PHYSICS 140 – Review for Exam 1 –Thursday, October 1

Try these review problems before the review session. Bring questions on old homework problems. Also review dimensional analysis, significant figures, and the metric system. The exam will consist of five 10 pt. problems, four problems with some short answer questions, or some similar combination

1. A model rocket is fired vertically and ascends with constant vertical acceleration of 4.0 m/s^2 for 6.0 s. Then its fuel runs out, and it continues in free fall.

   (a) Sketch graphs for y vs. t, v_y vs. t, and a_y vs. t for the entire motion. Mark T_1 as the time when the rocket runs out of fuel, T_2 as the time when it reaches its maximum height, and T_3 as the time it strikes the earth.

   (b) Find the maximum height that the rocket reaches.

   (c) Find the total time that the rocket spends in the air.

   (d) Find the velocity with which the rocket hits the ground.

   Ans. y_{max} = 101 m; T_3 = 13.0 s; $v(T_3)$ = –44.6 m/s.

4. After you hit a baseball, it flies into a window across the street. The baseball leaves your bat at a distance 1 m above the ground, and the window is 12 m above the ground. The ball leaves your bat with a velocity of 30 m/s ∠ 30° above the horizontal. Include a diagram, clearly labeled.

   (a) How long was the ball in the air? Note: if your solution contains two roots, explain the meaning of each.

   (b) How far away is the building from home plate?

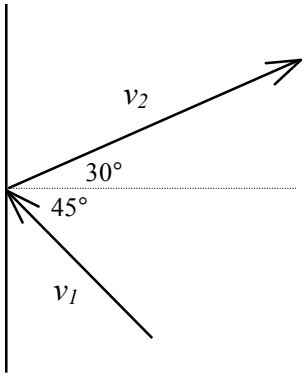
   (c) Find the magnitude and direction of the velocity of the ball when it breaks the window.

   Ans. t = 1.84 s or 1.22 s; R = 47.8 m or 31.7 m; **v** = 26.2 m/s ∠ ±6.65°.

5. A force with magnitude F_0 acting on an object produces an acceleration of 3 m/s^2. If the forces $2F_0$ ∠ 30° and F_0 ∠ –10° act on the object, use the Laws of Sines and/or Cosines to find the magnitude and direction of the acceleration. Include a diagram, clearly labeled.

   Ans. **a** = 8.52 m/s^2 ∠ 16.9°

7. A 400-gram hockey puck is struck and changes its velocity as shown in the diagram below. If the puck was initially moving at 5.5 m/s, and moves away at 7.0 m/s, find the magnitude and direction of the force exerted by the stick on the puck. Assume that the hockey stick contacts the puck for 0.15 sec. (A solution using x, y components will be presented in the review session.)

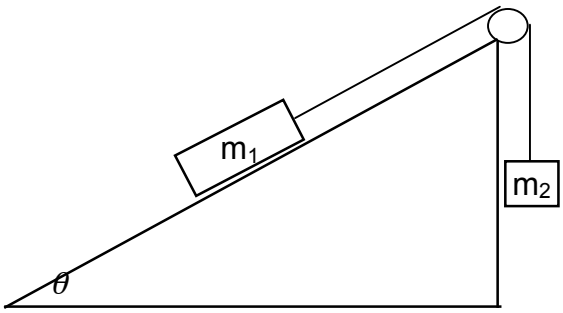


Ans. $\mathbf{F} = 26.6\text{ N} \angle -2.24°$

8. Two objects are connected by a massless string which passes over a frictionless, massless pulley. The incline is also frictionless.

(a) Find the acceleration of the objects and the tension in the string for general values of m_1, m_2, and θ. In your diagram, indicate clearly the forces, the coordinate system, and the force components. Set up your equations clearly using Newton's Laws of Motion.

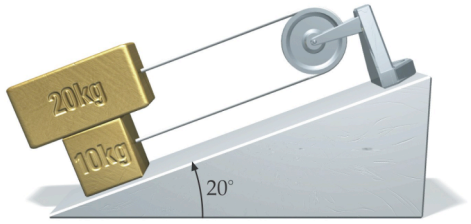
(b) Using your expression from part (a), find the acceleration and tension if $m_1 = 3$ kg, $m_2 = 1$ kg, and $\theta = 30°$.



Ans. $a = \dfrac{m_2 - m_1 \sin\theta}{m_1 + m_2} g = -1.23 \dfrac{m}{s^2}$;

$T = \dfrac{m_1 m_2}{m_1 + m_2} g(1 + \sin\theta) = 11.0\text{ N}$

6. A 20-kg block is sliding on a 10-kg block. All surfaces are frictionless. Find the acceleration of each block and the tension in the string that connects the blocks. Also find all the normal forces acting on the blocks.

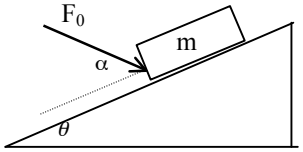


7. A crate of mass m is pushed up a smooth plane inclined at angle θ, by an applied force F_0.

   (a) In terms of the symbols given, find a mathematical expression for the minimum force F_0 required to move the crate at constant velocity if the force is directed at an angle α relative to the plane. (See diagram.)

   (b) In terms of the symbols given, find an expression for the normal force exerted on the crate by the plane.

   (c) If m = 50 kg, θ=25°, and α = 45°, find the force (in Newtons) that must be applied if the crate accelerates at 1 m/s^2.



Ans. $F_0 = \dfrac{mg\sin\theta}{\cos\alpha}$; $F_N = mg\sin\theta\tan\alpha + mg\cos\theta$; $F_0 = 364$ N