Lesson 4 Fostering Curiosity and Creativity

What-If Science

Have you ever wondered, "What if I could run so fast that nobody could see me?" If you have asked this kind of question, you may be ready to become the next Galileo. The Italian scientist Galileo Galilei is famous for a thought experiment, which is an imaginary experiment designed to explore a mathematical or scientific hypothesis. With only his thoughts, he demonstrated that objects with different masses should fall at the same speed when dropped from the same height in the absence of air resistance. With a hypothesis based on creativity and imagination, anyone can become a great scientist.

1. What if the size of a human body became enormous?

The tallest man in recorded history was 272 cm tall, but have you ever wondered what would happen if humans could grow to enormous sizes like the giant in Jack and the Beanstalk? Unfortunately, the answer to this hypothetical question is that it is impossible due to the scale effect. When the length of an object doubles, its area increases by a factor of four (2x2), and its volume by a factor of eight (2x2x2). These changes can create many problems that would put the giant's life in danger.

One issue is that the giant would not be able to stand properly on his own because of the weight pushing down on his feet. If a person's height increased ten times, his weight would increase by a factor of 1,000 (10x10x10) because weight changes in proportion to volume. However, the area of the feet supporting his body would only increase by a factor of 100 (10x10). This means that his feet would be under too much pressure to support the increased weight because the mass would have increased far more than the area of his feet.

In addition, there is an issue of heat emission. Heat is generated in the human body, and it is constantly released from the surface of the skin to prevent heat from accumulating in the body. If a person's height were to increase ten times, the amount of heat generated would increase a thousand times in proportion to the body's volume. However, the surface area of the person's skin would only increase a hundred times, and as a result, not enough heat would be released from the body through the skin. This shows that while we may wish to grow as tall as a giant, we would not be able to survive in that form.

2. What if there were no Moon?

"O, swear not by the moon, the inconstant moon." This is a famous line from Romeo and Juliet. Juliet warns Romeo not to swear his love by the Moon as it may change just as the Moon changes its shape. Although its appearance changes, the Moon is always present in the night sky and plays a crucial role in regulating the length of the day on Earth as well as the Earth's seasons and weather patterns. Then, what would happen if there were no Moon?

Without the Moon, our day would no longer be 24 hours. The Moon's gravity causes the Earth's ocean to rise and fall. Since the ocean is moving and the Earth is also spinning, friction occurs between them. This friction leads to a decrease in the rotation rate of the planet. Without the Moon, however, the Earth's rotation would not slow down, resulting in a change in the length of a day. According to some scientists, when the Earth first formed, there was no Moon and a day was only five hours long. This indicates that without the Moon, we would see the Sun rise every five hours.

Additionally, the absence of the Moon would completely change weather patterns on Earth. We experience the beauty of different seasons because the Earth is tilted on its axis. The axis of rotation of the Earth is tilted at an angle of 23.5 degrees, and the Moon's gravity holds the Earth in place by stabilizing the tilt. However, if there were no Moon, the tilt could vary wildly between 0 and 85 degrees. Suppose the Earth were tilted at an angle of 60 degrees. The hemisphere of the Earth facing the Sun would receive much more energy from the sun than the other hemisphere. This could bring about extreme shifts in weather patterns, potentially making summers hotter and winters colder. If this trend continued, the Earth would become uninhabitable.

3. What if the oxygen concentration in the atmosphere doubled?

Oxygen is a vital gas for life, making up 21 percent of the Earth's atmosphere. It is essential for breathing and is also necessary to burn common fuels like wood and oil to generate heat and light. Undoubtedly, it is an indispensable element for organisms on Earth. Then, would it be better to have a higher concentration of oxygen in the atmosphere? What would happen if the oxygen concentration were to double?

While more oxygen may seem beneficial, it could have unexpected consequences, especially for insects. Insects, such as bees and dragonflies, do not have lungs and instead take in air through external openings called spiracles. Although insects can survive without lungs, their spiracles are not as efficient as lungs at taking in air.

Therefore, with the current oxygen concentration, insects cannot evolve to be larger than their current size. If they were bigger in size, oxygen would not be able to reach the deepest parts of their bodies. However, if the concentration of oxygen were to double, insects could grow in size as oxygen would be more readily available.

This increase in insect size could have a significant influence on the ecological environment, potentially disrupting the food chain. Dragonflies, for example, may become as large as eagles, altering the balance of predators and prey in the ecosystem.

Fortunately, you wouldn't need to worry about giant insects chasing after you if this were to occur. If the oxygen concentration were to double, you would be able to run faster than you can right now. Considering that oxygen is used to break down energy so that muscles can use it, the increase in oxygen would help to use energy more efficiently and improve our capability for physical exercise. This leads us to expect that athletes would set new world records at the Olympics.

While these three thought experiments offer interesting possibilities, it is important to consider that they are simply based on imagination and have not been tested through scientific research.