." _________

(2a) Relative to laboratory…
Find m release speed for "Flinger." _________

(3a) To scale†, sketch lab $\mathbf{v}(t_r)$ assuming release at B.
† Let $1cm$ be $1cm\cdot s^{-1}$.

(1b) Relative to turntable…
Find m release speed for "Trebuchet." __________

(2b) Relative to laboratory…
Find m release speed for "Trebuchet." __________

(3b) To scale†, sketch lab $\mathbf{v}(t_r)$ assuming release at B.
† Let $1cm$ be $1cm\cdot s^{-1}$.

How long does m take to go from A to release point B? _____sec.
Plot or (preferably) construct its orbit on a polar graph like Fig. (a) but in the lab-relative frame.

(4) Compare throwing turntable-relative and laboratory-relative performance (speed and direction) of the Flinger versus that of the Trebuchet.