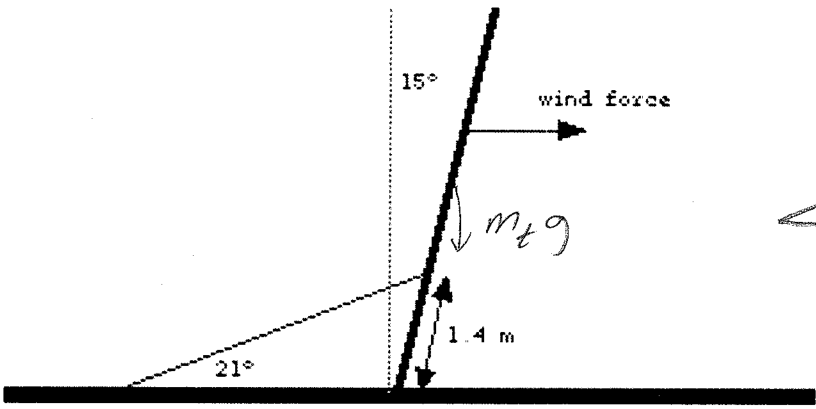
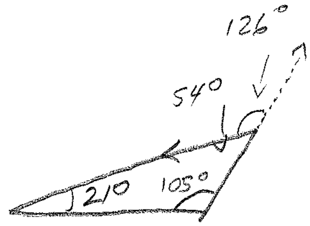
Physics 10154 - Exam #8D

Answer the following two questions. Be sure to clearly indicate your answer with a circle or box. Show all work. If I cannot see how you arrived at an answer, I will deduct points!

1. A 5.0-meter tall tree is being supported by a thin rope against the wind. Due to the strength of the wind, the tree is tipped over 15° from the vertical as shown below. Assume the tree is a uniform 85-kg rod which ends at the ground. The wind exerts a force of 160 Newtons spread over the tree, and you can sssume the point of application of that force is 3.5 meters from the bottom of the rod. What is the tension in the rope?





$$\Sigma \tau = \tau_{wire} + \tau_{tree} + \tau_{wind} = 0$$

$$\tau_{wire} = +(1.4) F_{wire} \sin 126°$$

$$\tau_{tree} = -(2.5)(85)(9.8) \sin 165°$$

$$\tau_{wind} = -(3.5)(160) \sin 75°$$

$$1.13 F_{wire} - 539 - 541 = 0$$

$$\boxed{F_{wire} = 960 \text{ N}}$$

2. A 120-kg solid cylinder merry-go-round with a radius of 1.3 meters is spinning at a rate of 15 rev/min. A 45-kg child (with no initial angular speed) jumps onto the rim and moves with the merry-go-round from that point on.

a) What is the final speed of the merry-go-round?
b) How much Kinetic Energy was lost due to the child's jump?

$$I_{mgr} = \frac{1}{2}(120)(1.3)^2 = 101.4\ kg\cdot m^2$$

$$\omega_{i,mgr} = 15\ \frac{rev}{min} = 1.57\ rad/sec$$

$$I_{child} = MR^2 = 45\,(1.3)^2 = 76.1\ kg\cdot m^2$$

$$\omega_{i,child} = 0$$

$$I_{mgr}\,\omega_{i,mgr} + I_{child}\,\omega_{i,child} = (I_{mgr} + I_{child})\,\omega_f$$

$$(101.4)(1.57) + 0 = (177.5)\,\omega_f$$

$$\boxed{\omega_f = 0.90\ rad/s}$$

$$K_i = \frac{1}{2} I_{mgr}\,\omega_{i,mgr}^2 + \frac{1}{2} I_{child}\,\omega_{i,child}^2$$

$$= \frac{1}{2}(101.4)(1.57)^2 + 0$$

$$= 125\ J$$

$$K_f = \frac{1}{2}(I_{tot})\,\omega_f^2$$

$$= \frac{1}{2}(177.5)(.90)^2$$

$$= 71\ J$$

$$\boxed{\Delta K = 54\ J}$$