

Bill Gates' Great Great Grand-daughter's Honeymoon Trip:**The 10 Tourist Wonders of the Universe**Astronomy Lab by Andrew Fraknoi (*Foothill College*) (© copyright 2009 A. Fraknoi)**Sample of a Completed Answer Sheet**

1. Tourist Sight: The Planet Saturn and Its Rings

Website: <http://hubblesite.org/newscenter/archive/releases/2001/15/image/a/>

Justification: Saturn is the second largest giant planet in our solar system, and a beautiful example of the class of planets which are made mostly of liquid and gas. While all four giant planets in our solar system have rings, only Saturn has a spectacular ring system worthy of any tour's visit. The whole ring system is so large that, if we placed it next to the Earth, it would stretch almost to the Moon. In the ring system, there are many thousands of smaller structures (ringlets) and a host of small moons. Understanding how the countless small chunks of ice that make up the rings interact with each other and the moons inside and near them is a major challenge to astronomers. How ring chunks become organized into denser "crest" and less dense "troughs" helps astronomers understand the interactions of other organized systems in the universe, such as the arms of spiral galaxies. (And, of course, seeing rings is very appropriate for our honeymoon couple after their recent wedding ceremony.)

2. Tourist Sight: Eris, The Largest Known Dwarf Planet

Website: <http://hubblesite.org/newscenter/archive/releases/2007/24/image/c/>

Justification: Eris is the largest of the dwarf planets in our solar system discovered so far, even larger than Pluto. Dwarf planets are a population of objects in our home system, consisting of smaller (but still round) worlds which are too small to have cleared out their immediate neighborhoods. There may be many others beyond Neptune which have not yet been discovered (although many others will likely be known by the time our couple takes its tour). Eris is part of the Kuiper Belt, a region which also includes many smaller icy chunks. (Eris is named after the goddess of discord in Greek mythology, but our honeymoon couple is much too much in love to worry about that concept.)

3. Tourist Sight: The Orion Nebula, an interesting, relatively nearby star-formation region

Website: <http://hubblesite.org/newscenter/archive/releases/2006/01/image/a/>

Justification: This region of star birth, one of the closest and best studied we know, shows many young stars and dusty disks that are star systems in the process of forming. The visible nebula is just a small "pimple" on a much larger, colder (and invisible) cloud of cosmic raw material, through which a wave of star birth is passing. Our own solar system was probably born, about 5 billion years ago, in the same way as the new stars we see in the Orion Nebula. (The honeymoon couple's parents wanted us to include a tourist sight that referred to birth as a subtle hint to the newlyweds that they were looking forward to being grand-parents.)

4. Tourist Sight: Betelgeuse, a Red Giant Star

Website: <http://hubblesite.org/newscenter/archive/releases/1996/04/image/a/>

Justification: Toward the end of its life, every star goes through an unstable period when it swells up into a huge star, cooler than it used to be, called a red giant. Our own Sun is expected to become such a red giant in about 5 to 6 billion years. Betelgeuse is a well-known and much studied example of a red giant and the first star beyond the Sun for which astronomers actually got an image which showed the stars as a disk and not just as a point. If Betelgeuse were put into our solar system as a replacement for the Sun, it would reach almost to the orbit of Jupiter. (Since the hearts of the honeymoon couple are swelling with love, we thought they would enjoy seeing a star that has swelled up too.)

5. Tourist Sight: The Ring Nebula, the last gasp of a dying star

Website: <http://hubblesite.org/newscenter/archive/releases/1999/01/image/a/>

Justification: At the end of its life, every star that resembles the Sun undergoes a last period of unstable behavior (a kind of last gasp before dying). The star expels one or more outer layers before it starts to collapse into the “star corpse” astronomers call a white dwarf. Early observers mistakenly called the expelled shell of such a dying star a “planetary nebula”, and, unfortunately, the name has stuck, even though this nebula has nothing to do with planets. Our own Sun is expected to produce just such a nebula before it dies. The Ring Nebula is a well-known example of a star’s last gasp. While it looks like a ring from Earth, it probably would look like a barrel of glowing atoms and dust from nearby. (And, after all, the honeymoon couple is supposed to be having a barrel of fun on their trip.)

6. Tourist Sight: Sirius B, a White Dwarf Star

Website: <http://hubblesite.org/newscenter/archive/releases/2005/36/image/a/>

Justification: When stars like the Sun (stars of relatively lower mass) die, they become extremely compressed “star corpses” called white dwarfs -- very small, but very hot. Such a white dwarf happens to orbit Sirius, the star that appears brightest in our skies, and is given the very boring name, Sirius B. Still, such a tiny white dwarf is an impressive thing. If the couple were to land (strongly not advised) they would weigh about one million times their Earth weight and that would be the end of their trip. This is a sight best viewed from afar, but with a contemplation of the fact that becoming a white dwarf will be the ultimate fate of our Sun too. (The inner core of each white dwarf consists of carbon, fused in the last years of the star’s life. But it is carbon under enormous pressure, whose structure resembles that of diamond. As the bride and groom look at their engagement ring, they will enjoy comparing it to the great diamond-like structure inside Sirius B.)

7. Tourist Sight: The Crab Nebula, Remnant of An Exploded Star

Website: <http://hubblesite.org/newscenter/archive/releases/2005/37/image/a/>

Justification: Massive stars end their lives in huge explosions that astronomers call supernovae. As much as 90% of the star's material can be thrown off during the explosion and, in the process, new (heavier) elements are made, and then distributed at high speed into the Galaxy. In many ways, life on Earth owes its existence to supernovae and the fact that they "recycle" the material of early generations of stars and make them available to form new stars and planets enriched by their elements. The Crab Nebula is the remnant of a supernova whose light reached the Earth in the summer of 1054 AD. Even though it is about 6500 light-years away, it was so bright then that it could be seen in the daytime. The Crab Nebula was also the first supernova remnant in which astronomers discovered a pulsar (short for pulsating star) which flashes 30 times a second, and is evidence that inside the nebula the last remains of the star that exploded is still spinning energetically. (The pulsar is like a speeded-up heartbeat, which is just what the newlyweds feel when they look at each other adoringly.)

8. Tourist Sight: Fomalhaut, the first star whose planet we photographed in visible light

Website: <http://hubblesite.org/newscenter/archive/releases/2008/39/image/a/> _____

Justification: Being fans of astronomy, our honeymoon couple knows that one of the most important discoveries in modern astronomy has been the discovery of planets around other stars. Although, at the time in the future that our trip is happening, millions of planets are likely known in orbit around the stars of our Galaxy, for sentimental reasons, the couple will visit the first planet ever photographed in visible light, way back in 2004 and 2006, with that old Hubble Telescope that the couple learned about in history class. Fomalhaut is a star located about 25 light-years away and its planet is not likely to harbor any kind of life as we know it. The planet takes 872 Earth years to revolve around the star, and it is about 10 times further from Fomalhaut as Saturn is from the Sun. It is in part because the planet is so far from its star that it is not completely lost in the star's glare, and could be distinguished from Earth.

9. Tourist Sight: Omega Centauri, the largest known globular cluster of stars

Website: <http://hubblesite.org/newscenter/archive/releases/2008/14/image/a/>

Justification: Stars in a galaxy are sometimes organized in larger groups called star clusters, and the biggest and oldest of these groups are called globular clusters. These huge clusters are like "fossils," giving us hints about the early history of the Galaxy. Omega Centauri is the largest of these, containing as many as 10 million stars. It is located about 17,000 light-years from us. Stars at its core are so crowded together; some may be as little as a tenth of a light-year apart. (For stars, that are getting really "cozy," a concept the honeymoon couple really likes to identify with.)

10. Tourist Sight: Galaxy NCC1300

Website: <http://hubblesite.org/newscenter/archive/releases/2005/01/image/a/>

Justification: For their last trip before returning home, our couple wants to visit a galaxy, and this one is their favorite. It is a barred spiral shape, which resembles the Milky Way Galaxy in which we live (although the bar in NGC1300 is longer and more distinct than ours probably is.) This galaxy is also about the same size as the Milky Way and the couple wants to see a galaxy that looks like our own. NGC1300 lies about 69 million light-years away. Its center is quiet (not disturbed) indicating that it may have an inactive black hole or no black hole in the middle. (After all the excitement of the trip, our couple wants a peaceful last sight to finish off with.)