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FACULTY OF EDUCATION

Department of  
Curriculum and Pedagogy

# **Physical Sciences**

# **Astronomy: The Formation of**

# **The Solar System**

Science and Mathematics  
Education Research Group

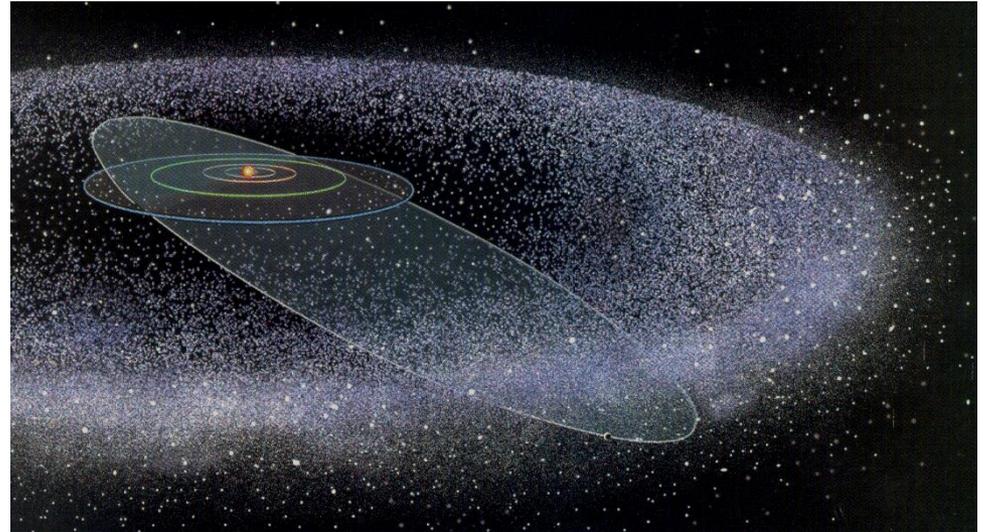
# Formation of the Solar System



# Solar System I

Which of the following theories attempts to explain how stars and the celestial bodies that orbit them are formed?

- A. The Big Bang Theory
- B. Nebular Theory
- C. The Theory of Evolution
- D. Planetary Formation Theory



# Solution

**Answer:** B

**Justification:** Nebular Theory explains how the giant gas clouds composed of helium and hydrogen, which formed as the universe expanded and cooled, could condense to form solar systems.

Remember: Celestial bodies are any collection of matter/structure existing in space.

The Big Bang theory describes how the giant gas clouds developed and were formed, but does not describe the process by which solar systems are created.

Although it sounds real, the Planetary Formation Theory isn't really a theory! And the Theory of Evolution explains how species change and develop over time.

# Extend Your Learning: Video

**Title:** Formation of the Solar System

Follow along with the video to explore the remaining questions in greater depth! There are timestamps in the comments section of each question to direct your learning.



# Solar System II

Six billion years ago, at the origin of our solar system, a super massive star exploded leaving behind giant clouds of gases and debris.

As the giant clouds of material began to collapse, a \_\_\_\_\_ was formed.

- A. Star
- B. Planet
- C. Gas Giant
- D. Nebula
- E. Neutron Star



# Solution

**Answer:** B

**Justification:** Giant gas clouds condense to form nebulas. Originally these nebulas only contained hydrogen and helium, as heavier elements had yet to be fused in the hearts of stars.

When massive stars die they explode in what is called a super nova. The result is the vaporization of the surrounding solar system and the formation of a new nebula. Due to this cyclical process, systems will contain more heavy elements with every passing generation of the star.

# Solar System III

Approximately what percentage of the mass in a solar system was originally contained within its pre-solar nebula?

- A. 100%
- B. 70%
- C. 0%
- D. 50%



# Solution

**Answer:** A

**Justification:** The formation of the solar system is analogous to the formation of pottery from a lump of clay. If we take a lump of clay, and from it we create a tea pot and four tea cups, all of the pottery must have come from the original lump of clay.

Similarly, you can consider the pre-solar nebula to be the lump of clay. All of the celestial bodies that currently exist must have come from this pre-solar nebula.

# Solar System IV

What was the most abundant element in our solar system's pre-solar nebula?

- A. Hydrogen
- B. Helium
- C. Carbon
- D. Oxygen
- E. Nitrogen



# Solution

**Answer:** A

**Justification:** The Sun is comprised of 99.8% of the mass in the solar system.

Because we know the Sun is made of primarily hydrogen and it is almost all of the mass in our solar system, we can infer that our pre-solar nebula must have been primarily composed of hydrogen as well.

# Solar System V

What percentage of the atoms in the human body were likely to have been formed at the heart of a star?

Consider:

10% of the mass of a human body is hydrogen; 18% is carbon.  
There is no helium in the human body.

- A. 0%
- B. 10%
- C. 28%
- D. 90%

# Solution

**Answer:** D

**Justification:** We know that Hydrogen and Helium are the only two elements that formed during the cooling of the universe. Therefore, all other elements have been formed at the hearts of stars through fusion reactions.

Because we are composed of 10% hydrogen and 0% helium, the remaining 90% of our bodies is composed of elements that were fused at the hearts of stars.

# Extend Your Learning: Video

**Title:** The Most Astounding Fact



# Solar System VI

How does the number of planetoids in a solar system change as the solar system ages?

- A. Increases
- B. Decreases
- C. Stays the same



# Solution

**Answer:** B

**Justification:** A planetoid is defined as a chunk of solid material, floating around in space.

Consider the following examples of how the number of planetoids could change. These are not all examples, but cover a large number of the possibilities:

Planetoids collide with each other and break into pieces. In most cases, a small planetoid will hit a large planetoid and the small planetoid will be absorbed by the large one. Ex. when meteorites hit Earth they collide and get absorbed into Earth.

# Solution Cont'd

**Answer:** B

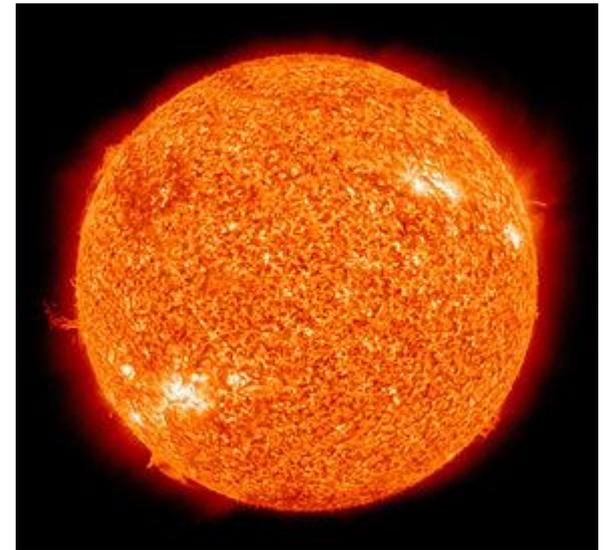
**Justification:** Other (much less common) options are:

- a) Some planetoids will collide with such high energies that they do not break into pieces. Instead they meld to form one planetoid.
- b) Other planetoids will break into smaller pieces. In this case, the smaller pieces will likely be pulled in by the gravitational force of the largest remaining piece, resulting in a single planetoid.
- c) Smaller particles condense into larger bodies because of the attractive forces of gravity. This only occurred in the early solar system when the density of matter in space was high and the smaller particles were moving slowly.

# Solar System VII

What does the elemental make up of our solar system tell us about our sun?

- A. The sun is a first generation star
- B. The sun is not a first generation star
- C. The sun will become a white dwarf
- D. The elemental make up of our solar system tells us nothing about the sun



# Solution

**Answer:** B

**Justification:** If the Sun was a first generation star, then the only elements present in our solar system would be hydrogen and helium.

We know that the Sun is not a first generation star because we interact with heavier elements – such as carbon, nitrogen, oxygen, and sulphur – every day. Therefore, we can be certain that the Sun is at least one generation old.

The mass of a star determines how it will age. We know that the Sun will eventually become a white dwarf, because it is a medium sized star. However, knowing the elements in the surrounding Solar System does not tell us anything about the mass of the star.

# Solar System VIII

Would the universe's first solar systems contain any terrestrial planets?

- A. Yes – Some of the extra gas that was not used in forming suns fell into orbit around those suns, eventually forming terrestrial planets.
- B. No – After the formation of the first solar systems, all of the gas in the nebulas was contained within the suns.
- C. No – The first solar systems did not contain the necessary elements in order to form terrestrial planets.
- D. Yes – Terrestrial planets existed before the formation of the first solar system.

# Solution

**Answer:** C

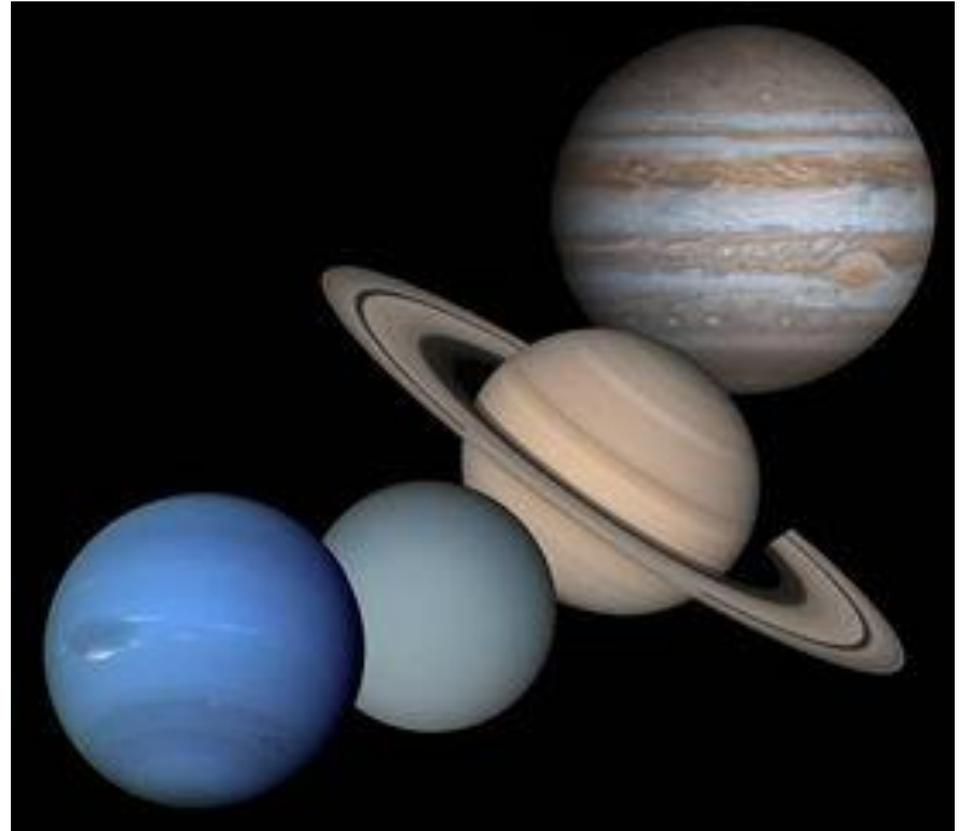
**Justification:** A planet is said to be terrestrial if it has a solid rocky surface. Considering that the early universe was entirely composed of helium and hydrogen, none of the elements required to create the hard, rocky surfaces characteristic of terrestrial planets (such as the Earth, Mars and Mercury) existed. Therefore, terrestrial planets could not be formed in the universe's first solar systems.

# Solar System IX

Did the universe's first solar systems contain any gas planets?

A. Yes

B. No



# Solution

**Answer:** A

**Justification:** Remember that the early universe was entirely composed of gases (hydrogen and helium). All matter in the early universe was condensing (i.e. moving closer together) and formed stars. After stars were formed, the remaining gas formed planets similar to the gas giants in our solar system today.

# Solar System X

When the Sun's internal fusion reactions first began, the solar wind produced by the sudden release of energy pushed the surrounding cloud of dust and material away from the Sun.

Which of the following correctly lists the effect of the appearance of the solar wind on the elements (Carbon, Iron, Hydrogen and Helium), from most effected to least effected?

- A. Carbon, Iron, Hydrogen, Helium
- B. Hydrogen, Iron, Carbon, Helium
- C. Iron, Carbon, Helium, Hydrogen
- D. Hydrogen, Helium, Carbon, Iron
- E. All elements are effected evenly

# Solution

**Answer:** D

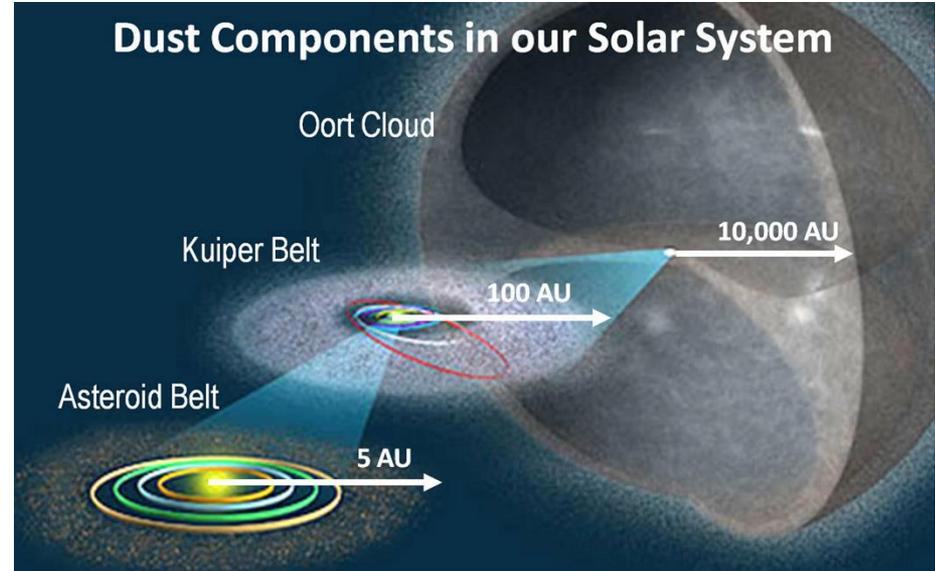
**Justification:** Heavier elements are harder to push and therefore will be effected less by the Sun's solar wind.

It is hypothesised that during the formation of our solar system, the Sun's solar wind pushed the lighter elements further than the heavier elements. As a result, all of the terrestrial planets (made of heavier elements) were formed closer to the sun than the gas planets (made of lighter elements).

# Extend Your Learning: Question

What event could have caused the ejection of the asteroids, dwarf planets and space dust into the asteroid belt and Oort cloud?

- A. The Sun's internal fusion reactions began
- B. The Oort cloud and asteroid belt were here before the origin of this solar system
- C. The transition of a high mass star into a neutron star
- D. The collision between two planets



# Solution

**Answer:** A

**Justification:** When the Sun first became a star and the internal fusion reactions began, a huge solar wind was produced. The solar wind was so strong that it blew a large amount of smaller debris and gas into the edges of our solar system. The gas that was ejected coalesced to form the gas giants, and the smaller planetoids fell into orbit as the asteroid belt, Kuiper Belt and Oort Cloud.