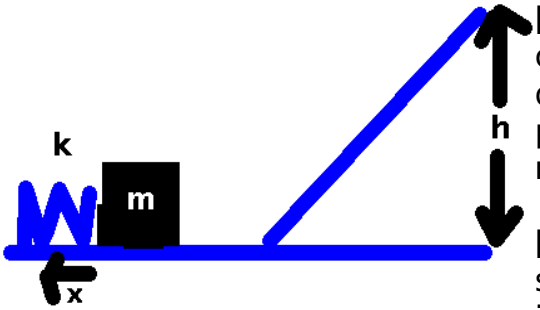
Time Start_____ Time finish_____ Pledged_____

Instructions: You have a total of 50 minutes to complete this test.
Answer each of the following questions completely.
Supply all details that led to your answer and correct SI units where required.
Do not discuss any aspect of this test with anyone until I return the test.



[1] A mass m at rest is against a spring of spring constant k which has been compressed through a distance x as shown. In this problem both the level plane and the inclined plane are frictionless. **You must use ENERGY considerations here.**

[a] In the box provided, make a free body diagram showing all forces on the system right after the spring is released. Be sure to correctly label all forces.

[b] The spring is allowed to expand. Find the **speed** of the mass at the bottom of the plane in terms of k, m and x.

[c] The mass then slides up the inclined plane. Find the maximum height to which the mass rises in terms of k,x,m and g.

[d] Provide numerical answers together with correct units for the special case that m=2 kg, k=5 N/m and x=0.3 m.

d:b _____ d:c _____

[2] A point mass is attached to the end of a massless bar of length R=2m. The other end of the bar is attached to a hinge at the origin. Suppose a mechanism is devised so that the mass undergoes an angular acceleration given by $\alpha=\alpha_0$ where α_0 has units of "rad"/s^2. You may assume that the mass is initially at rest and is initially at θ=0. After a time of t=10 s, answer the following for the case (with correct SI units) in which $\alpha_0=1.5\frac{\text{rad}}{s^2}$.

(a) What is the angular velocity of the mass?

(b) What is the angle that the mass has gone through?

(c) What is the tangential velocity of the mass.

(d) What is the centripetal acceleration (a_c) of the mass?

(e) What is the tangential acceleration (a_t) of the mass?

(f) What is the magnitude of the translational acceleration?

[3] A force varies in time as $\vec{F}=F_0\hat{y}$ where b is a constant which has SI units of N/s and F_0 has units of N. This force is applied to a mass m which is initially at rest for a time $t_0=0$.

[a] What is the change in the **vector** momentum of the mass in terms of the symbols F_0 and t?

[b] What is the **vector** velocity of the mass after a time t in term of the symbols F_0, m and t?

[c] After the time t, the mass slides along a horizontal surface with a coefficient of friction μ. At the instant the mass encounters the surface, the force is removed. How far does the mass slide until it stops?

[d] Provide numerical answers to (b) and (c) above with correct SI units for the case $F_0=2N$, m=1.5Kg, t=2 s and μ=0.5.

(d:b) v=_____ (d:c) x=_____

[4] A mass m_1 is moving along the x-axis at a velocity v_b. In this problem, assume m_1=2 kg, m_2=3 kg, and $\vec{v}_b = +15\frac{m}{s}\hat{x}$. **Your answers here must show details and include correct SI units.**

[a] If it strikes and sticks to mass m_2 which initially at rest, what is the **vector** velocity after the collision?

[b] Suppose that masses m_1 and m_2 experience a completely elastic collision. What is the vector velocity of each mass after the collision?

$\vec{v}_{1,after}$ = _____ $\vec{v}_{2,after}$ _____

[c] Suppose mass m_1 experiences a completely elastic collision with a much much larger mass. What is the approximate vector velocity of mass m_1 after the collision?

$\vec{v}_{1,after} \approx$ _____

[d] Suppose mass m_1 experiences a completely elastic collision with a much much smaller mass (m_3). What is the approximate vector velocity of mass m_3 after the collision?

$\vec{v}_{3,after} \approx$ _____