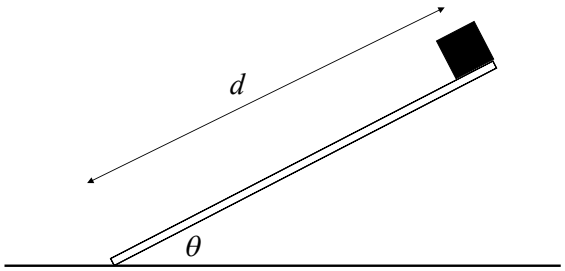
Classical Mechanics

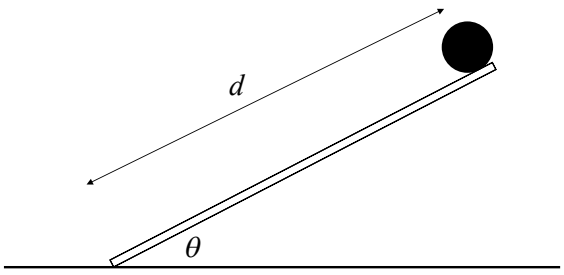
Do <u>two</u> of the following three problems, each on a separate sheet (or sheets). Attach each set to a provided cover sheet with your name, subject, and problem number.

Problem 1

Sliding vs. Rolling



A block of mass m slides without friction down a ramp. The ramp makes an angle θ with respect to the horizontal. The block begins at rest, and slides a distance d down the ramp in a time t_{block}; it has a linear speed v_{block} when it reaches the bottom of the ramp.



Now, instead of a block, we have a disk of mass m and radius R that rolls without slipping down the ramp. The disk begins at rest, and rolls a distance d down the ramp in a time t_{disk}; it has a linear speed of v_{disk} when it reaches the bottom of the ramp.

- What is the ratio of the two speeds, $v_{\text{block}}/v_{\text{disk}}$?
- What is the ratio of the two times, $t_{\text{block}}/t_{\text{disk}}$?

Please show your work leading to the answers.

Problem 2

Find the differential equations for 2-D projectile motion in a uniform gravitational field using the Lagrangian method. Solve them for $x(t)$ and $y(t)$.

Problem 3

a. An object of mass m is dropped from a height h on Earth. Derive equations for its motion in 3-D, and show that it drifts a distance x_h eastward as it falls, where

$$x_h = \frac{1}{3}\sqrt{\frac{8h^3}{g}}\cos\lambda.$$

Here ω is the angular velocity of the Earth and λ is the lattitude. (8 points)

b. Where on Earth is the Coriolis force smallest? (2 points)