ESS 100 (Stapleton) Name: ___________________________

Notes: Formation of Our Solar System

Part 1: The Nebula Contracts

1. Gravity is a force of attraction between bits of matter. Anything that has mass will be pulled by gravity toward anything else that has mass.

   Is dust affected by gravity? What about ice?

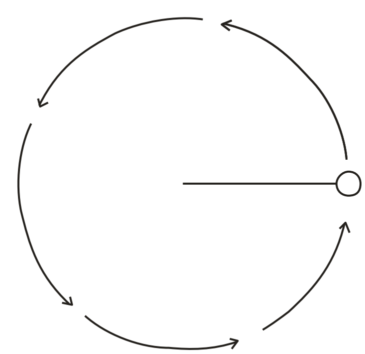
2. About 4.6 billion years ago, a **nebula** (cloud of dust and ice) was floating freely in space. The "dust" was rock and metal, and the "ice" was mostly frozen Hydrogen, plus some Helium. This nebula contained matter from other stars that had lived, died, and destroyed themselves in events called supernovae. According to your answer to question number 1, what must have begun to happen to the bits of dust and ice in the nebula?

   Why?

Part 2: The Nebula's Motion Changes

3. The nebula that formed our solar system was vast in size, and it was rotating very slowly. What happened to the rotation of the nebula as it began to contract (be pulled together) by gravity? [Hint: think of a spinning figure skater pulling in his/her arms and legs.]

Part 3: The Nebula's Shape Changes



4. Imagine you have a ball on a string, and you begin swinging the ball in circles over your head. As you swing the ball, you feel a pull. If you let go, this pull will cause the ball to fly away. On the diagram to the right, show the direction in which the ball will fly after you let it go.

5. What causes the ball to continue flying in this direction?

6. When a pizza maker spins a ball of soft dough in the air, what shape does it make?

7. A ball of pizza dough forms this shape because it's middle is pulled outward. What is stretching the dough outward?

8. *(Bonus info)* When the spinning pizza dough ball that gets stretched outward, it is only the middle (equator) that gets pulled outward. Why is the middle pulled outward (as opposed to the poles)?

9. What would happen if you were to spin a water balloon faster and faster and faster, using a drill? Why?

Part 4: The Nebula's Temperature Changes:

10. What happens to the speed and temperature of molecules when you squeeze them into a small space?

Speed: Temperature:

11. As gravity caused our **solar nebula** to contract, what happened to the nebula's temperature?

Why?

12. Where in the nebula do you think the temperatures were the hottest? Why? [This area is where the *sun is soon to be "born*."]

Part 5: The Sun is Born (and the Nebula's temperature *really* changes)

15. The Sun's energy comes from **nuclear fusion**.

a. Define "fuse."

b. Where is an atom's nucleus?

c. Why does it take a LOT of pressure for nuclear fusion to happen?

d. Where in the nebula was there enough energy for fusion to begin?

e. In the Sun, what element fuses, and what gets created when it fuses?

16. Why does fusion of Hydrogen into Helium produce so much energy? The answer is that it takes four hydrogen atoms to fuse into one helium atom, and one helium atom does not have as much mass as four hydrogen atoms. This means some mass gets "lost" during the fusion process. This mass isn't really lost; it is turned into energy.

a. The amount of energy that is produced by nuclear fusion can be calculated using the formula $E=mc^2$. E = the energy. m = the mass that is "lost." c = the speed of light. $c^2$ = the speed of light, squared. Even if the lost mass is very small, an enormous amount of energy is produced by this process. Calculate the amount of energy produced when one gram of mass is turned to energy.

b. Why don't we use nuclear fusion to create energy here on Earth?

<u>Part 6: The Nebula Clears Up</u>

16. Before nuclear fusion began in the sun, the solar system had been a rotating disk of ice ("frozen gas") and dust. When nuclear fusion began and the sun was born, what do you suppose happened to the ice ("frozen gases") near the center of the center of the solar system?

17. The planets near the sun (inner planets) are rocky, with very little gas around them. The outer planets are *gas giants*, made of mostly hydrogen gas. What accounts for this difference between the inner and outer planets?

<u>Part 7: Planets Form and Continue To Orbit</u>

19. What force(s) caused the dust and gas in the solar system to clump together to form planets?

20. Today we have a solar system of planets that orbit the sun in relatively stable orbits. In a stable orbit, two opposing tendencies are in balance. One tendency pulls planets away from the sun. The other pulls them toward the sun.

a. What prevents planets from flying away from the sun?

b. What prevents planets from falling into the sun?

Approximately 4.6by ago, the solar system was a giant, slowly rotating cloud of dust and *frozen gas* (a nebula). The “frozen gas” wasn’t really a gas, since it was frozen, but it was an element that is usually a gas at ordinary temperatures.

The cloud began to shrink due to

Shrinking caused the nebula’s rotation to

The nebulastretched into a disc because its ____________ pulled it outward.

The nebula began to heat up because of

The sun was “born” as nuclear fusion began in the center of the nebula. Nuclear fusion could only happen here because

Only the frozen gases far from the sun survived. Near the sun, dust and gas remained , but the frozen gases were

Particles of matter in the cloud gradually clumped together due to the force of

The outer planetsprobably formed thick gas layers around rocky cores, but the inner planets only formed rocky cores without large amounts of gas because

The planets are stable in their orbits because _______________ pulls them away from the sun about as hard as _______________ pulls them toward the sun.