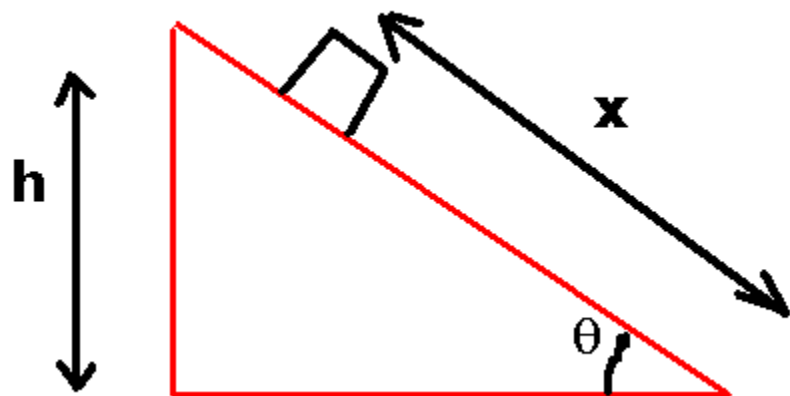


Time Start _____ Time finish _____ Pledged _____

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 $R=2\text{m}$. 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 $\alpha=\alpha_0+bt^2$ where b is a positive constant with SI units of "rad"/ s^4 . You may assume that the mass is initially at rest and is initially at $\theta=0$. After a time of $t=20\text{ s}$, answer the following for the case (with correct SI units) in which $\alpha_0=1.5\frac{\text{rad}}{\text{s}^2}$ and $b=3\frac{\text{rad}}{\text{s}^4}$.

- What is the angular velocity of the mass?
- What is the angle that the mass has gone through?
- What is the tangential velocity of the mass.
- What is the centripetal acceleration (a_c) of the mass?
- What is the tangential acceleration (a_t) of the mass?
- What is the magnitude of the translational acceleration?



[2] A mass m is resting on an inclined plane (inclined at an angle θ) at a height h above the floor. The coefficient of kinetic friction between the mass and the plane is μ . Note that x and h are related by $h = x \sin(\theta)$

[a] draw a correct free body diagram for this system.

Suppose the mass is given a tiny theoretical velocity down the plane (which you may approximate to be zero).

[b] When the mass slides down the plane (through the distance x), how much work is done? Your answer here must involve h , μ , m and a trigonometric function.

[c] Calculate ΔK_c in terms of m and v (velocity).

[d] Calculate ΔU in terms of m , g and h .

[e] How fast is the mass traveling at the bottom of the plane?

[f] if $m=1.5$ kg, $h=2$ m, $\theta=45^\circ$ and $\mu=0.25$, provide a numerical answer for [e] together with correct SI units.

[3] Suppose a force varies in time as $\vec{F}=(F_0+bt)\hat{x}$ where b is a constant which has SI units of $\frac{N}{s}$. This force is applied to a mass m which is initially at rest for a time t_1 .

(a) What is the change in the **vector** momentum of the mass in terms of the symbols F_0 , b and t ?

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

(c) After the time t , the mass strikes and compresses a spring of spring constant k (at which time the force is completely removed). When the mass stops, how much is the spring compressed in terms of the symbols F_0 , b , m , k and t ?

(d) Provide numerical answers to (b) and (c) above with correct SI units for the case $F_0=2N$, $m=1.5Kg$, $t=2 s$, $b=3 N/s$ and $k=5 N/m$.

(d:1) $v=$ _____ (d:2) $x=$ _____

[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 $\vec{v}_b = +15 \frac{\text{m}}{\text{s}} \hat{x}$. Your answers here must show details and include correct SI units.

(a) If it strikes and sticks to a mass m_2 which initially at rest, how fast is the system traveling after the collision?

(b) After it strikes mass m_2 , it slides up a frictionless plane. How far (h) above the ground level will the combined mass slide till it stops?

(c) Suppose that the mass struck a mass m_2 and instead of sticking together, went through a completely elastic collision. After the collision, what is the **vector** velocity of each mass?

$$v_{1a} = \underline{\hspace{2cm}} \quad v_{2a} = \underline{\hspace{2cm}}$$