

# Celestial Mechanics – Exercises

Alexander V. Krivov & Tobias Stein<sup>1</sup>

Distributed: **30 Oct 2024**. Due: **07 Nov 2024**.

## Unit 3

### Problem 3.1

Consider Neptune and Pluto. The orbital periods and eccentricities of these objects are:  
Neptune:  $P_N = 165$  years,  $e_N = 0.00$ ; Pluto:  $P_P = 248$  years,  $e_P = 0.25$ .

- (a) Compare the minimum and the maximum distances of Neptune and Pluto from the Sun. **(1 point)**
- (b) Could Pluto collide with Neptune? Which other criteria must be fulfilled for such a collision to occur? **(1 point)**
- (c) Determine the ratio of Pluto's orbital velocities at its pericenter and apocenter. **(1 point)**

### Problem 3.2

Imagine you are standing on a non-rotating spherical asteroid – that would be cool, right? ;) – with a radius  $R$  and mean density  $\rho$ , and you are throwing a stone at an angle  $\alpha$  and a velocity  $v$  away from the surface. If the stone enters an elliptic orbit (that will eventually lead to fallback), what will be the semi-major axis and the eccentricity of that orbit? **(2 points)**

*Bonus:* at which distance from the starting point will the stone fall back to the surface? **(+1 point)**

---

<sup>1</sup>tobias.stein@uni-jena.de