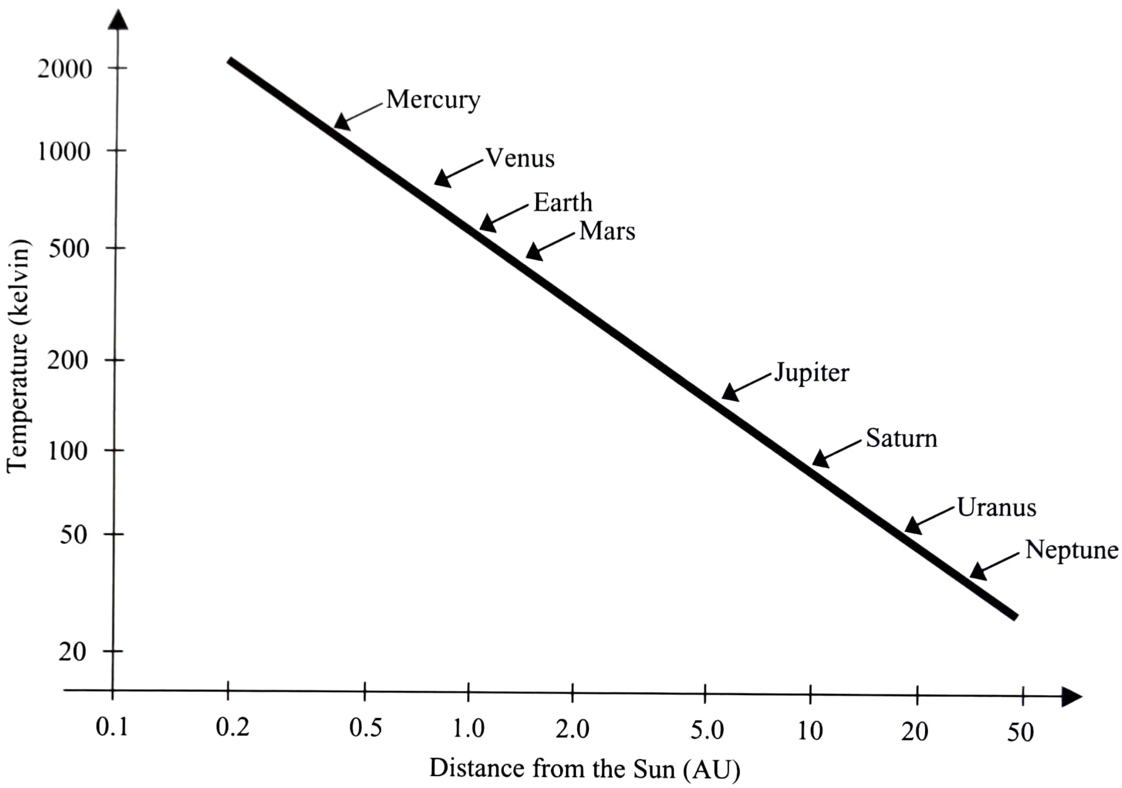
Consider the information provided in the graph and table below. The graph shows the temperature (expressed in kelvins) at different distances from the Sun (expressed in astronomical units or AUs) in the solar system during the time when the planets were originally forming. The table provides some common temperatures to use for comparison.



Condition	Temp. Fahrenheit	Temp. Celsius	Temp. kelvin
Severe cold temps. on Earth	−100	−73	199
Water freezes	32	0	273
Room temp.	72	22	296
Human body	98.6	37	310
Water boils	212	100	373

1) What was the temperature at the location of Earth?

2) What was the temperature at the location of Mars?

3) Which planets formed at temperatures hotter than the boiling point of water?

4) Which planets formed at temperatures cooler than the freezing point of water?

At temperatures hotter than the freezing point of water, light gases, such as hydrogen and helium, likely had too much energy to condense together to form the large, gas giant, Jovian planets.

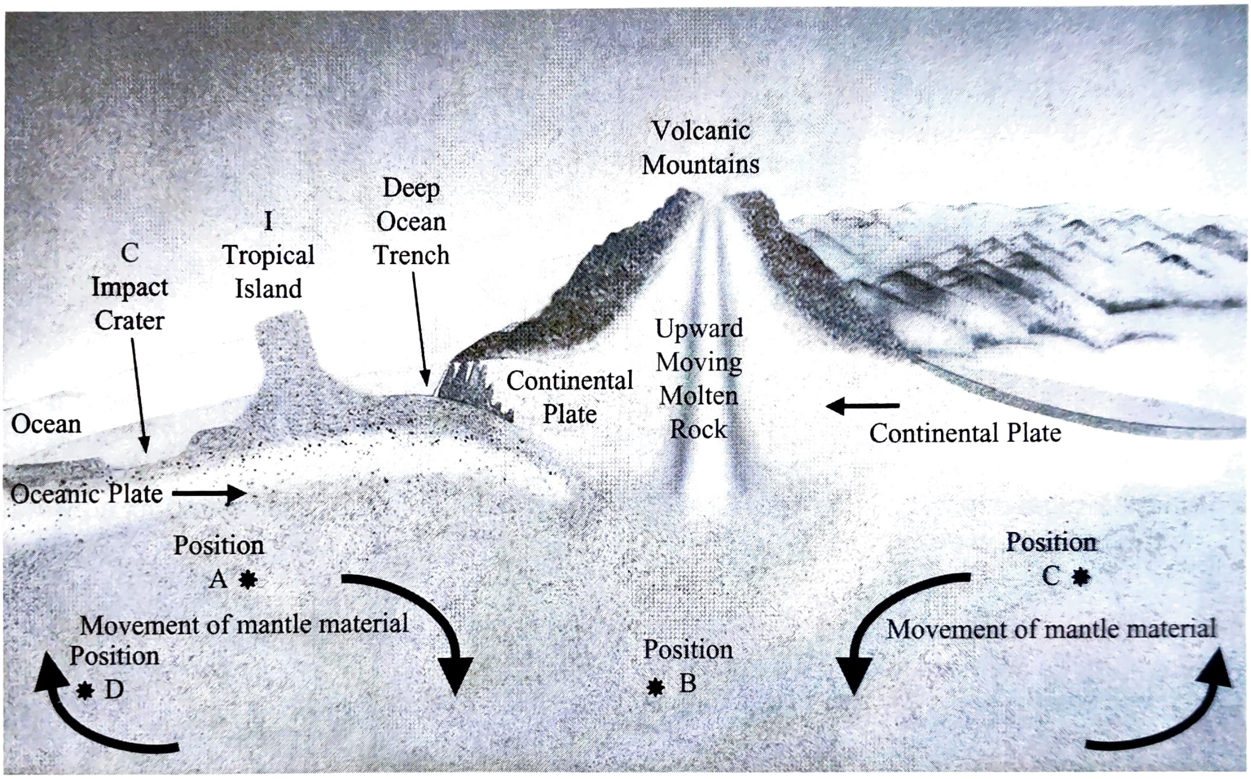
5) Over what range of distances from the Sun would you expect to find light gases, such as hydrogen and helium, collecting together to form a Jovian planet? Explain your reasoning.

6) Over what range of distances from the Sun would you expect to find only solid, rocky material collecting together to form a terrestrial planet? Explain your reasoning.

7) Is it likely that a large, Jovian planet would have formed at the location of Mercury? Explain your reasoning.

The extremely high temperature of Earth's core causes material in the surrounding mantle to become hot, expand, and rise toward the surface. The mantle material then cools and sinks, resulting in a circular motion of material moving beneath Earth's surface. This circulation of mantle material causes the continental and oceanic plates to move across Earth's surface. At various locations on Earth's surface, we are able to observe plates colliding, plates separating, and plates moving horizontally with respect to each other.

The drawing below shows a cross-section of Earth's surface and its underlying mantle. At this particular location of the surface, the dense oceanic plate is being forced beneath the less dense continental crust. The dense oceanic plate experiences higher temperatures (and pressures) as it is forced deeper into the mantle. This interaction between the oceanic plate and continental plate causes molten material to move upward through the continental plate until it breaks the surface in the form of volcanoes.



Oceanic to Continental Plate Convergence Zone

In the drawing above, Positions A–D show the position of four pieces of mantle material. Use this drawing to answer the next three questions.

1) Which direction (right or left) are the oceanic and continental plates moving?

2) Which is hotter, the piece of mantle material at Position A or the piece of mantle material at Position D? Explain your reasoning.

3) What direction are the pieces of mantle material moving (up, down, left, or right) at Positions A, B, C, and D?

4) Consider the following discussion between two students debating why the oceanic and continental plates move.

Student 1: *The plates are moving because the mantle material is constantly moving beneath Earth's plates, and this causes the plates to move.*

Student 2: *I disagree. The plates are just floating on the mantle material. The plates started moving a long time ago when Earth initially formed, and the plates' momentum keeps them moving toward each other.*

Do you agree or disagree with either or both of the students? Explain your reasoning.

5) Just beneath Point I on the drawing is a tropical island. What will eventually happen to the island as the oceanic plate moves? Why?

6) Just beneath Point C on the drawing is an ancient impact crater on the ocean floor where a giant comet collided with Earth. What will happen to the ancient impact crater as the oceanic plate moves? Why?

7) Imagine that an impact occurred on the continental plate millions and millions of years ago, leaving behind an impact crater near the right side of the base of the volcano. Why would there be little evidence of this impact crater found today?

8) Consider the image below of the rocky and crater-covered Moon. Its very old surface has remained virtually unchanged over the last few billion years. Do you think the Moon has an active, hot, and molten interior or an inactive, cold, and solid interior? Why?

9) If a new planet were discovered, what evidence would you look for to determine whether or not it has an active, hot, and molten interior? Why?