Your Name: ____________________

Reading: Earth's Formation

Adapted from: Ward, P, & Brownlee, D. The Life and Death of Planet Earth. 2003. Times Books, New York.

1 In the beginning, our planet was the product of hydrogen gas, stardust, and gravity. Gas and dust floating in the space between stars were drawn together by gravity until they coalesced into a spinning disk that became our solar nebula, the Sun forming at the center and the planets assembling in the Frisbee-like plane of debris that circled it: called by astronomers an "accretion disk." The Earth then formed by the collision and clumping of untold rock bodies intersecting its orbital path that ranged in size from dust motes to small planets. Since astronomers have observed that accretion disks around other stars last for only a few tens of millions of years, Earth's creation must have been similarly rapid.

2 As our infant planet grew larger, it was like both a gravitational vacuum cleaner and a leaf blower. Its gravity either pulled in more and more debris to add to its bulk, or it added enough energy to passing bits of rubble to eject them toward other planets or outside the solar system. The process of growth was violent with impacts and explosions, a sweeping of orbital material that cleared its orbital path mostly bare but left the infant Earth red-hot from the accumulated energy of countless collisions.

3 Late in this process of accretion, planet-sized bodies as large as Mars slammed into the still-lifeless Earth. Shrapnel from such a smash-up formed a debris ring around Earth that quickly coalesced into our Moon. While our Moon is by no means the largest satellite in the solar system, it (along with Pluto's moon) is the largest moon relative to the mass of the planet it orbits, and its presence is one of the lucky conditions that makes our planet unique. Our relatively gigantic Moon has had a profound effect on Earth's history. It stabilized the tilt of the Earth's axis, allowing our planet's climate, seasons, and ocean circulation to stabilize. If our planet did not tilt, we would not have seasons as we orbit the Sun each year, and the temperature difference between equatorial regions and temperate regions would be even greater, and less hospitable, than they are now: the cycle of summer and winter helps moderate overall temperature extremes. Yet if we tilted too much, or if the tilt shifted, our climate would become more extreme or be thrown into chaos. This may have happened to Mars, in fact, allowing that planet to lose its oceans. The Moon keeps Earth's tilt at a stable angle, providing needed stability for complex life.

4 Moreover, by helping to generate large ocean tides, the Moon created the alternately wet-and-dry tidal zone that encouraged the transfer of life from the sea to the land. This tidal pull has also slowed the frenetic early spin of the Earth, lengthening our planet's day to twenty-four hours. This dance of two worlds has not just braked the spin of the Earth, it has pushed the Moon farther away, and these twin trends continue today. Just over the past 500 million years, for example, the length of Earth's day has increased by about 10 percent because of the Moon.

5 Even as other giant craters were being formed on the Moon, the same kind of stupendous collisions were occurring on Earth. Each great impact was capable of repeatedly blowing away part of our planet's fragile atmosphere and vaporizing newly formed oceans into steam. Earth was hit by monstrous, planetary sized chunks of rock and ice that cratered so deeply into the interior that their heat, water, and future atmospheric gases were retained. As Earth reached its final size, the great power delivered by these bodies melted the Earth's surface down to depths of hundreds of kilometers, creating an ocean of magma. In Earth's earliest history, its surface was molten rock and its atmosphere was a torrid mix of steam and other gases. It was truly a hellish place, although when the impact rate diminished sufficiently the surface cooled, leaving a rock crust covered by warm bodies of water. For hundreds of millions of years occasional giant impactors continued to hit the planet. The embryonic seas were repeatedly annihilated-with each impact of a body larger than a hundred kilometers in diameter-flashing them back into vapor; they recondensed again and again, seas forming within only a few thousand years of a great collision.