PHY151 Practical Questions for Nov 21 to 25

1. In a movie scene, a truck travelling at highway speeds loses a wheel. The wheel keeps rolling without slipping. The protagonist is on a motorcycle and wants to deflect the wheel. Assume the wheel is going east, and the protagonist uses their foot to nudge the wheel with a north-directed kick. How does the wheel react if it kick is aimed at: (a) the top of the wheel; (b) the front of the wheel; (c) the back of the wheel? In each case, choose the centre of the wheel as the pivot point (which is correct for the motorcycle's reference frame).

2. Show that for an elliptical orbit around a planet of mass M, $v_1 = \sqrt{\frac{2GMr_2}{r_1(r_1+r_2)}}$ where r_1 and r_2 are the closest/farthest points (perigee and apogee) of the orbit.

   This will help with question 3.

3. How much impulse do you need to give to a 1000 kg spaceship in close orbit around Earth in order to get it into a close orbit around Mars? You get to do only two boosts, one to leave Earth and the other to park in orbit around Mars. You can ignore the Moon. (Check out the answer to question 2, it will help here.)

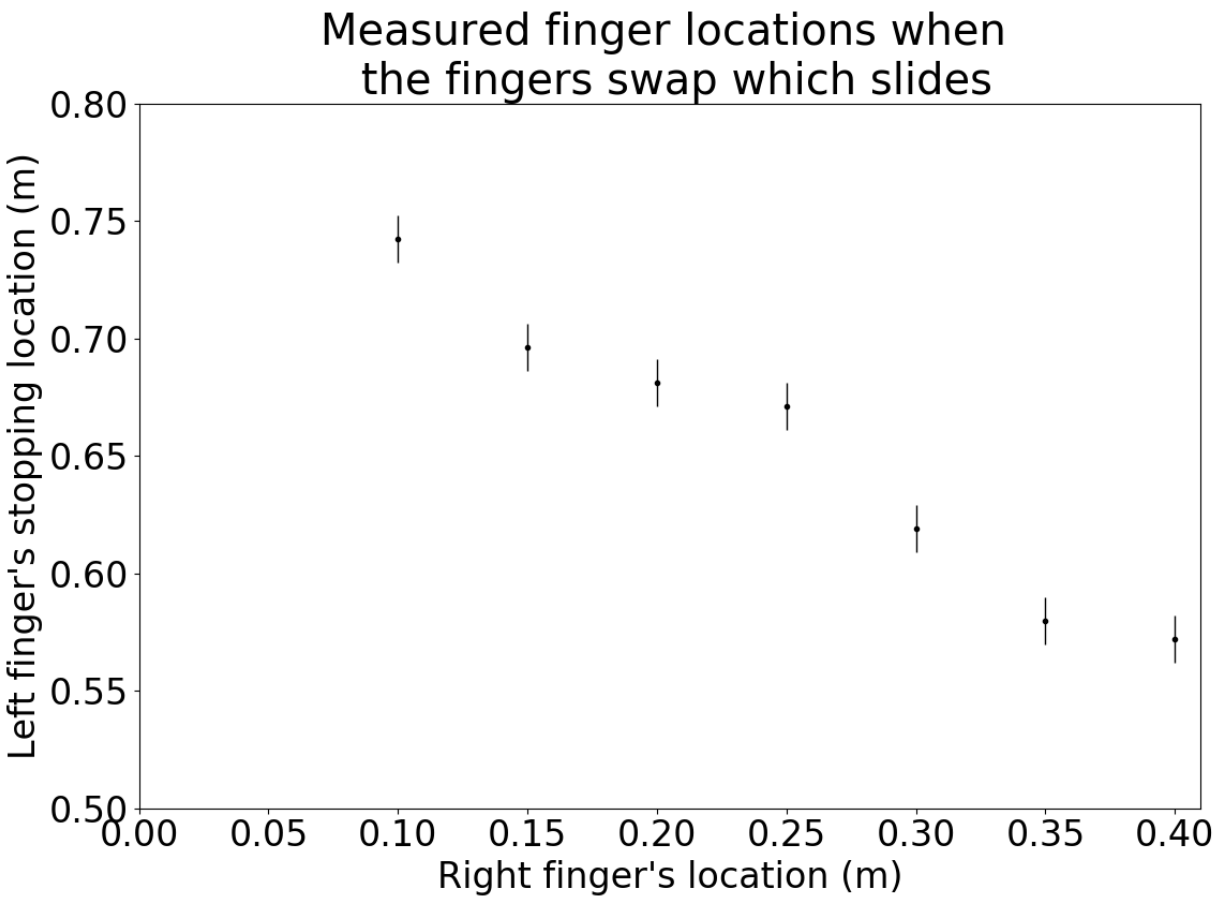
   Earth: mass 6.0×10^{24} kg, radius 6400 km, distance to Sun 1.5×10^8 km

   Mars: mass 6.4×10^{23} kg, radius 3400 km, distance to Sun 2.3×10^8 km

   Sun: mass 2.0×10^{30} kg, radius 7.0×10^5 km

   $G = 6.67 \times 10^{-11}\,\mathrm{N\,m^2\,kg^{-2}}$

4. Data analysis question: I balance a meter stick on two fingers, one from each hand. The left hand always starts at the 1.00-m-mark. The right hand starts at various locations. I try to slowly slide my fingers together, which always results in the left hand sliding while the right hand stays put until at some point they switch. For each starting right hand position I measure where my left hand is when the fingers switch which one slides. The data is presented below. Find the ratio $\frac{\mu_k}{\mu_s}$ between my fingers and the meter stick.


Measured finger locations when
the fingers swap which slides
Left finger's stopping location (m)
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
Right finger's location (m)