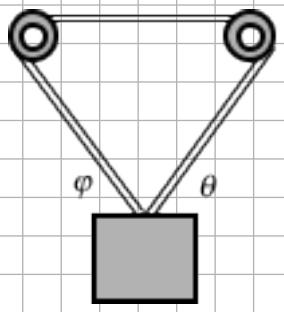
Name:

2012 FINAL
Honors Physics

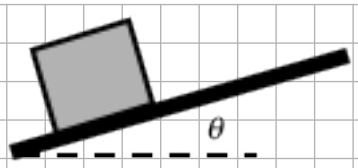
1. The box of mass 6 kg hangs at rest.



a. Prove that $\theta = \varphi$.

b. Determine the tension in the rope, if $\theta = 50°$.

2. A box of mass m slides with an initial velocity of 3 $\frac{m}{s}$ down a ramp which is inclined 20° from the horizontal. The coefficient of kinetic friction between the ramp and box is .45.



a. Determine the direction and magnitude of the acceleration of the box as it slides down the incline.

b. Discuss the subsequent motion of the box (qualitatively - no numbers are necessary).

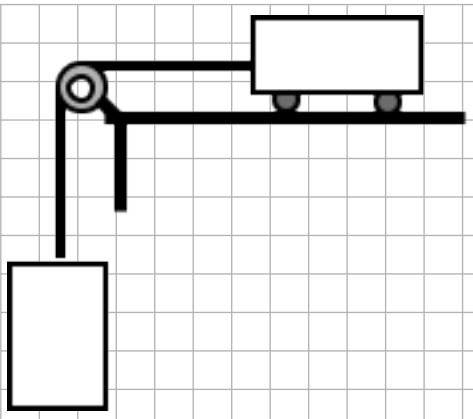
3. A .5 kg air puck moves to the right at 3 $\frac{m}{s}$, colliding with a 1.5 kg air puck that is moving to the left at 1.5 $\frac{m}{s}$.

a. Determine the direction and speed of the pucks' motion if they stick to each other after the collision.

b. Suppose instead that the pucks do not stick together. If the 1.5 kg puck moves to the right at .231 $\frac{m}{s}$ after the collision, was the collision elastic? Provide evidence!

c. Determine the size and direction of the average force acting on the $.5kg$ puck during the collision, if the collision lasted for 25 ms.

4. A half-Atwood machine consists of a cart of mass $M = 1\ kg$ rolling on a flat table connected by a string to a hanging box of mass $m = .2\ kg$.



a. Use energy (CoEM or ETM) to determine the speed of the cart after it has moved 40 cm to the left, assuming that the system is released from rest.

b. If a spring of stiffness constant $k = 45\ \frac{N}{m}$ is attached (unstretched) to the cart before the system is released, how far will the block drop before the system turns around?

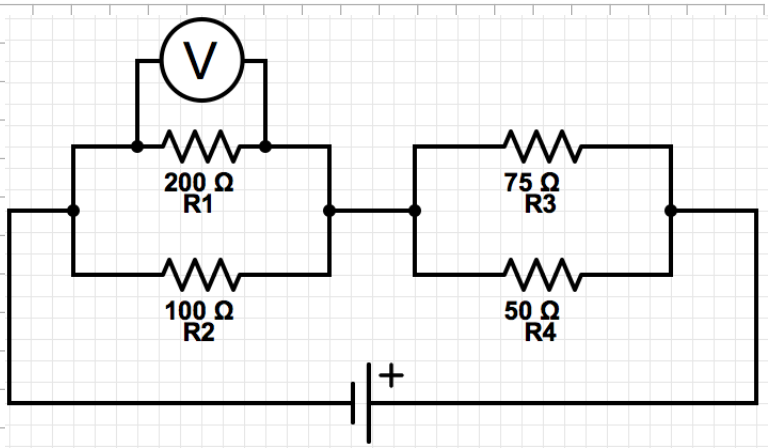
5. $\left(G = 6.67 \times 10^{-11}\ \frac{Nm^2}{kg^2}\right)$ A satellite is said to be in *geosynchronous orbit* if it always stays above the same spot on the body that it is orbiting. It accomplishes this by having the same orbital period as the rotational period of the body that is it orbiting. (How long is that for the Earth?)

a. Determine how far from the surface of the Earth a satellite must be placed in order to be in a geosynchronous orbit. ($R_\oplus = 6,370\ km; M_\oplus = 5.97 \times 10^{24}\ kg$)

b. The space shuttle orbits the Earth with a period of around 90 minutes. Is it closer to the Earth or further from the Earth than geosynchronous satellites? Be convincing!

6. (Optional CEM Reassessment)

a. Determine the equivalent resistance of the circuit.



b. The voltmeter shown reads -16.55 V. Determine the current through R1.

c. Determine the current through R2.

d. Determine the battery voltage.