Rope Simulator to Recreate Two Effects Involving Air Resistance

APC 523 Final Project

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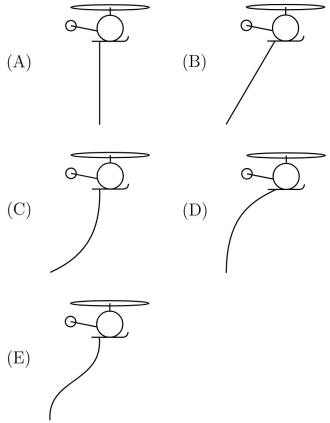
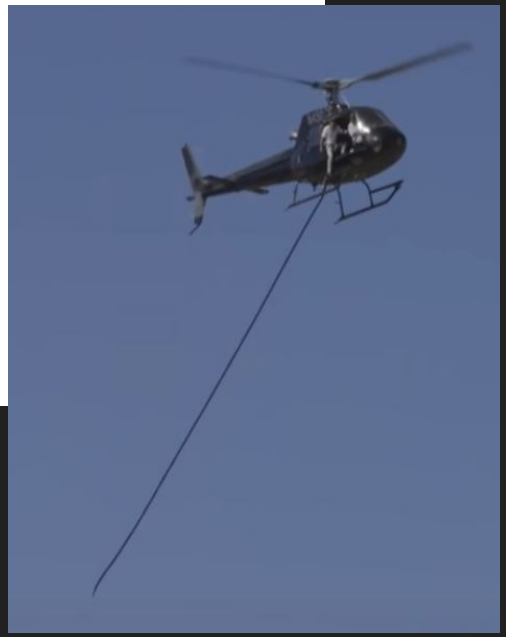
Problem 1 - Rope Dangling from a Helicopter

- Original problem from 2014 F=ma competition, video by Veritasium
- What happens when a rope is towed from a helicopter and there is air resistance?
  - What happens if we add a weight to the bottom?
  - What happens if we add a parachute to the bottom?

19. A helicopter is flying horizontally at constant speed. A perfectly flexible uniform cable is suspended beneath the helicopter; air friction on the cable is *not* negligible.

Which of the following diagrams best shows the shape of the cable as the helicopter flies through the air to the right?

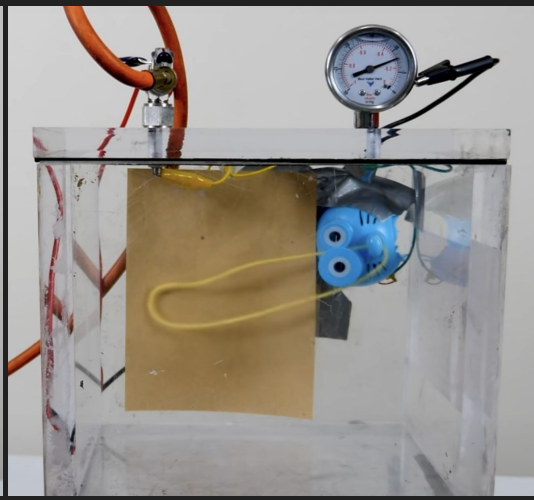




Problem 2 - String Shooter in Air vs Vacuum

- From Action Lab video
- String shooter has wheels to accelerate a loop of string
- What shape does the loop form when in air vs when in a vacuum?

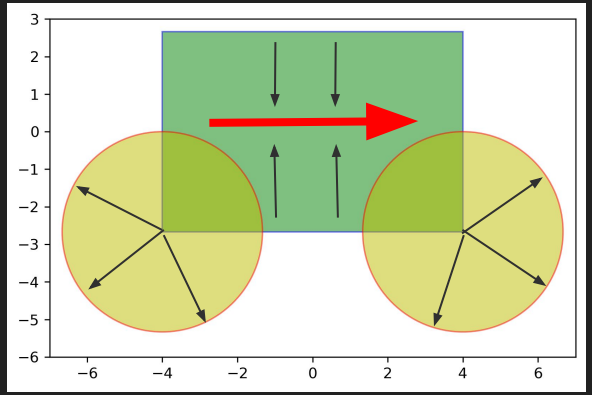
String shooter in Vacuum



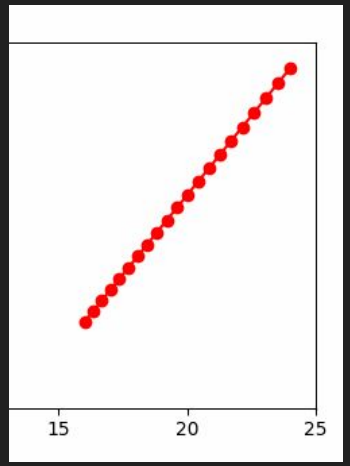
String shooter in Air

Implementation Details

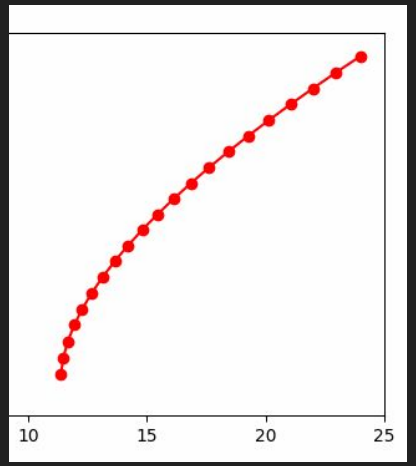
- Point masses connected by stiff springs
- Air resistance and gravity
- Symplectic Euler with small time step is sufficient
- Nonperiodic rope for Helicopter, periodic rope for String shooter
- Helicopter boundary condition made by giving initial velocity and turning off forces for top particle
- Shooter for string shooter consists of rectangle which constrains and pushes particles forward and circles to constrain particles outward



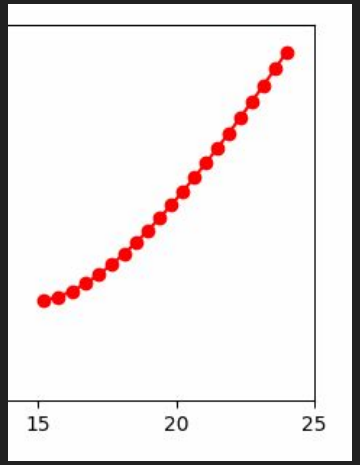
Results for Helicopter



Just rope

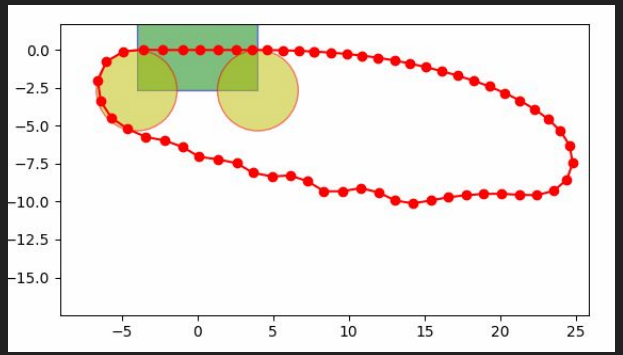


Rope with mass

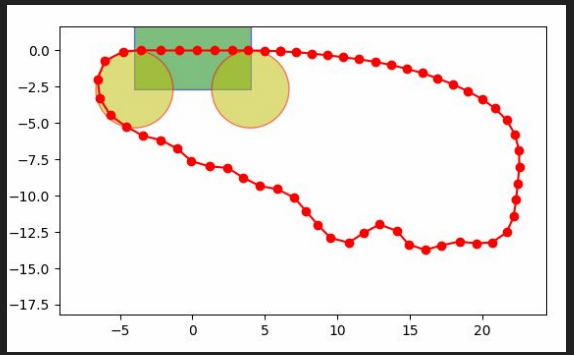


Rope with Parachute

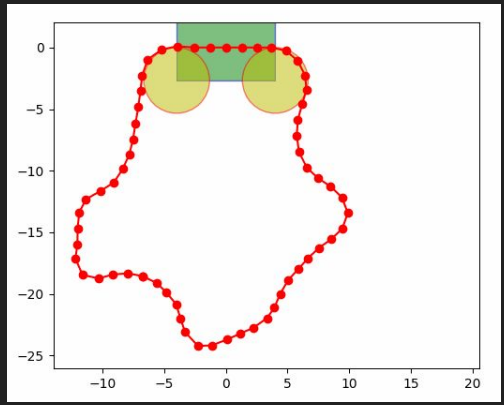
Results for String Shooter



High air resistance



Medium air resistance



Low air resistance