PROCESSO SELETIVO – TURMA 2021
FASE 1 – PROFICIÊNCIA EM LÍNGUA INGLESA

Prezada candidata, prezado candidato

Este exame é composto por um artigo em inglês e 2 questões.

O artigo, *Demonstrating the physics involved in astronaut spacewalk training*, de Josip Slisko, foi publicado na revista The Physics Teacher volume 58, página 680, em 2020.

Leia-o com atenção e, com base no que consta no texto, responda em português às questões apresentadas em seguida.

As suas respostas deverão ser enviadas digitalizadas. Posteriormente, será agendada a arguição oral, com membros da comissão de seleção, das respostas apresentadas por você. Essa arguição será feita em conjunto com a da prova de Física e seu Ensino.

Boa prova

NOME: ____

ASSINATURA: ____

Número: ______________

Leia o artigo *Demonstrating the physics involved in astronaut spacewalk training*, de Josip Slisko, publicado na revista The Physics Teacher 58, 680 (2020).

A partir do texto, responda às questões abaixo.

Questão 1
Quais as duas abordagens que, segundo o autor, são utilizadas para treinar astronautas para viagens em ambientes sem gravidade? Descreva cada uma delas.

Questão 2
Quais as diferenças entre as duas abordagens, a de ausência de peso e de flutuabilidade neutra?

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Demonstrating the physics involved in astronaut spacewalk training

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While in space, astronauts live and function in a weightless environment, both inside and outside of their spacecraft. This situation differs greatly from Earth's gravity-dominated environment. In order for astronauts to experience the challenges of weightlessness prior to performing actual spacewalks, it is necessary that they undergo simulated weightless conditions here on Earth. (Note: In this article the terms "weightless" and "weightlessness" are used to refer to situations in which the effects of gravity are not observed or felt. Of course, the gravitational force between bodies exists everywhere in the universe, but astronauts in space usually do not experience its effects.)

Training astronauts for the weightless environment of space: Two approaches

For short (approximately 30-second long) experiences of weightlessness, astronauts are taken aloft on a specially fitted aircraft that flies along a parabolic path. With its engines switched off, the plane performs a dive at a 45° angle. In a state of what is essentially free fall, due to the principle of equivalence, the plane's interior becomes what is referred to as a reduced gravity environment.[1]

Fig. 1. The extended neck of the water-filled balloon indicates that the balloon has weight.

For simulated weightlessness of longer durations, such as those experienced in a spacewalk, another training approach was designed.[2] To replicate, as much as possible, a weightless environment, a huge basin of water (62 m long x 31 m wide x 12 m deep), such as NASA's Neutral Buoyancy Laboratory (NBL) in Houston, TX, is used. While astronauts are immersed in water, the buoyant force equals the combined weight of their bodies and heavy space suits. This equilibrium condition allows them to practice their mission duties both inside and outside of a replica of the International Space Station in conditions that mimic those existing in space.

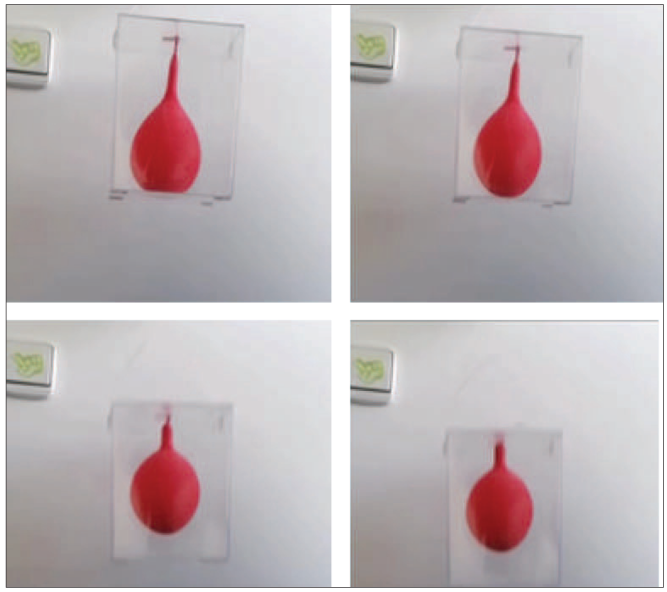

Fig. 2. When the container is in free fall, the neck of the balloon is no longer extended. A non-extended neck indicates that the balloon is in weightless condition. That the container is falling is revealed by its position relative to the light switch on the wall.

Weightlessness in free fall

It is possible to demonstrate the basic physics involved in training astronauts in a neutrally buoyant environment using a water-filled balloon, which acts as the astronaut, attached to the top of a rectangular plastic container. When the plastic container is empty and at rest, the water-filled balloon is pulled down by the force of gravity. The balloon's extended neck clearly shows that the balloon has weight (Fig. 1). This situation corresponds to one in which an astronaut is on Earth.

In a spacewalk, an astronaut is in free fall and can be thought of as weightless. The same effect for the water-filled balloon can be demonstrated if the plastic container is allowed to fall freely. The water in the balloon becomes weightless and, consequently, the neck of the balloon returns to its non-extended length (Fig. 2).

Weightlessness simulated by buoyant force

It is also possible to have a water-filled balloon with a non-extended neck when the container is at rest. This can be achieved by filling the plastic container with water. When the balloon is completely immersed in the water, the buoyant force of water and the weight of the water in the balloon will be in equilibrium and, as a result, the neck will assume its non-extended length (Fig. 3). In other words, the immersed water-filled balloon becomes effectively "weightless," demonstrating the simplified physics behind astronaut training for spacewalk in the NBL.

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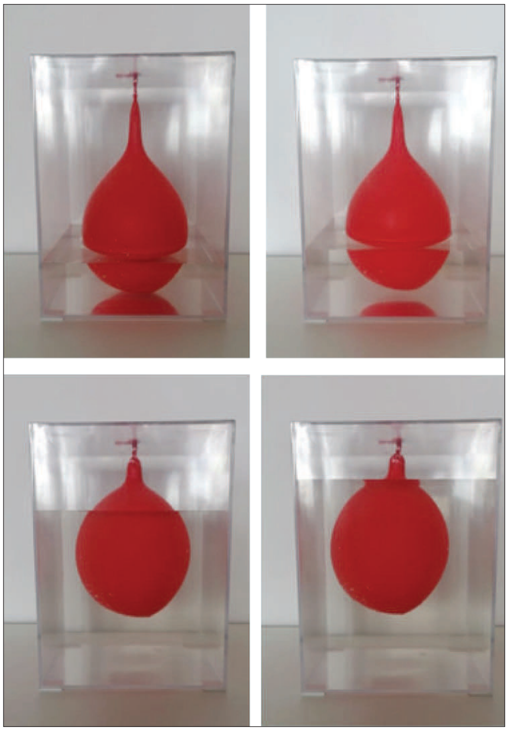

Fig. 3. Adding water to the container produces a buoyant force. This reduces the force on the balloon's neck.

Differences between the experience of weightlessness and neutral buoyancy

Working in the NBL simulates walking in space to a great degree, but the two situations are not identical. While immersed in water, astronauts experience neutral buoyancy; however, they still feel their weight while in their suits: Tilting their suits causes them to be pressed against whichever inside surface is facing down. In addition, while moving, astronauts experience drag, the resistance to motion due to the water. In space, once in motion an object will continue in motion until stopped by an external force. In water, motion continues only as long as a force is applied to an object. The resistive effects of water are the opposite of what is experienced in space, where it is easy to set an object in motion but very difficult to keep it still.

As is the case with motion through any fluid, the drag on an object increases with speed. This can be demonstrated by moving the balloon at different speeds in the water-filled container. Pulling the balloon by its neck through the water slowly produces very little drag. This is evidenced by the minimal extension of the balloon's neck. However, the neck's extension becomes greater when the balloon is pulled at a faster rate. So, in order to simulate an actual spacewalk as closely as possible during training in the NBL, drag effects are minimized by doing tasks slowly.

Pre-demonstration questions

Prior to performing the above demonstrations, a puzzle-based challenge for students might consist of the following questions:

1. Show students the water-filled balloon in the empty container with extended neck (Fig. 1) and ask: Why is the neck extended?
2. After the students explain that the extension is due to the weight of the water in the balloon, ask: How might the neck's extension be eliminated without touching the balloon?

Hopefully students will propose the demonstrations described above. An additional benefit of puzzle-based learning is that frequently students come with interesting physical ideas about how to get an effect that the teachers would never imagine. Best education episodes occur when teachers learn good physics from their students!

Acknowledgment

I would like to thank physics teacher Željan Kutleša (Primary schools Split 3 and Lokve Gripe, Split, Croatia) for his kind efforts to carry out these demonstrations and to make related photographs.

References

1. Daniel A. Beysens and Jack J. W. A. van Loon (Eds.), *Generation and Applications of Extra-Terrestrial Environments on Earth* (River Publishers, Aalborg, 2015), especially Chap. VII.
2. Michael J. Neufeld and John B. Charles, “Practicing for space underwater: Inventing neutral buoyancy training, 1963–1968,” *Endeavour* **39**, 147 (Sept.-Dec. 2015).