

# Deep Learning and Physics

## Midterm Exam (24 hours take-home)

(2025-1, April 22, 9am~April 23, 9am)

Department of Physics, Chung-Ang University  
Chang Hyeon Ha



# Jackson, Mississippi + 강원도 대구

**Question : Please analyze the 빵꾸통 motion used in one of painting methods.**

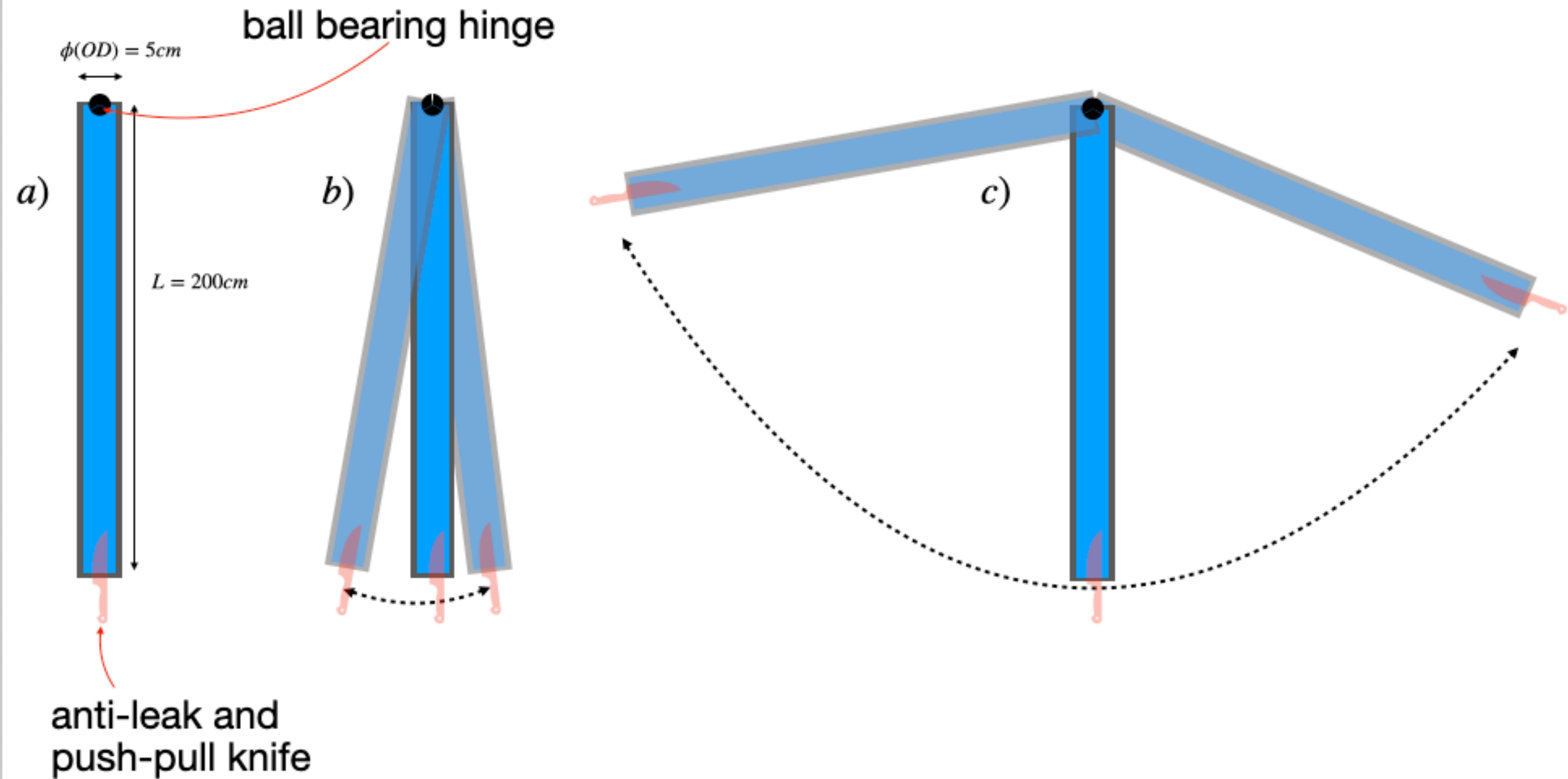
- a) The 빵꾸통 is initially at rest.
- b) You apply periodic external force to move the 빵꾸통 (for example, by push-pulling the knife handle horizontally)
- c) The mass of the 빵꾸통 reaches more than 60 degree relative to its equilibrium position.
- d) Then, suddenly the knife was detached and painting oil drips while the 빵꾸통 is continuously oscillating back and forth.
- e) The entire paint leaks out and the 빵꾸통 is still swinging.
- f) Eventually, the 빵꾸통 stops due to the air drag and frictions on a ball bearing.

# Make sure that your setup needs to have at least 5 back-and-forth motions in each step above.

**One end of a hollow acrylic cylinder**

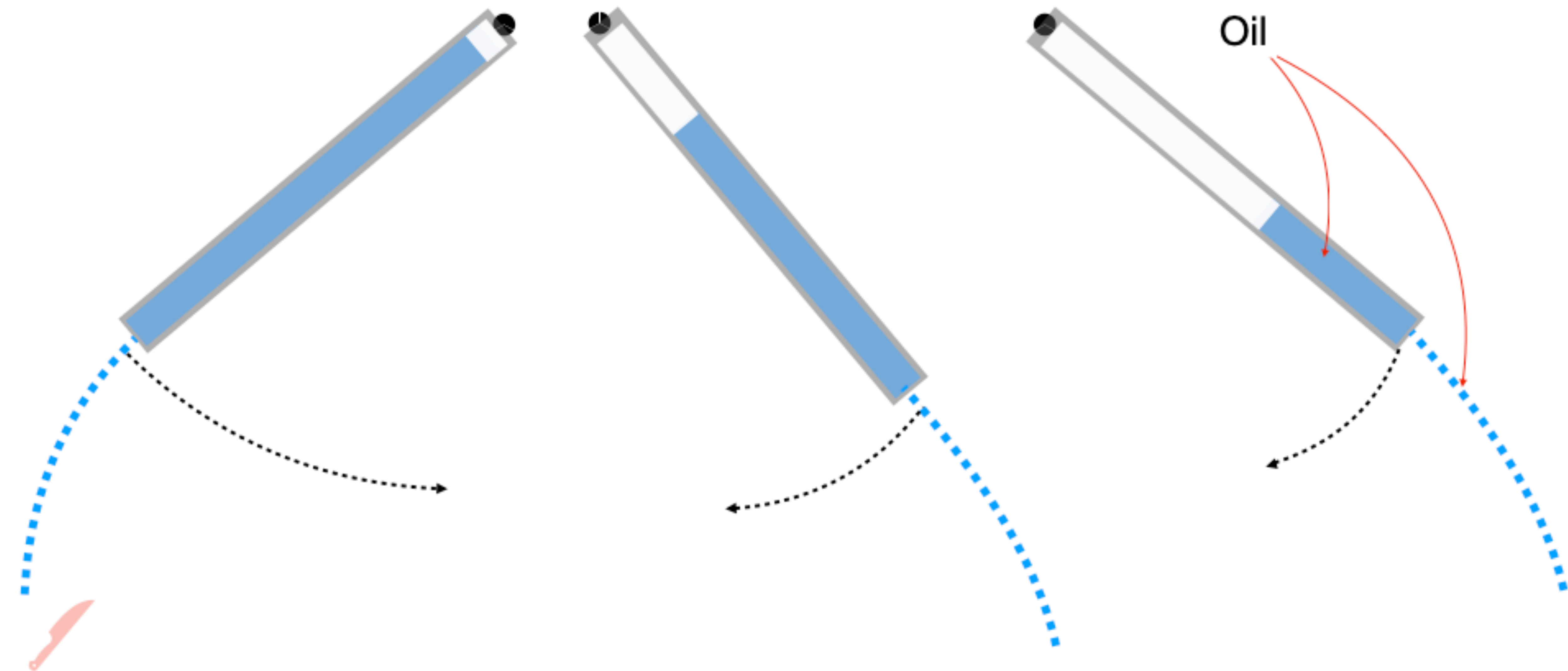
**[ $L = 200 \text{ cm}$ ,  $\phi(\text{outer}) = 5 \text{ cm}$ ,  $t = 0.5 \text{ cm}$ ] filled with painting liquid is hung to ceiling on a ball bearing. The other end is closed but there is a small crack on the surface. This crevice is clogged by a pocket knife ad hoc such that the liquid is not leaking out. This entire system is named as 빵꾸통.**

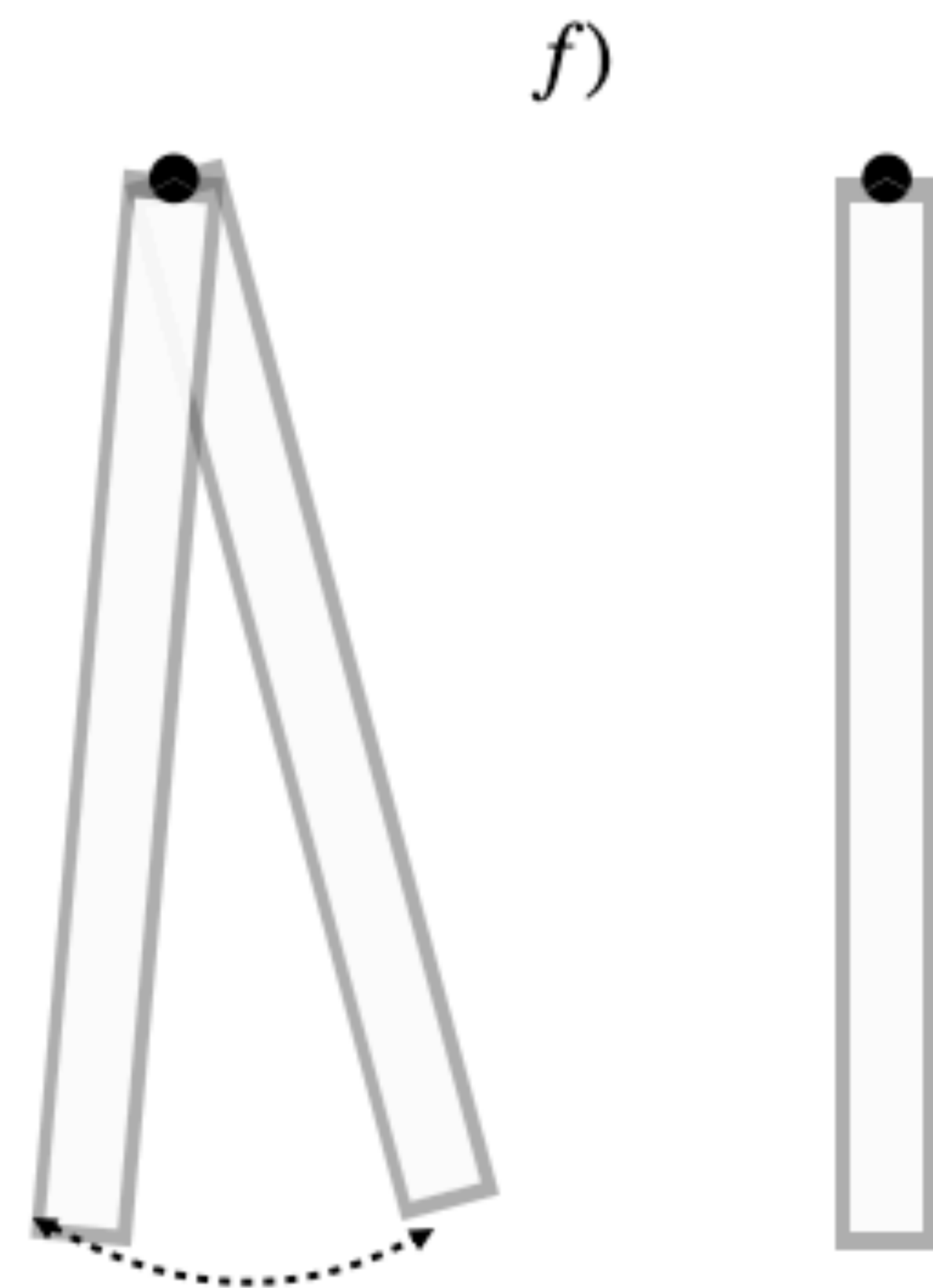
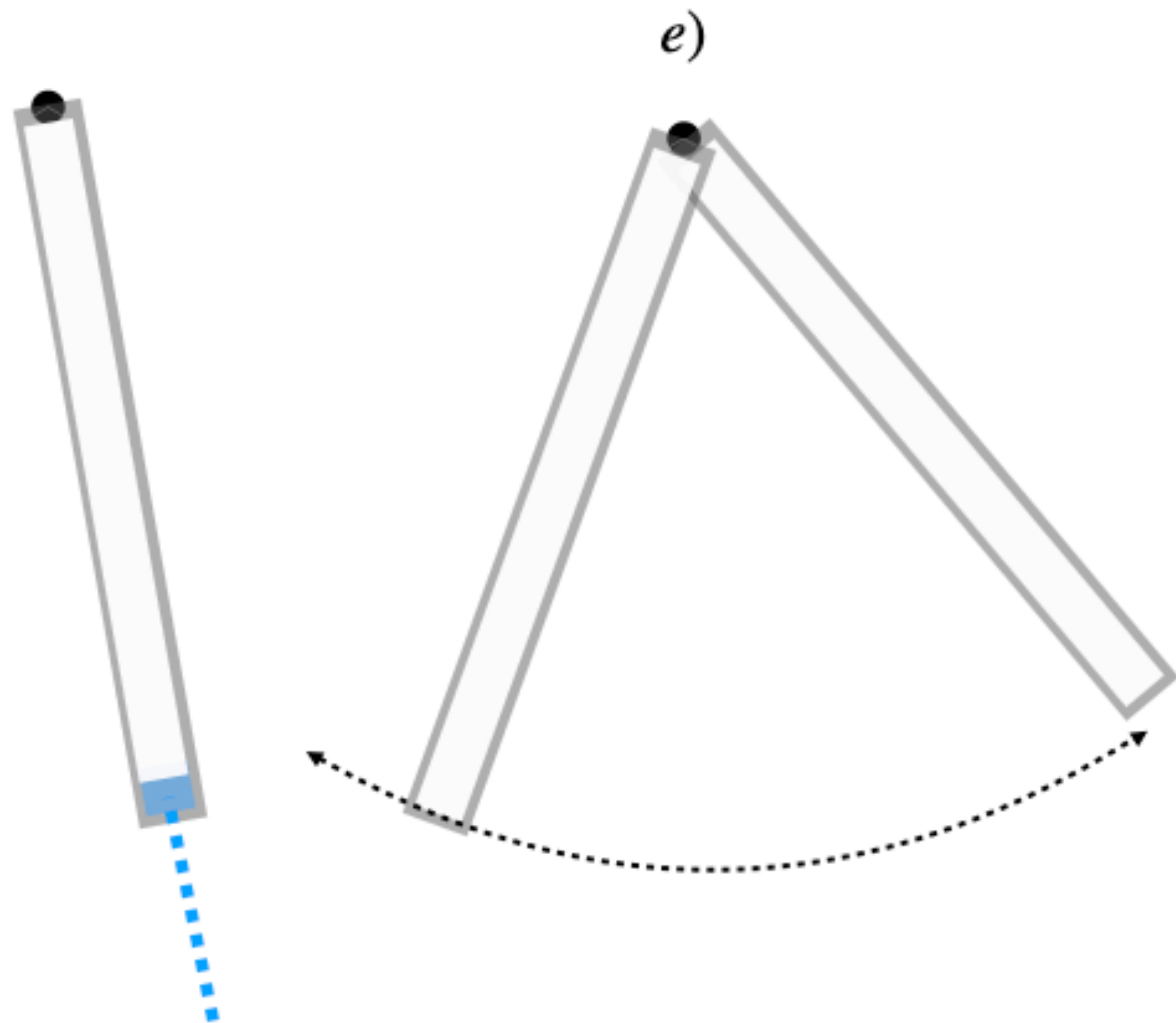
**The size of the crack is roughly  $0.07 \text{ cm}^2$ . The rate of leak is  $42 \text{ cm}^3/\text{s}$  when the knife is removed. Assume the liquid flow is constant because the flow variation is dependent more on the viscosity rather than gravity variations. Typical acrylic (PMMA) has a density of  $1.2 \text{ g/cm}^3$  and that of typical painting oil is  $1.5 \text{ g/cm}^3$ . Here  $L$  is length of the acrylic,  $\phi$  is a outer diameter(OD) of the cylinder, and  $t$  is thickness of the acrylic. The pocket knife's mass can be ignored (less than 50 grams). It is reasonable to assume the friction on the ball bearing does not depend on supported mass but the rolling speed of the balls inside.**





*d)*





# Instructions

- \*\*Model the motion of the 뽕꾸통 as close as the reality for about 2.0 minutes.**
- \*\*Apply reasonable assumptions when modeling, especially for the frictions and air drag. Of course, assume the mass and length of the 뽕꾸통 as well reasonably.**
- \*\* Model properly for the physics using a reasonable assumption of oil dripping speed.**
- \*\* It is reasonable that you model the 뽕꾸통 with the rendering of a pendulum.**

**Submit the following by 9am April 23 :**

- 1. your equations of the motion.**
- 2. plots of the angle, the angular velocity, the external driving force, and the period as functions of time.**
- 3. python codes as dot-py files and movie of the full motion of the 뽕꾸통.**
- 4. Please specify your assumptions and explain your solution**
- 5. Answer in words what would happen if 뽕꾸통 is made of a rubber balloon filled with oil instead of an acrylic cylinder?**

**Note that this is a take-home exam. No discussion is allowed with anyone.**