

Welcome! Today, we have a variety of questions from QOTW for you guys to solve. There is a total of **41** points. Points indicate relative difficulty.

Week 5

- [4] **Problem 1.** A regular uniform n -gon (a regular polygon with n sides) of side length a and mass m is held at rest on an incline angled at 25° above the horizontal. If the coefficient of static friction between the incline and the n -gon is sufficient enough to prevent the polygon from sliding, find the largest n such that the n -gon will remain in equilibrium after being released from rest.

Week 6

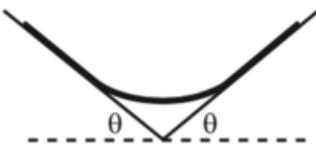
- [6] **Problem 2.** A circular loop of rope with radius R and mass density λ (kg/m) lies on a frictionless table and rotates around its center, with all points moving at speed v . What is the tension in the rope? *Hint:* Consider the net force on a small piece of rope that subtends an angle $d\theta$.

Week 7

- [7] **Problem 3.** Gary is falling through the sky (assume gravitational constant g everywhere, and assume no air drag), directly below him, there are infinite layers of very dense and thin clouds, vertically separated by uniform distances h . When he falls through each cloud, his downward velocity would be decreased by a positive quantity Δv . After sufficient time, Gary's velocity would follow a periodic pattern. Find Gary's average velocity over infinite time.

Week 8

- [7] **Problem 4.** A rope rests on two platforms that are both inclined at an angle θ . The rope has uniform mass density, and the coefficient of friction between it and the platforms is 1. The system has left-right symmetry.



What is the largest possible fraction of the rope that does not touch the platforms? For what angle θ is this friction maximized?

Week 9

- [7] **Problem 5.** When a projectile moves slowly through air, the drag is linear in the velocity,

$$F = -\alpha mv.$$

Find the velocity $v(t)$ of a projectile thrown upward at time $t = 0$ with speed v_0 . *Note:* This problem requires calculus.

- [10] **Problem 6.** For this problem, linear drag is represented by Cv , where C is a constant and v is the velocity in a particular direction.

Gary is snowboarding down Mount Washington in the middle of a winter storm. The wind is blowing horizontally southward at a speed of v_{wind} . Gary launches off a cliff on the southern side of the mountain at a height h_0 . Upon leaving the cliff, he is already moving downward at his terminal velocity and horizontally at speed $v_x < v_{wind}$, while the wind pushes him further south.

Miraculously, Jonathan has placed a ramp on the ground so that it exactly meets Gary's trajectory, allowing him to land tangentially on the ramp. Question: Determine the angle and horizontal distance from the cliff at which Jonathan must place the ramp, expressed in terms of v_{wind} , v_x , h_0 , and C .

Note: you will need to know the downward terminal velocity Gary is at based on the information given.

Note: Vivek is filming the whole thing and is shocked to see Gary's flawless descent, but is in the path and Gary collides into him!