PHY 420, Fall 2019

Problem Set #2

Assigned: September 3
Due: September 11

Part I: Read the 1980 Popular Mechanics article on ski jumping attached in the subsequent pages, and then watch the video of the ski jumper at the link provided and answer the following questions.

https://www.youtube.com/watch?v=J-QEjwieXIU

1. In an idealized situation, what speed would a 100 kg (body + skis) jumper have at the bottom of a ramp (formally referred to as the "in-run") that is inclined at an angle of 36 degrees and has a length of 90 meters?

2. For this problem assume idealized conditions, and consider that the end of the ramp curves so that the jumper leaves the ramp at an angle of 10 degrees below the horizontal (ignoring any jumping motion of the skier). Let us also simplify the problem and imagine that there is no slope and instead the skier lands on flat ground (very dangerous) located a vertical distance of 75 meters below the end of the ramp. What is the expected horizontal distance traveled from the end of the ramp to the landing point using your answer from the previous question?

3. Now we will consider the dynamics with drag. It is not easy to solve a 2D problem with quadratic drag (which we should assume because of the high speeds), so we will use a hack to try to get a sense of how much things should change. To do this part, we reason that since the skier leaves the jump traveling mostly horizontally at a large speed, the drag force will have a substantially greater influence on the x-motion. Therefore, redo the problem as before but now including a horizontal drag force equal to $c_2 A v_x^2$, and take c_2=2.0 (when using SI units). Consider a skier who is about 2 meters tall when standing upright (do skiers fly through the air upright?) and has an average width of 0.5 meters. What is the new horizontal travel distance under these circumstances?

4. Considering that a typical slope has an incline of 40 degrees (as shown in the Popular Mechanics article), and if an actual skier descends a <u>vertical</u> distance of 75 meters from the launch point, can you say whether the presence of air is a benefit or a hindrance to the skier's performance?

Part I: Complete the following problems in *Classical Mechanics by Fowles & Cassiday*:
2.1, 2.2, 2.3, 2.6 (more review problems)
2.8, 2.10, 2.19 (challenge problems)