Time Start________________ Time finish________________ Pledged______________________

Instructions: You have a total of 55 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 point mass is attached to the end of a massless bar of length R. The other end of the bar is attached to a hinge at the origin. The mass is observed to have an time-dependance to its angular velocity which is given by $\theta=\theta_0+b\,t^3$.

[a] What is the function that describes the behavior of ω(t)?

[b] What is the function the describes the angular acceleration of the mass α(t)?

For the rest of the problem, assume that $\theta_0=0,\omega_0=0,b=0.2\frac{\text{rad}}{\text{s}^3}$, and $R=0.5\text{ m}$.

Answer the following **providing correct SI units.**

[c] What is the tangential velocity at t=2 s?

[d] What is the tangential acceleration at t=2 s?

[e] What is the centripetal acceleration at t=2 s?

[f] What is the magnitude of the total acceleration at t=2 s?

[2] A mass m is resting on an inclined plane (inclined at an angle θ) at a height h above a table. The inclined plane is frictionless. In answering this question, you **must use energy considerations.**

[a] How fast is the mass moving at the bottom of the plane in terms of h and g?

After the mass is at the bottom of the plane, it slides along the table where the coefficient of friction is μ.

[b] Draw a correct free body diagram for this system (when the mass is sliding on the table).

[c] How far will the mass slide until it stops in terms of h and μ?

[d] If the mass was placed on a compressed spring of spring constant k which was compressed through a distance x, how large would x need to be so that the mass would move through the distance z if, after the mass left the spring, the coefficient of friction was μ. Assume no friction exists until the mass leaves the spring. Express your answer in terms of m,g,h and k.

[3] An object of constant mass m is observed to change its velocity so that $\Delta\vec{v}=bt^2\hat{x}$ where b is a positive constant with SI units of m/s.

[a] Find the functional dependence of the change in **vector** momentum, $\Delta\vec{P}$. Express your answer in terms of m,b and t with appropriate vector notation.

[b] Find the functional dependence of the **vector** impulse that was required. Express your answer in terms of m,b and t with appropriate vector notation.

[c] Find the functional dependence of the **vector** force that was required assuming that the force started at t=0. Express your answer in terms of m,b and t with appropriate vector notation.

[d] Suppose that after a time t, the impulse was removed and the object collided with and compressed a spring of spring constant k through a distance x. How much did the spring compress? You may assume that before the impulse was applied, the object was at rest. Express your answer in terms of m,b,t, and k.

[e] Provide a numerical result for your answer in **[d]** for the case that m=8 kg, k=2 N/m, b=0.75 m/s^3 and t=0.4 s together with correct SI units.

[4] A point mass m_1 is moving with a speed $v_{1,B}$. The other point mass is $m_2=3m_1$ which is initially at rest. In answering the following questions, your answers are numeric only without units.

[a] If the two objects stick together and move off, what is the value of $\frac{v_{final}}{V_{1,B}}$?

[b] What is the value of $\frac{K_{after}}{K_{before}}$?

[c] Suppose that the collision is completely elastic. What is the value of $\frac{v_{1,A}}{v_{1,B}}$?

[d] Again, assuming the collision is completely elastic, what is the value of $\frac{v_{2,A}}{v_{1,B}}$?