A Brief History of the Solar System

Name & set

1. The Solar System consists of the Sun, nine planets, some 60 moons (the exact number is not known; new ones continue to be discovered), several thousand asteroids (lumps of rock ranging in size from several metres to a hundred kilometres and more - the largest asteroid is Ceres: diameter 950 km), millions of comets (like asteroids, but made mainly of ice, rather like gigantic dirty snowballs), and huge numbers of tiny fragments of rocky material and grains of dust. These are collectively known as meteoroids. Large numbers of meteoroids collide with Earth, and are often seen at night as brief, bright streaks of light called meteors. Planets, moons, asteroids, comets and dust all orbit the Sun.
2. The Solar System began forming about 4.6 billion years ago (4,600,000,000 yrs.), and took between 50 and 100 million years to reach its present state from a huge cloud of gas ice and dust. Three quarters of the cloud consisted of hydrogen, one quarter of Helium. The cloud also contained a tiny fraction of water ice, gases such as methane and ammonia, and rocky material, amounting to not much more than 1 or 2 percent of the cloud. The age of the Solar System was determined by measuring the amount of Uranium in meteoroids found on Earth, and from a knowledge of the half life of Uranium.
3. The cloud collapsed in on itself due to gravitational attraction between its parts. The collapse may have been triggered by a shock wave from a nearby supernova. As the cloud shrunk it became denser, and heated it up. At the same time, it also began to spin. The spinning cloud flattened out into a disc, known as an *accretion disc*, the centre of which became so hot and dense that fusion reactions began. A star was born: the Sun. At this point strong winds, called *stellar winds*, flowed out from the young Sun, and the remaining material in the accretion disc was blasted back into interstellar space, from where it had come.
4. During this phase, planets began forming in the accretion disc around the Sun. Near to the Sun, the accretion disc was hot enough to vaporise ice and other substances with low melting points. The Sun's stellar wind drove these substances towards the edge of the disc. Away from the Sun the disc was cool enough for water to exist as ice. It is in this cooler region that the first planets began to form from ice and rock.
5. At first tiny fragments grew larger through random collisions with other fragments. Because the collisions were random, they grew slowly at first. The larger they became, the more quickly they grew as their increased gravity began to play a part by attracting other particles. The eventual size of the bodies produced in this way ranged from hundreds of metres to several hundred kilometres in diameter. These are called *protoplanets*.
6. In the outer reaches of the accretion disc, where there was more material, protoplanets grew extremely large. Since much of the solid material here was ice, these protoplanets were composed mainly of ice and rock. Icy protoplanets collided with one another to create two huge icy cores that were able to attract what little hydrogen and helium remained in the disc, becoming the *gas giants* Jupiter and Saturn. All the while the material in the accretion disc was being driven away. By the time Uranus and Neptune began to form, very little gas remained, which is why they are composed principally of ice and rock. They contain very little hydrogen or helium. They are *ice giants*.
7. The planets that formed in the inner Solar System are composed mainly of rocky material, the stuff that wasn't vaporised and driven off by the stellar wind. These *rocky* planets therefore contain little water or other *volatile* substances. Mars, Earth-Moon, Venus and Mercury were formed through collisions between rocky protoplanets well after the outer planets had formed.
8. So the timetable of planet formation looks like this: The first to form are the gas giants, Jupiter and Saturn, next Uranus and Neptune, finally Mars, Earth-Moon, Venus and Mercury. And Pluto? Strictly speaking not a planet: its in the wrong place. It is similar in size and composition to Triton, the largest of Neptune's moons. Despite this, Pluto will continue to be classed as a planet for the foreseeable future.

Useful Internet sites on the Solar System

Nine Planets: http://www.seds.org/billa/tnp/

NASA: http://photojournal.jpl.nasa.gov/

1 Define the following and give an example of the body in question.

(a) Star _____

_____ [2]

(b) Planet _____

_____ [2]

(c) Moon _____

_____ [2]

(d) Asteroid _____

_____ [2]

(e) Comet _____

_____ [2]

(f) Meteoroid _____

_____ [2]

2 How old is the Solar System? _____ [1]

3 How has the age of the Solar System been determined? _____

_____ [2]

4 What is an accretion disc? _____

_____ [2]

5 What did the accretion disc contain? _____

_____ [2]

6 How did the tiny particles in the accretion disc grow into larger bodies several metres across?

_____

_____ [3]

7 How were planets built up from these larger bodies? _____

_____ [2]

8 Which planet formed first? _____ [1]

9 Why are the planets in the outer Solar System composed mainly of ice and gas whereas those of the inner Solar System are composed almost entirely of rock and metal?

_____

_____ [3]

10 Why did Jupiter and Saturn become gas giants, whereas Uranus and Neptune became ice giants?

_____

_____ [3]