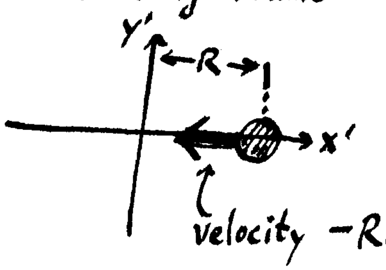
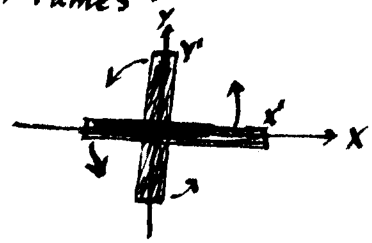
Physics 1, section 7 newsletter...Mark Zimmermann, X1665, 133 Bridge, & 449-9203, 103 MJ.

I think I have a lot of things to say...first, for the least important, quiz 1: this one looked like a tough but good test--if you haven't done it, or didn't get very far on it, you really should try to work it or a variation of it (for example, change the initial condition on $\vec{v}'$ to $\vec{v}'(t = 0) = -R\omega\hat{x}'/\pi$). Answers that I got (not checked yet with anyone else): (1) since the coordinates coincide, position vectors are the same, $\vec{r} = R\hat{x}$. For velocity observed in the inertial frame, ~~XXXXXXXX XXX XXX~~ add the velocity of the rotating frame to the puck velocity. It helps a lot to draw a picture here:

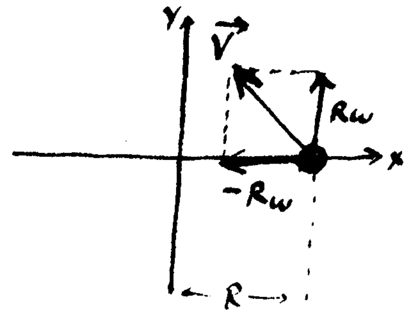
In rotating frame:



Rotating & Inertial Frames:

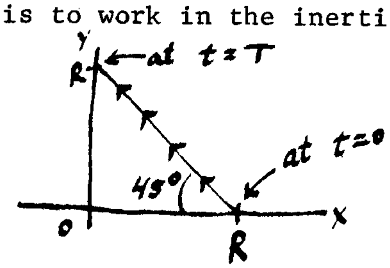


In Inertial Frame:



The net puck velocity is $\vec{v} = -R\omega\hat{x} + R\omega\hat{y}$.

(2) Well, easiest is to work in the inertial frame where motion is very simple, a straight line.



The distance to go is 1.414R, puck's speed is $1.414\omega R$, so it gets back to a distance R from the origin (in <u>both</u> frames, of course) at time $T=1/\omega$. In time T, the rotating frame has turned an angle T= 1 radian (=57.2957795...° for you calculator freaks), and so the angle that the puck was observed to have moved through in the rotating frame is $\theta' = -1+(\pi/2)$ radians. (3) "Equations of motion" means $\vec{F}=m\vec{a}$; since F in the inertial frame is zero, we just have(using the eqn that they "remind" us of at the bottom of the test, with $\vec{F}/m=\vec{a}$): $\vec{a}_R = -2\vec{\omega}\times\vec{V}_R - \vec{\omega}\times(\vec{\omega}\times\vec{r}_R)$, where subscript R means "measured in rotating frame". We can write this out in terms of $\hat{x}'$ & $\hat{y}'$ since $\vec{\omega} = \omega\hat{z}'$ and (by right hand rule) $\hat{z}'\times\hat{x}' = \hat{y}'$ & $\hat{z}'\times\hat{y}' = -\hat{x}'$. So, work out the cross products; $\vec{a}_R = \frac{d^2x'}{dt^2}\hat{x}' + \frac{d^2y'}{dt^2}\hat{y}'$; $\vec{\omega}\times\vec{V}_R = \omega\hat{z}'\times\left(\frac{dx'}{dt}\hat{x}' + \frac{dy'}{dt}\hat{y}'\right)$ $= \left(\omega\frac{dx'}{dt}\right)\hat{y}' + \left(\omega\frac{dy'}{dt}\right)(-\hat{x}')$; $\vec{\omega}\times\vec{r} = \omega\hat{z}'\times(x'\hat{x}' + y'\hat{y}') = (\omega x')\hat{y}' + (\omega y')(-\hat{x}')$; $\vec{\omega}\times(\vec{\omega}\times\vec{r}) = (\omega^2x')(-\hat{x}') + (\omega^2y')(-\hat{y}')$. So, grand result is:

$$\frac{d^2x'}{dt^2}\hat{x}' + \frac{d^2y'}{dt^2}\hat{y}' = -2\omega\frac{dx'}{dt}\hat{y}' + 2\omega\frac{dy'}{dt}\hat{x}' + \omega^2x'\hat{x}' - \omega^2y\hat{y}'.$$

We can split this into $\hat{x}'$ and $\hat{y}'$ equations; using $\dot{x}' \equiv dx/dt$, the equations are:

$$\boxed{\ddot{x}' = 2\omega\dot{y}' + \omega^2x'} \quad \& \quad \boxed{\ddot{y}' = -2\omega\dot{x}' + \omega^2y}.$$

I'm almost out of space, so will make other comments in class or in next newsletter. One item: David Finkelstein, who's fairly famous in the field of relativity, is giving a seminar at 4^{pm} today, in 114 Bridge. It will probably be incomprehensible to me, but these things are good to go to, for entertainment & culture ... you're all invited....

Mark Z.