# PHYS 1410: PHYSICAL SCIENCE (FW 2012/2013)

**Additional problem for Oct. 30**

Consider an object that moves on a circular path. Starting from the position vector $\vec{r}(t)$ show that the acceleration can be written as

$$\vec{a}(t) = \vec{a}_c(t) + \vec{a}_t(t)$$

with

$$\begin{aligned} a_c &= \left(\frac{d\theta}{dt}\right)^2 R \\ a_t &= \left|\frac{d^2\theta}{dt^2}\right| R. \end{aligned}$$

Note: consult Sec. 2.6 of the Math Addendum if you have problems with the chain rule.

1. Show that $a_c = \frac{v^2}{R}$ (where $v$ is the speed of the object). Is $a_c$ a constant or does it change with time?
2. Show that $a_t = \left|\frac{dv}{dt}\right|$. Is $a_t$ a constant or does it change with time?
3. Show that $\vec{a}_c \perp \vec{a}_t$ (at all times)[1].
4. Show that $a_t = 0$ for the special case of *uniform* circular motion.

[1] Consult Sec. 1.5 of Math Addendum