Introductory Astronomy

Homework 16: Minor Planets, Asteroids, Icy Bodies, Meteoroids, and Target Earth Not to be handed in. Homework solutions are posted already.

1. Let's get the terminology straight once and for all.

   a) **meteors** travel in space, **meteoroids** shoot in the sky, and **meteorites** hit the Earth.
   b) **meteoroids** travel in space, **meteorites** shoot in the sky, and **meteors** hit the Earth.
   c) **meteoroids** travel in space, **meteors** shoot in the sky, and **meteorites** hit the Earth.
   d) **meteorology** travels in space, **meteorlights** shoot in the sky, and **meteorealis** hits the Earth.
   e) **meteorology** travels in space, **meteorlights** shoot in the sky, and **Montreal** hits the Earth.

2. The largest asteroid (i.e., minor planet confined within about the orbit of Jupiter) is:

   a) Uranus. b) Io. c) Comet Halley. d) Ceres. e) Chicago.

3. Of order how many asteroids with known orbits are there?

   a) 4 circa 2004. b) 10 circa 2004. c) 10 billion circa 2004. d) Between 200,000 and a million circa 2004. e) none.

4. Asteroids (i.e., minor planets confined within about the orbit of Jupiter) are probably mainly:

   a) icy planetesimals left over from the formation of the solar system.
   b) fragmented or unfragmented icy planetesimals or protoplanets left over from the formation of the solar system.
   c) fragmented or unfragmented rocky planetesimals or protoplanets left over from the formation of the solar system.
   d) star-like objects beyond the orbit of Pluto.
   e) star-like objects closer to the Sun than the orbit of Mars.

5. An asteroid less than 300 km in size scale:

   a) must be spherical. b) can be asymmetric. c) must be cubical. d) must be green. e) must tetrahedral.

6. The asteroids (i.e., minor planets confined within about the orbit of Jupiter) which were discovered early on are much larger than typical asteroids we discover today. Why?

   a) The biggest asteroids are more easily resolved. Thus they were found first.
   b) The biggest asteroids tend to reflect the most sunlight, and thus they are brighter and more obvious. Therefore they were found first.
   c) The biggest asteroids are simply much more numerous. Thus, the odds are that the biggest asteroids would be discovered first.
   d) The biggest asteroids were found first just by accident.
   e) The biggest asteroids cause huge gravitational perturbations of Jupiter's orbit. Early 17th century mathematical astronomers were able to deduce the approximate positions of the biggest asteroids. Subsequent searches quickly found these bodies.

7. Why couldn't radioactive potassium (^{40}K: half-life 1.30 billion years), thorium (^{232}Th: half-life 14.1 billion years), or uranium (^{238}U: half-life 4.50 billion years) have melted the rocky planetesimals (which were the parent bodies for the asteroids) and caused them to chemically differentiate?

a) Because of their small size, the planetesimals will lose heat **SLOWLY** through their surface to space. Thus the heat from radioactive species with long half-lives cannot accumulate sufficiently to melt the planetesimals. It has been hypothesized that radioactive aluminum (^{26}Al: half-life 0.742 million years), which releases heat relatively quickly, accounts for heat accumulation sufficiently rapid to cause planetesimal melting.

b) Because of their small size, the planetesimals will lose heat **RAPIDLY** through their surface to space. Thus the heat from radioactive species with long half-lives cannot accumulate sufficiently to melt the planetesimals. It has been hypothesized that radioactive aluminum (^{26}Al: half-life 0.742 million years), which releases heat relatively quickly, accounts for heat accumulation sufficiently rapid to cause planetesimal melting.

c) None of these radioactive nuclear species (i.e., radioactive nuclides) were contained in the material that formed the planetesimals in the Asteroid Belt area of the solar system. The radioactive nuclides are all highly **NON-VOLATILE**, and so **ONLY** condensed in the **INNER REGION** of the solar system where almost all the material got incorporated into rocky planets. The radioactive nuclides in the rocky planets, of course, help to melt and elementally differentiate them.

d) None of these radioactive nuclear species (i.e., radioactive nuclides) were contained in the material that formed the planetesimals in the Asteroid Belt area of the solar system. The radioactive nuclides are all highly **VOLATILE**, and so **ONLY** condensed in the **FAR OUTER REGION** of the solar system where almost all the material got incorporated into Uranus, Neptune, and icy planetesimals (Pluto being considered the largest of these). The radioactive nuclides in these gas giant planets and icy planetesimals, of course, help to melt and elementally differentiate them.

e) There is no known reason why they couldn't have. That they didn't is a mystery.

8. In 1908, an impactor (perhaps a small asteroid of order 30 m in scale) hit the Earth in:

   a) Flagstaff, Arizona. b) the Tunguska region in Siberia. c) Sudbury, Ontario. d) Oak Ridge, Tennessee. e) Chicxulub on the Yucatán Peninsula.

9. "Let's play *Jeopardy*! For $100, the answer is: This fragmented comet impacted on Jupiter in 1994."

   What is Comet _____, Alex?

   a) Tunguska b) Halley c) Shoemaker-Levy 9 d) Cobbler-Dam IX e) Hale-Bopp?

10. Why is a 100-meter diameter Earth-bound impactor much more worrisome than a 10-meter diameter one?

    a) Mass and kinetic energy tend to be proportional to **DIAMETER**. The 100-meter impactor will thus tend to be ten times more devastating than the 10-meter one.

    b) Mass and kinetic energy tend to be proportional to the **SQUARE OF DIAMETER**. The 100-meter impactor will thus tend to be a hundred times more devastating than the 10-meter one.

    c) Mass and kinetic energy tend to be proportional to the **CUBE OF DIAMETER**. The 100-meter impactor will thus tend to be a thousand times more devastating than the 10-meter one.

    d) It is not more worrisome. The bigger the impactor, the less effect on the target.

    e) The smaller impactors always land in the oceans.

11. "Let's play *Jeopardy*! For $100, the answer is: On date 2880mar16, this asteroid has a very small chance of making a continentally devastating impact on Earth if nothing is done."

    What is _____, Alex?

    a) 1950 DA b) Ceres c) Shoemaker-Levy 9 d) Sedna e) Eros

12. Why might a person support the search by Spacewatch (or whoever) for solar system bodies that could

impact the Earth?

a) Never in human history has there been significant harm from an impact event. Annie Hodges of Sylacauga, Alabama in 1954 November was awoke from a nap by a meteorite coming through her roof and bouncing off her radio set and then her arm and leg. Probably it left nasty bruises. Wanda and Robert Donahue of Wethersfield, Connecticut in 1982 November (November is the cruelest month) were disturbed (while watching M*A*S*H) when a 3 kg meteorite came through their roof, bounced up into the attic, and came to rest under the dining room table. Michelle Knapp of Peekskill, New York in 1992 October woke up to find her 1980 Chevy Malibu (just bought from her grandmother) had its rear end smashed by a 1.5 kg meteorite that cratered the driveway. These and other impact events on the human condition, totaling 61 recorded incidents in the period $\sim$ 1790–1990, havn't amounted to much compared to other tribulations.

b) Although that the risk of significant harm is small, it is real. Tunguska-like events probably happen once a century or so (or maybe every two thousand years or so), but usually in oceans or relatively uninhabited and out-of-world locations. With the world more populated today and more connected, a Tunguska-like event with heard-of tragic consequences could happen any century. Widespread or global devastation events (as the Chicxulub event was supposed to have been) are extremely rare, but they can happen too. So it is probably worthwhile to support a modest public program to discover dangerous solar system bodies especially as some of the searchers (space guards?) are unpaid volunteer enthusiasts. Maybe we could do something—duck for instance. Still we'll probably never be able to protect our cars from Peekskill-like events.

c) To prevent ozone loss.

d) To prevent coffee stains.

e) For peace on Earth, goodwill toward humankind.