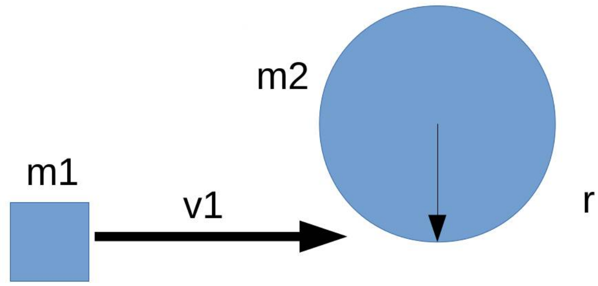
# Homework #3: Phys 3344: Prof. Olness Fall 2020

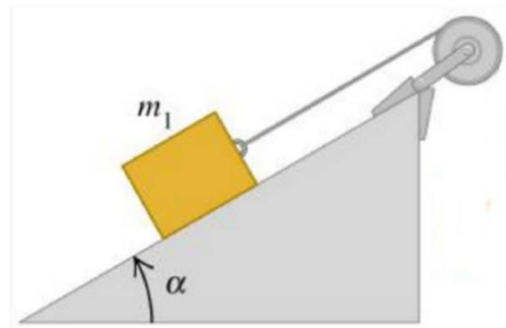
***Due 9 September2020***

1) Using Newton's universal law of gravitation, show that Kepler's $2^{nd}$ and $3^{rd}$ laws follow.

- For the $2^{nd}$ law, use the fact that Newton's gravitation force is radial, so has no torque.
- For the $3^{rd}$ law, I suggest you relate T and r for a circular orbit to demonstrate the relation.

2) Putty & Disk: A ball of putty of mass $m_1$ with velocity $v_1$ sticks to a cylindrical turntable [$I=(1/2)\ m_2\ r^2$] which is initially at rest. Assume the impact is perpendicular to the turntable axis and it strikes at the radius r. Find the final angular velocity $\omega$ of the putty+turntable system.




3) Consider the figure at right. The pulley is friction-less, but has mass $m_2$ and moment of inertia $I=(1/2)m_2r^2$. The block has mass m1, and slides on a friction-less surface with angle $\alpha$.

Compute 1) the acceleration a of mass m1, 2) the angular acceleration $\alpha$ of the pulley, 3) the tension T in the string.

4)

**4.3** ★★ Do the same as in Problem 4.2, but for the force $\mathbf{F} = (-y, x)$ and for the three paths joining $P$ and $Q$ shown in Figure 4.24(b) and defined as follows: **(a)** This path goes straight from $P = (1, 0)$ to the origin and then straight to $Q = (0, 1)$. **(b)** This is a straight line from $P$ to $Q$. (Write $y$ as a function of $x$ and rewrite the integral as an integral over $x$.) **(c)** This is a quarter-circle centered on the origin. (Write $x$ and $y$ in polar coordinates and rewrite the integral as an integral over $\phi$.)

5) Using Newton's gravitational formula, $F=GMm/r^2$, compute the acceleration "g" at:

a) the surface of the earth,
b) for astronauts in orbit (about 100 miles above the surface)
c) at the distance of the moon.
d) Using a=g, compute how long it would take a cannon ball to fall to earth.
e) OPTIONAL: Repeat part d), but use the correct formula for "a" based on
Newton's gravitational formula.

FYI, you might find this of interest: Pages 219-224 of the text (pages 123-126 of the PDF):

Galileo pokes fun at a contemporary philosopher for calculating the time it takes a cannon ball to fall to Earth from rest starting from a distance of the Moon's orbital radius, more than six days. Galileo shows how to perform the calculation "correctly," but Galileo uses a constant 9.8 m/s^2 acceleration for the whole trip. The real answer, which your students can verify, is a few days. Of course, the philosopher's answer is only accidentally close to the right one; the method is nonsense.