<u>Our Solar System</u>

Curricular Materials Prepared by
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<u>Scientific Summary</u>:

Our own solar system formed 5 billion years ago. The star that we call the Sun, as well as our eight planets and many asteroids, emerged from a vast cloud of matter made from the remnants of supernovas. While we might tend to think of the creative processes that shaped our solar system as being over, our solar system is still in process. Drawn together in a vast play of gravity, collisions, and shared energy from the Sun, our solar system is an ongoing flow of creativity that we have only recently begun to gather detailed knowledge of.

Even in its very first days, a massive cloud of simple elements such as hydrogen, carbon, and silicon surrounded our Sun. Relatively homogenous at first, the cloud contained small amounts of matter that were slowly drawn together by gravity. These small groupings of elements coalesced into tiny lumps of dust that grew larger and large with time. Occasionally, these tiny collections of elements collided violently and broke apart, but eventually most of the matter in this vast cloud collected into the small planet-sized chunks called “planetesimals.” These, in turn would eventually gather more matter and become our eight planets (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune) and the many asteroids and dwarf planets that, along with the Sun, make up the solar system that we call home.

The Earth, the third planet from the sun, is currently in a state that is both fluid and solid. When it first formed, the Earth was a roiling ball of molten rock and swirling elements. Just as a heavier liquid, such as water, will sink to the bottom of a container that contains both water and vegetable oil, the heavier elements in the Earth sank towards the Earth’s center. The heavier metals, such as iron and nickel were drawn by the force of gravity past less dense matter into the core of the Earth. Iron-rich silicates and magnesium piled up on top of this dense, molten core to form the mantle of the Earth. Finally, a crust that ranges from approximately 10-100 miles think formed on the surface. This crust is made from felsic rock such as granite as well as massive areas of oceanic crust that consists primarily of basaltic rocks. Over all of this, after a great deal of time, a fragile atmospheric shell enveloped the Earth’s surface.

An important and ongoing feature of the Earth is the slow movement of its crust. Driven by a convection cycle where rising matter floats up to the surface, which sometimes breaks through as lava and volcanic eruptions, the matter in the Earth's interior is in constant motion. Upon nearing the crust, much of the matter cools and drops back down towards the Earth's core. The solid crust, which is composed of massive plates, floats upon this churning mass in a process referred to as plate tectonics. This process of recycling has been going on for billions of years and has resulted in the creation of several thousand new minerals and polymers in the Earths interior and on its surface.

During its earliest days, the Earth had no moon. However, over three billion years ago a large planetesimal the size of Mars collided with the Earth and the formation of the Moon began. Still largely molten in its early state, the Earth absorbed much of the planetesimal in this dramatic impact. However, the force of the collision was so great that a portion of both planetary bodies were blasted into a ring of lava around the Earth. This ring of lava began clumping together and formed a ball of floating magma that rapidly circled the Earth. Eventually, it cooled into the round shape of the Moon that we see today. At this point in time, the Earth and the Moon were quite close, but over the course of the last four billion years, the Moon has been drifting further and further from the Earth.

The early days of the Earth were a frenetic time of great change and upheaval. Over the course of millions of years the Earth cooled and the surface hardened. Meanwhile, volcanic processes released lava and huge clouds of gases and dust into the atmosphere. Large planetesimals and asteroids regularly struck the earth adding to its mass, its water, and contributing other elements and compounds. Temperatures were high on the early Earth and any water quickly boiled into steam and vapor. This steam then cooled and fell as rain only to be quickly heated up and to repeat the cycle again. In this early formative period, the Earth rotated rapidly with the day being just five hours long. The Moon, which was close to the surface of the Earth, caused massive waves to roll over the face of the Earth's brown oceans. The sky, rich with hydrogen-sulfide, was a pinkish-orange. Millions of years passed until the earth became more stable, the oceans calmed down and a thin layer of atmosphere persisted. In these conditions, at a very early point in time in the history of the Earth, the first cell could form.

Discussion Questions:

1. For tens of thousands of years, cultures around the world have been contemplating the meaning of the movement of the sun, stars, and planets. This knowledge was often used to ground the human in seasonal and cosmic cycles and within the context of the heavenly bodies. How are we still doing this today? How does the *Journey of the Universe*, when considered within the context of the development of our own solar system, help to give the human a sense of meaning and purpose? How does it help us to change what it means to "participate" in the larger story of the universe?
2. In the *Journey of the Universe* film, there is a scene where Brian Thomas Swimme cuts into a hardboiled egg to show that the interior of the Earth looks like. What did you find to be useful, surprising, or inspiring about this image? How did it lead you to think differently about the Earth?

3. The *Journey of the Universe* book describes the Earth as a planet that is finding its way "to remain in the creative zone between the chaos of roiling gas and the rigidity of solid rock" (39). How is the Earth still in a "creative zone?" If so, how does the Earth's current creativity link back to, reflect, or continue the early creative processes involved in the formation of the Earth? What role, if any, does this human play in this creative process?
4. The *Journey of the Universe* book describes several major milestones in scientific discovery that expanded our knowledge of the solar system. How are we still building on the knowledge of Kepler, Copernicus, and Wegener and how is this shaping our perception of the larger story of the universe? How does the film or book change your perception or understanding of these scientific discoveries?

Online Resources:

- The Hubble Telescope is one of our greatest tools for observing galaxies and stars from the early moments of the universe, but it has also made a number of important discoveries in our own solar system. Visit the Hubble Telescope website for images, tutorials, and videos about the planets in our solar system. Visit the Hubble Site News Center for regular updates on discoveries and research concerning our solar system.
- The National Aeronautics and Space Administration (NASA) has a FAQ on our solar system.
- The National Aeronautics and Space Administration (NASA) website has an educational page on the sun. Scroll down to the bottom of the page for news items as well as for activities and lesson plans aimed at 9th-12th grade learners.
- The Hayden Planetarium hosts a number of useful educational tools such as the Digital Universe Atlas, the Astrophysics Visualization Archive, and a plethora of useful links, news items, multimedia and programs such as this set of videos and interactive features on our solar system.
- NASA's "Astronomy Picture of the Day" website features daily pictures of the Sun, the planets, and other astronomical bodies in our solar system. Each photograph is accompanied by explanations, links, and other useful information written by professional astronomers. View thousands of photos of our solar system such as this dramatic sun flare, this surprisingly vivid infrared photo of Saturn's auroras, or this breathtaking rise of the Moon and Venus over Switzerland.
- Another useful resource is NASA's Wavelength Digital Library. Browse by grade level, subject matter, or search with keywords.

Print Resources:

- *Journey of the Universe* Bibliography.

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