UNIVERSITY OF OTTAWA
Principles of Physics
PHY1321/1331 FALL 2014
Dr. A. Czajkowski

CLASS: PHY_____

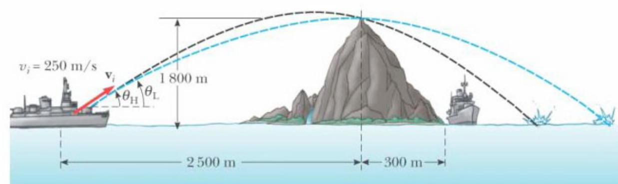
STUDENT #: ________________

NAME: ______________________

Assignment 3: Kinematics and Forces

Assigned: Sept 19 14:30 Due: September26 18:00

1 An enemy ship is on the east side of a mountain island, as shown. The enemy ship has maneuvered to within 2 500 m of the 1 800-m-high mountain peak and can shoot projectiles with an initial speed of 250 m/s. If the western shoreline is horizontally 300 m from the peak, what are the distances from the western shore at which a ship can be safe from the bombardment of the enemy ship?



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Find the highest firing angle θ_H for which the projectile will clear the mountain peak; this will yield the range of the closest point of bombardment. Next find the lowest firing angle; this will yield the maximum range under these conditions if both θ_H and θ_L are > 45°; $x = 2500$ m, $y = 1800$ m, $v_i = 250$ m/s.
We may use the equation for trajectory obtained during our lecture:

$$y = (\tan\theta)x - \frac{g}{2v_o^2\cos^2\theta}x^2 \text{ but } \frac{1}{\cos^2\theta} = \tan^2\theta + 1 \text{ so}$$

$$0 = \frac{gx_f^2}{2v_i^2}\tan^2\theta - x_f\tan\theta + \frac{gx_f^2}{2v_i^2} + y_f.$$ Substitute values, use the quadratic formula and find $\tan\theta = 3.905$ or 1.197, which gives $\theta_H = 75.6°$ and $\theta_L = 50.1°$.

Range at θ_H $R = \frac{v_o^2 \sin 2\theta}{g} = 3070$ from enemy ship : $3.07\times10^3 - 2\,500 - 300 = 270$ m from shore.

Range $R = \frac{v_o^2 \sin 2\theta}{g} = 6280$ from enemy ship Range at θ_L $6.28\times10^3 - 2\,500 - 300 = 3.48\times10^3$ from shore.

Therefore, safe distance is $\boxed{< 270 \text{ m}}$ or $\boxed{> 3.48\times10^3 \text{ m}}$ from the shore.

2 For each object in the table below write the Newton's II Law in component form

System	Diagram	X component	Y component
Mass M suspended on the vertical string in the elevator moving with acceleration (a) down			
Block of mass m resting on the floor of the rocket cabin accelerating up with the acceleration a			
Block of mass me is pressed against the rough vertical wall by the applied force Fa directed at angle Θ below the horizontal. Block is moving up with acceleration a			
Block of mass ma on the rough surfaced incline (α with horizontal) in equilibrium.			
Ball on a string moving in vertical circle . at its top position			

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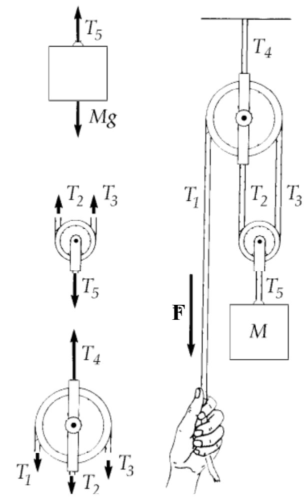
Assignment 3: Forces CONT.

Assigned: Sept 19 14:30 *Due: September 26 18:00*

3 An object of mass *M* is held in place by an applied force **F** and a pulley system as shown in Figure P5.55. The pulleys are massless and frictionless. Find (a) the tension in each section of rope, T_1, T_2, T_3, T_4, and T_5 and (b) the magnitude of **F**. *Suggestion:* Draw a free-body diagram for each pulley.



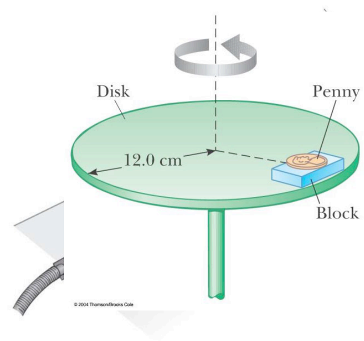
First, we note that $F \square T_1$. Next, we focus on the mass M and write $T_5 \square Mg$. Next, we focus on the bottom pulley and write $T_5 = T_2 + T_3$. Finally, we focus on the top pulley and write $T_4 = T_1 + T_2 + T_3$.

Since the pulleys are not starting to rotate and are frictionless, $T_1 \square T_3$, and $T_2 \square T_3$. From this information, we have $T_5 = 2T_2$, so $T_2 \square \frac{Mg}{2}$.

Then $\boxed{T_1 = T_2 = T_3 = \frac{Mg}{2}}$, and $\boxed{T_4 = \frac{3Mg}{2}}$, and $\boxed{T_5 = Mg}$.

(b) Since $F \square T_1$, we have $\boxed{F = \frac{Mg}{2}}$.

4 A penny of mass 3.10 g rests on a small 20.0-g block supported by a spinning disk. The coefficients of friction between block and disk are 0.750 (static) and 0.640 (kinetic) while those for the penny and block are 0.520 (static) and 0.450 (kinetic). What is the maximum rate of rotation in revolutions per minute that the disk can have, without the block or penny sliding on the disk?



For penny

$$\sum F_r = m\frac{v_{\max}^2}{r}$$

$$\mu n = m\frac{v_{\max}^2}{r}$$

$$\mu mg = m\frac{v_{\max}^2}{r}$$

$$v_{\max} = \sqrt{\mu gr}$$

$$v_{\max} = \sqrt{0.520(9.8)(0.12)}$$

For block

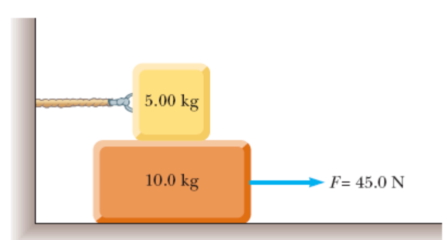
$$\sum F_r = m\frac{v_{\max}^2}{r}$$

$$0.750(0.020+0.00310)g + 0.520(0.0031)g = 0.020\frac{v_{\max}^2}{0.12}$$

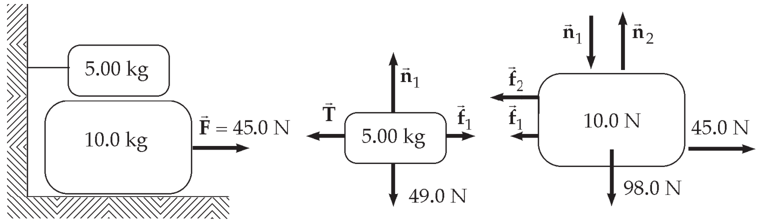
$$\sqrt{\frac{[0.750(0.020+0.00310)+0.520(0.0031)](9.8)(0.12)}{0.020}} = v_{\max}$$

Since the lower value is limiting value we get and since we get 0.78 m/s for the penny and 1.06 m/s for the block.
The maximum rate is 62.23rev/min (determined by the velocity at which the penny slips).

44. A 5.00-kg block is placed on top of a 10.0-kg block (Fig. P5.44). A horizontal force of 45.0 N is applied to the 10-kg block, and the 5-kg block is tied to the wall. The coefficient of kinetic friction between all moving surfaces is 0.200. (a) Draw a free-body diagram for each block and identify the action-reaction forces between the blocks. (b) Determine the tension in the string and the magnitude of the acceleration of the 10-kg block.



P5.44 (a)



f_1 and n_1 appear in both diagrams as action-reaction pairs

(b) 5.00 kg: $\Sigma F_x = ma:$ $n_1 = m_1 g = 5.00(9.80) = 49.0$ N $f_1 - T = 0$

$T = f_1 = \mu mg = 0.200(5.00)(9.80) = \boxed{9.80 \text{ N}}$

10.0 kg: $\Sigma F_x = ma:$ $45.0 - f_1 - f_2 = 10.0a$

$\Sigma F_y = 0:$ $n_2 - n_1 - 98.0 = 0$

$f_2 = \mu n_2 = \mu(n_1 + 98.0) = 0.20(49.0 + 98.0) = 29.4$ N

$45.0 - 9.80 - 29.4 = 10.0a$ $a = \boxed{0.580 \text{ m/s}^2}$