

# The Solar System – Exercise classes

## Problem Set 3

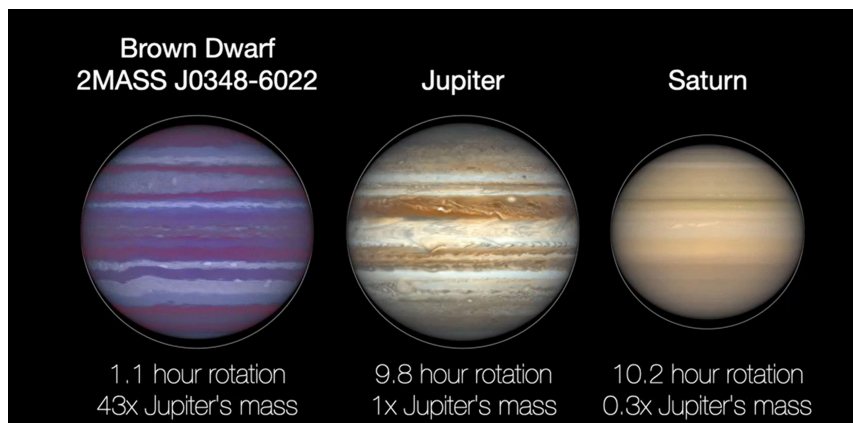
Distributed: 1 Nov 2022, results due: 8 Nov 2022.

### Problem 3.1

Estimate the depth (underneath Earth's surface) below which the hydrostatic pressure exceeds the plasticity limit of rocks ( $3 \times 10^8$  Pa). Assume  $\sim 2700 \text{ kg m}^{-3}$  for the rocks. To which height could you stack polystyrene foam with a density of  $20 \text{ kg m}^{-3}$  and a compressive strength of 200 kPa before the lower layers yield? (2 points)

### Problem 3.2

Jupiter exhibits an observed geometric flattening  $\varepsilon_F = (R_{\text{eq}} - R_{\text{pole}})/R_{\text{eq}} \approx 0.065$  and a rotation period of almost exactly 10 hours. Estimate Jupiter's  $J_2$  moment and the relative difference between the free-fall accelerations near its poles and its equator. (2 points)



**Figure 1:** Geometrical flattening caused by rotation. The surface details of the (purple) brown dwarf are based on artistic impression. (Image credit: NASA/JPL-Caltech)

### Bonus problem 3.3

Assume two non-rotating planets of equal mass and radius, one with a constant density, one with density increasing towards the center. Show that the planet with constant density has a lower central pressure. You can argue analytically or verbally. (2 points)