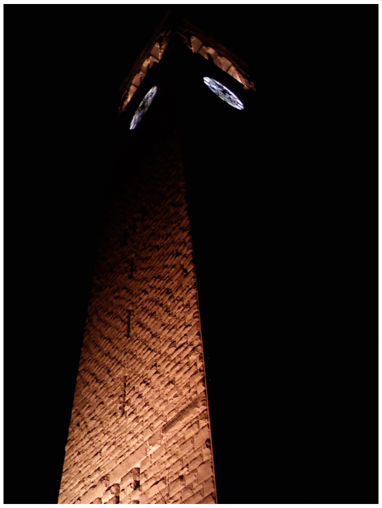
Name: ____ **Quiz 7**

MAT 295 **Fall 2016**

Problem 1: The McGraw Clock Tower at Cornell University has minute hand and hour hands roughly 5 ft and 3 ft in length, respectively. If a student walked by Olin Library at 12:19am and looked up at the clock, what would they measure the rate of change of the distance between the tips of the hands of the clock to be?



Problem 2: In Newtonian Physics for particles, $F = ma$ where F is the force, m is the mass, and a is the acceleration of the particle. But $F = ma$ does not always hold. Generally, $F = \frac{dp}{dt}$, where $p = mv$ is the momentum of the particle at time t.

(a) Suppose that a particles mass is essentially constant and that its velocity is not "too large." Use $F = \frac{dp}{dt}$ and $p = mv$ to show that $F = ma$.

For particles moving at a high velocity, $F = ma$ is no longer valid. In Special Relativity, the momentum of a particle is given by

$$p = \gamma m v = \frac{mv}{\sqrt{1 - \frac{v^2}{c^2}}}$$

where m is the (rest) mass of the particle and c is the speed of light in a vacuum.

(b) What happens to the momentum of a particle as v approaches c? Can an object with mass travel at the speed of light?[1]

(c) Given $F = \dfrac{dp}{dt}$ still holds in Special Relativity, show that the relativistic force for a particle with rest mass m moving at velocity v is given by

$$F = \frac{ma}{\left(1 - \frac{v^2}{c^2}\right)^{3/2}}$$

Use this to show why it is impossible to accelerate an object with nonzero mass to the speed of light.

[1]Note: sometimes the particle is said to have mass $M = \gamma m$, called the relativistic mass. Then the rest mass is when $v = 0$ and $p = Mv$. However, this is convention; *Mass is an intrinsic, invariant quantity that does not depend on velocity.*]