Physics 109: Homework #9 Solutions

9.1 We surmise that the volcanos of the Tharsis region are younger than most of the rest of the surface of Mars because we observe that they have a low crater density. The runoff channels resemble river systems with tributaries and appear to have originated by the collection of widely distributed water. The outflow channels have few tributaries and have very local origins.

9.2 Olympus Mons on Mars and shield volcanos on Venus like Gula Mons and Sif Mons are very large single volcanos that have grown to great size because of the lack of horizontal motion of their planet's crust. The Hawaiian islands on the other hand are individually rather much smaller and are spread out over a large area because the motion of the Earth's Pacific plate moves each newly formed volcano away from the hot-spot of magma that wells up from the interior.

9.3 Water played a critical role in the evolution of the atmospheres of Venus, the Earth, and Mars. On the Earth and Mars CO_2 was removed from the atmosphere by rain and was dissolved in lakes and oceans. In time the CO_2 combined with crustal rocks. On the Earth, CO_2 is recycled back into the atmosphere as crustal rock is subducted into the lithosphere, melted, and reemerges through volcanic eruptions. On Mars, where plate tectonics does not occur, the CO_2 remains locked in the crust. Over time Mars' atmosphere dwindled, the water froze, and the level of atmosphere dropped to the low value we observe now. Venus, on the other hand, did not have liquid water on its surface, so the CO_2 released from the interior through volcanism remained in the atmosphere to produce Venus' dense atmosphere and massive greenhouse effect.

9.4 Arguments against life: No oxygen in atmosphere, no liquid water on the surface, surface temperature too low. Arguments in support of life: Compelling evidence for the existence of liquid water on Mars in the past, frozen water on Mars now.

9.5 The winds flow outward from a high pressure zone. In the southern hemisphere of Jupiter this pattern of wind flow combined with the Coriolis effect produces a counter-clockwise rotation, as observed. Infrared images of Jupiter's atmosphere have allowed us to determine the relative temperatures of the belts and zones. Dark belts are hotter (hence lower in the atmosphere) than the light zones. The Great Red Spot is an exception (visually dark, but cool in the infrared, indicating a high cloud bank). These observations shed light on the convective processes occuring in Jupiter's atmosphere.