Introductory Astronomy **NAME:**

Homework 16: Small Bodies of the Inner Solar System and Target Earth : Homeworks and solutions are posted on the course web site. Homeworks are **NOT** handed in and **NOT** marked. But many homework problems ($\sim$ 50–70 %) will turn up on tests.

Answer Table

Name:

	a	b	c	d	e
1.	O	O	O	O	O
2.	O	O	O	O	O
3.	O	O	O	O	O
4.	O	O	O	O	O
5.	O	O	O	O	O
6.	O	O	O	O	O
7.	O	O	O	O	O
8.	O	O	O	O	O
9.	O	O	O	O	O
10.	O	O	O	O	O
11.	O	O	O	O	O
12.	O	O	O	O	O
13.	O	O	O	O	O
14.	O	O	O	O	O
15.	O	O	O	O	O
16.	O	O	O	O	O
17.	O	O	O	O	O
18.	O	O	O	O	O
19.	O	O	O	O	O
20.	O	O	O	O	O
21.	O	O	O	O	O
22.	O	O	O	O	O
23.	O	O	O	O	O
24.	O	O	O	O	O
25.	O	O	O	O	O
26.	O	O	O	O	O
27.	O	O	O	O	O
28.	O	O	O	O	O
29.	O	O	O	O	O
30.	O	O	O	O	O
31.	O	O	O	O	O
32.	O	O	O	O	O
33.	O	O	O	O	O
34.	O	O	O	O	O
35.	O	O	O	O	O
36.	O	O	O	O	O

	a	b	c	d	e
37.	O	O	O	O	O
38.	O	O	O	O	O
39.	O	O	O	O	O
40.	O	O	O	O	O
41.	O	O	O	O	O
42.	O	O	O	O	O
43.	O	O	O	O	O
44.	O	O	O	O	O
45.	O	O	O	O	O
46.	O	O	O	O	O
47.	O	O	O	O	O
48.	O	O	O	O	O
49.	O	O	O	O	O
50.	O	O	O	O	O
51.	O	O	O	O	O
52.	O	O	O	O	O
53.	O	O	O	O	O
54.	O	O	O	O	O
55.	O	O	O	O	O
56.	O	O	O	O	O
57.	O	O	O	O	O
58.	O	O	O	O	O
59.	O	O	O	O	O
60.	O	O	O	O	O
61.	O	O	O	O	O
62.	O	O	O	O	O
63.	O	O	O	O	O
64.	O	O	O	O	O
65.	O	O	O	O	O
66.	O	O	O	O	O
67.	O	O	O	O	O
68.	O	O	O	O	O
69.	O	O	O	O	O
70.	O	O	O	O	O
71.	O	O	O	O	O
72.	O	O	O	O	O

1. Did you complete reading the Introductory Astronomy Lecture before the **SECOND DAY** on which the lecture was lectured on in class?

   a) YYYessss! b) Jawohl! c) Da! d) Sí, sí. e) OMG no!

2. 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.

3. 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.

4. The size distribution of asteroids is given in the following table.

Table: Approximate Number of Asteroids N Larger than Mean Diameter D

D (km)	N	D (km)	N
900	1	10.0	10,000
500	3	5.0	90,000
300	6	3.0	X
200	28	1.0	750,000
100	200	0.5	2×10^6
50	600	0.3	4×10^6
30	1100	0.1	25×10^6

NOTE.—The numbers for diameters larger than 500 km are exact counts. The numbers for diameters larger than 300 km and 200 km are nearly exact counts. The only source of uncertainty is that the mean diameters of asteroids are a bit uncertain and asteroids near the diameter bin boundaries lines may be marginally in the wrong diameter bin. It is likely that all asteroids larger than about 100 km have been discovered, but the table only gives approximate numbers for the bins from 100 km down in mean diameter. As the mean diameter get smaller, the number of asteroids become more and more uncertain. The sources are Wikipedia articles *Asteroid* and *List of Notable Asteroids*. The asteroids are the small rocky bodies inward of about Jupiter's orbits that are not moons. Below about 10 meters in size scale, small bodies are considered meteroids rather than asteroids, but there seems to be no exact lower cut-off for asteroid mean diameter.

The **UNSPECIFIED** asteroid number X in the table must be:

   a) 2. b) 20. c) 200. d) 200,000. e) 20×10^6.

5. 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.

6. The Asteroid Belt is located:

   a) between the orbits of Mars and Jupiter. b) between the orbits of Mercury and Venus. c) beyond the orbit of Pluto. d) inside the Sun. e) between the Sun and the orbit of Vulcan.

7. 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.

8. The kinetic energy of a body of speed v and mass m is given by the formula

$$E_{\rm kin} = \frac{1}{2}mv^2 \ .$$

A typical meteoroid (a small body in space: it becomes a meteor in precise speech only when it penetrates the Earth's atmosphere) has a speed of order $30\,\text{km/s} = 30,000\,\text{m/s}$ relative to the Earth. Given that it has a mass of **1 g (note: 1 gram)**, what is the kinetic energy of this typical meteoroid? (Note that a 1 kg mass falling 1 m under the force of gravity near the Earth's surface acquires about 10 J of kinetic energy.)

a) 10 J. b) 4.5×10^8 J. c) 9×10^8 J. d) 4.5×10^5 J. e) 9×10^5 J.

9. 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.

10. Why couldn't radioactive potassium-40 (^{40}K: half-life 1.251(3) Gyr), thorium-232 (^{232}Th: half-life 14.05 Gyr), uranium-235 (^{235}U: half-life 0.7038 Gyr) uranium-238 (^{238}U: half-life 4.468 Gyr) 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 (^{26}Al: half-life 0.717 Myr), 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 0.717 Myr), 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.

11. The supposed dinosauricidal impactor hit near:

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

12. "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

13. 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.

14. "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."

   What is ____________, Alex?

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