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| October 5, 2026 | Physics 240: UnTest #2: page 1 | Name _____ |
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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 mass  $m_1 = 1.0$  kg moving on a frictionless horizontal table with speed  $v_0 = 12.0$  m/s collides perpendicularly with a mass  $m_2 = 3.0$  kg and sticks to it. Mass  $m_2$  is connected to a pivot point by a massless rigid rod of length  $R = 2.0$  m and is initially at rest. After the collision, the combined mass moves in a circle on the horizontal table.

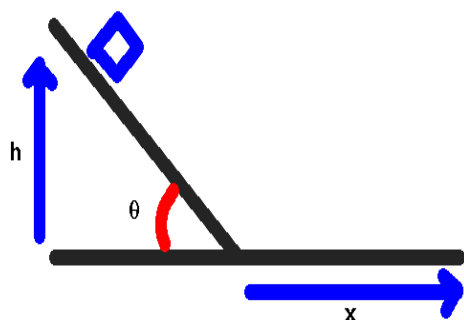
[1:a] Find the speed of the combined mass (in m/s) immediately after the collision.

[1:b] The angular velocity  $\omega$  (in "rad"/s ) of the system after the collision is given by:

[1:c] The centripetal acceleration (in  $\text{m/s}^2$  ) of the combined mass as it rotates is given by:

[1:d] The force (in N) exerted by the rod on the combined mass is given by:

[1:e] The mechanical energy lost (in J) during the inelastic collision is given by:



**[2]** A mass  $m$  is resting on an inclined plane (inclined at an angle  $\theta$ ) at a height  $h$  above the floor. The plane is frictionless. When the mass strikes the bottom of the plane, it slides along a flat surface through a distance  $x$ . There is a coefficient of friction  $\mu$  between the mass and the level surface.

[a] Draw a correct and complete free body diagram for this system when the mass is on the level surface.



[b] When the mass slides along the level surface until it stops, calculate  $\Delta K_{NC}$ . Your answer here must involve the symbols  $g$ ,  $m$ ,  $x$  and  $\mu$ .

[c] Calculate  $\Delta K_c$  in terms of  $m$  and  $v$  (velocity) starting at the beginning and ending where the mass has stopped.

[d] Calculate  $\Delta U$  in terms of  $m$ ,  $g$  and  $h$ .

[e] Solve, using your energy equation, to find out how far the mass slides until it stops.

[f] if  $h=2$  m, 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  $\frac{\text{N}}{\text{s}}$ . 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) After a time  $t$ , the force is removed and the mass is allowed to slide up a frictionless plane until it stops. When it stops, how high is it above the ground level? Your answer involves  $m$ ,  $F_0$ ,  $b$ ,  $t$ , and  $g$ .

(c) Provide numerical answers to (b) and (c) above with correct SI units for the case  $F_0=2\text{N}$ ,  $m=1\text{Kg}$ ,  $t=2\text{ s}$  and  $b=3\text{ N/s}$ .

$h=$ \_\_\_\_\_

**[4]** A mass  $m_1$  is moving along the x-axis at a velocity  $v_b$ . In this problem, assume  $m_1=3$  kg,  $m_2=1$  kg, and  $\vec{v}_b = +20 \frac{\text{m}}{\text{s}} \hat{x}$ . **Your answers here must show details and include correct SI units.**

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

(b) After the collision, the mass combination encounters a spring of spring constant  $k=10$  N/m. How much will the mass combination compress the spring until 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?

$\vec{v}_{1a} =$  \_\_\_\_\_  $\vec{v}_{2a} =$  \_\_\_\_\_