Physics 1 Practice Final

1. A constant force $\mathbf{F}$ is applied horizontally to a mass $\mathbf{m}$, initially at rest on a frictionless surface. Find the time it takes to move the object a distance $\mathbf{d}$.

2. A constant force $\mathbf{F}$ is applied horizontally to two different masses, one with mass $\mathbf{M}$ and the other with mass $2\mathbf{M}$. Both are initially at rest.
   a) If the force is applied to each mass over the same distance, which one will have the greater kinetic energy? Which one will have the greater momentum?
   b) If the force is applied to each mass for the same amount of time, which one will have the greater kinetic energy? Which one will have the greater momentum?

3. A golf ball of mass 46 grams is struck at an angle of 45 degrees with the horizontal. The drive lands 200 meters away on a flat fairway. If the golf club and ball are in contact for 7 milliseconds, what is the average force of impact?

4. A 12 gram bullet is fired horizontally into a 100 gram wooden block that is initially at rest on a rough horizontal surface and connected to a spring with a force constant of 150 N/m. If the bullet-block system compresses the spring by 0.8 meters, what was the speed of the bullet just as it enters the block? Assume that the coefficient of kinetic friction between block and surface is 0.6.

5. Find the center of mass of a right triangle of base length $\mathbf{a}$ and height $\mathbf{b}$. Use the result of this to compute the location of the center of mass of the triangle with corners at $(0,0)$, $(1,1)$, and $(3,0)$.

6. A 1kg mass moving to the right at a speed of 2 m/s collides with a 0.5 kg mass moving to the left at 3m/s. Determine the range of possible final velocities for each mass. Could either mass stop after the collision? If so, which one?
7. Consider a rod of length \( L \) and mass \( m_1 \), with a sphere of radius \( R \) and mass \( m_2 \) affixed to one end. The system is allowed to rotate about a hinge on the left end of the rod, as in the figure.

a) Find the total moment of inertia for this system rotating about the hinge. (The moment of inertia for a rod rotating about one end is \( \frac{1}{3}ML^2 \), and the moment of inertia for a sphere spinning about its axis is \( \frac{2}{5}MR^2 \).)

b) Find the location of the center of mass of the system, relative to the point of rotation.

c) If the system is released from rest from the horizontal position, find the angular velocity at the bottom.

8. A car accelerates uniformly from rest with an acceleration of 3 meters per second squared. If the tires have a diameter of 0.5 meters, find:

a) The speed of the car after 10 seconds.

b) The distance the car has covered in 10 seconds.

c) The angular acceleration of the tires.

d) The angular velocity of the tires after 10 seconds.

e) The speed of the top of each tire relative to the ground after 10 seconds.

f) The speed of the bottom of each tire relative to the ground after 10 seconds.

g) If the car slams on the brakes after 10 seconds and stops after traveling an additional 20 meters, determine the time required to stop.

9. The system in the figure is accelerating as shown. \( m_1 > m_2 \), the pulley has a moment of inertia \( I \) and radius \( r \), and the coefficient of kinetic friction between the second mass and the ramp is \( \mu_k \).

a) Compute the acceleration of the system.

b) Compute the tension in each section of the connecting string. Why should they be different?