

Tidal Heating Worksheet

to follow viewing of the astronomy demonstration video at <https://www.youtube.com/watch?v=9qHrzs6Mbp4>

1. Complete the 'narrative with blanks' section below summarizing the tidal heating of Jupiter's moon Io. Several blanks have more than one answer that will fit that context.

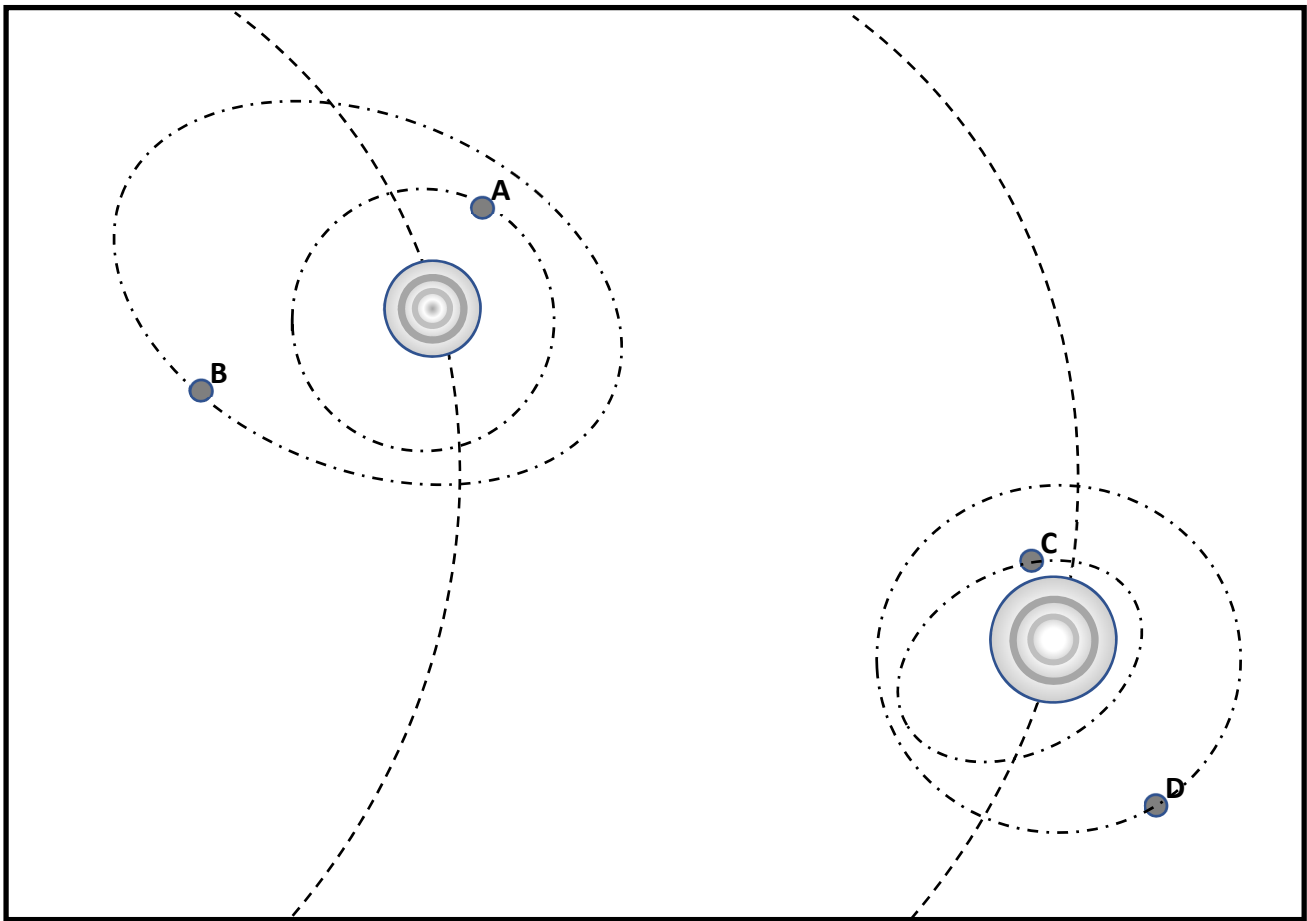
Io is one of four large moons orbiting Jupiter known as the Galilean Satellites which also include _____, Ganymede, and Callisto. Io is the closest of the four moons to Jupiter and thus has the smallest orbital period. Io is known for its _____ appearance and for the presence of _____, first observed by the Voyager Space Probe in a flyby.

Io's volcanic activity is caused by tidal heating due to _____. This phenomenon occurs due to Jupiter's gravitational pull being greater on the near side of Io, than the _____. This creates a stretching effect on the moon. For a moon in a _____ orbit which would always be the same distance away from Jupiter, the stretching force is constant. However, for a moon in an elliptical orbit, differential gravity varies – being greater when the moon is _____ to its parent object, and less when it is _____. Thus, Io is "worked" by Jupiter as it orbits because the stretching effect is greater when Io is close to Jupiter and less when it is farther away.

Io remains in an elliptical orbit due to the gravitational effects of the other Galilean moons closest to it. There are simple mathematical relationships between Io's period of revolution and that of Europa and Ganymede. Io's period of revolution is approximately 1.7 days, while Europa's period is 3.5 days and Ganymede's is 7 days (Callisto is _____ to have much effect on Io). Thus in the time that Ganymede makes one orbit around Jupiter, Europa makes _____ orbits and Io makes _____ orbits. Thus, Io is repeatedly passed by the outer moons at the same point in its orbit, meaning that the gravitational tugs delivered at this time of closest approach are delivered in the same direction, keeping the orbit elliptical.

Great heat is generated by the alternating stretch and release Io receives every orbit around Jupiter. This heat is released through tremendous volcanic activity. In fact, Io is the _____ geologically active body in the solar system.

2. The graphic on the following page displays two Jovian planets and their moons in a hypothetical solar system. We are looking down on the plane of the system and all objects orbit in this same plane. Estimate the likelihood (circle either High, Medium, or Low) of each of the labeled moons experiencing tidal heating at the epoch illustrated and provide a short justification for your choice.



Moon A: High Medium Low _____

Moon B: High Medium Low _____

Moon C: High Medium Low _____

Moon D: High Medium Low _____

3. Note that moon C is in an elliptical orbit. Astronomers expect that the such an orbit would gradually become circular over time unless something is keeping it in an elliptical orbit. If the orbital period of Moon C is 5.0 days, propose a theory by which the orbit of moon C could remain elliptical and clearly explain how it would work.
