

# PHYS 178 – Assignment 5

## Sketchy Answers

1. What is the evidence that Jupiter formed in a “protoJovian” nebula, analogous to the solar nebula?

*Once Jupiter’s core mass exceeded around 10-15 Earth masses, its gravity was able to capture the surrounding gas. This gas spiralled onto Jupiter through a flattened disk (the protoJovian nebula). It is thought that planet formation in miniature occurred through the agglomeration of dust particles within this disk to form the Galilean planets. The increasing ice to rock fraction in the compositions of the Galilean satellites with increasing distance from Jupiter is analogous to the change in the composition of planetary cores forming in the solar nebula – beyond a critical distance from Jupiter, dust particles in the protoJovian nebula retain a coating of ices. Note however, the rock-ice cores of Ganymede and Callisto never became massive enough to gravitationally capture hydrogen and helium.*

2. Describe the difference in the appearance of craters on Jupiter’s icy moons to those on the icy moons around Saturn.

*The craters are less well-defined on Jupiter’s moons (e.g. Callisto) because the ice is warmer, and it slumps/flows over long periods of time. The ice on the surfaces of (non-tidally heated) moons around Saturn is cold and more rock-like. The craters on Rhea, for example, resemble those on the Moon or Mercury, being sharply-defined and having the characteristic central peak.*

3. Some satellites are dark on one side and bright on the other. Why is this?

*Many satellites of the giant planets are tidally-locked, presenting the same face to the parent planet. This means that one hemisphere permanently faces the direction of orbital motion, while the complementary hemisphere is backward-facing. The forward-facing side is subject to a continuous deposition of dark material swept up by the planet.*

4. Why are planetary rings aligned so precisely with the equatorial plane of their host planet?

*The rings are composed of many small particles on individual orbits around the host planet. If the orbits are not perfectly organised they tend to become so because of collisions between the particles. For a spherical host planet the ring particles will tend towards occupying perfectly circular orbits in an “average” orbital plane. However, the equatorial bulges of the planets tend to stir things up and cause more collisions unless the orbital plane is aligned with the equatorial plane of the planet.*

5. What is a “shepherd moon”?

*A small moon orbiting just inside (or just outside) a planetary ring. The moon’s gravity tends to boost the ring particles outwards as it passes them. In the case that the moon is on the outside, its gravity retards the ring particles as they overtake the moon and they fall inwards. The net effect of a pair of shepherd moons – one inside, one outside – is to tightly confine the ring particles.*