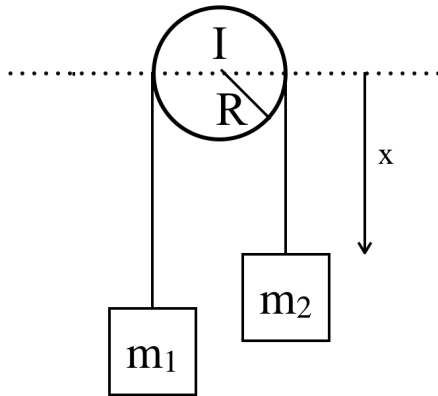


1 Atwood Machine

Consider an Atwood machine, in which two blocks m_1 and m_2 are suspended by an inextensible string (length l) which passes over a pulley with moment of inertia I and radius R . The pulley has frictionless bearings.



- Starting from Newton's 2nd Law, find the acceleration of the system.
- Write down the Lagrangian of the system and use it to find the acceleration of the system. (Do you get the same answer?)
- Use 3 sensemaking strategies to evaluate your answer.

2 Bead on a Rotating Rod

(modified from Taylor 7.21)

The center of a long frictionless rod is pivoted at the origin, and the rod is forced to rotate in a horizontal plane with constant angular velocity ω . Consider a bead with mass m that is free to move frictionlessly along the rod. Find the position of the bead as a function of time using the polar coordinate s as your generalized coordinate.

- Using a Lagrangian approach, find the position of the bead as a function of time using the polar coordinate s as your generalized coordinate.
- Use 3 sensemaking strategies to evaluate your answer. (Be sure to articulate your expected results during each strategy.)

3 Bead on a Helix 1

(adapted from Taylor 7.20)

A smooth wire is bent into the shape of a helix, with cylindrical polar coordinates $s = R$ and $z = \lambda\phi$, where R and λ are constants and z is vertically up (and gravity vertically down). Using z as your generalized coordinate, write down the Lagrangian for a bead of mass m threaded on the wire.

- (a) Find the bead's vertical acceleration $\ddot{z}$.
- (b) Use three sensemaking strategies to evaluate your answer to part (a). (Don't forget to articulate your expected result for each strategy.)
- (c) In the limit that $\lambda \rightarrow 0$, what is $\ddot{z}$? Explain conceptually how this makes sense.
- (d) How does the acceleration depends on the parameters of the problem (R and λ)? Plot the $\ddot{z}$ vs. R and $\ddot{z}$ vs. λ . Explain what these plots tell you about how the geometry of the helix affects the acceleration.

4 Generalized Force and Generalized Momentum

Demonstrate that when your generalized coordinate is an angle, the generalized force associated with that coordinate is a torque and that the generalized momentum associated with that coordinate is an angular momentum.