УДК 531.133.2=111

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The Third Law of Motion

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«What goes up must come down». You may have heard this description of gravity. Yet when you jump on a trampoline, the reverse is also true. “What comes down must go up.” How can a trampoline make you move up against gravity? This article will help you answer this question. You will take a close look at what happens when one object applies a force on another. Moreover, you will learn about a give-and-take between the two objects.

As you fall onto a trampoline, you apply a downward force that stretches the trampoline. The trampoline, then, applies an upward elastic force on you. It is this upward force that bounces you back up.

In short, a pair of forces is at work here. You apply a force to the trampoline. And the trampoline applies a force on you. The forces are opposite in direction. But they are equal in amount. The greater the downward force you apply on the trampoline, the greater the upward force it applies on you.

Forces always act in pairs. Each force in a pair acts on a different object. For example, when you use a finger to push a book, the book also pushes your finger. If you push a friend while you are both on skates, you are pushed as well. Your friend accelerates in one direction and you accelerate in the opposite direction. In each case, one object (or person) applies a force to the other.

Sir Isaac Newton made similar observations about pairs of forces. Newton summed up his observations in his Third

Law of Motion. This law states that for every action there is an equal and opposite reaction [1]. Your finger pushing a book, for example, is an action. The book pushing your finger is the reaction. The action force is equal in strength to the reaction force. But the two forces act in opposite directions.

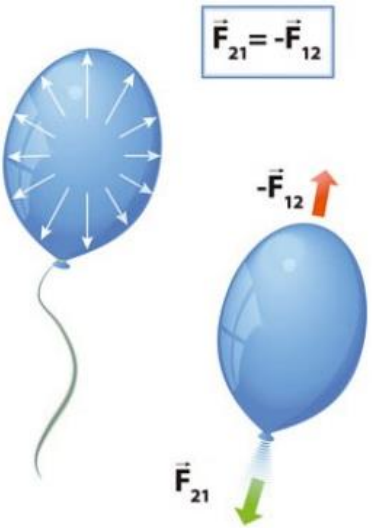

Figure 1. Pairs of Forces Acting on a Balloon

Compare the forces of action and reaction in Figure 1. The balloon applies an elastic force, an action force, on the air inside. The action force pushes the air out. The air, in turn, applies a reaction force on the balloon. The reaction force pushes the balloon in the opposite direction.

See Figure 2. A rocket is launched by a similar kind of reaction force. A rocket engine produces gases. It applies an action force that pushes the gases downward. The gases, in turn, apply a reaction force on the rocket. They push against the rocket, causing it to lift up.

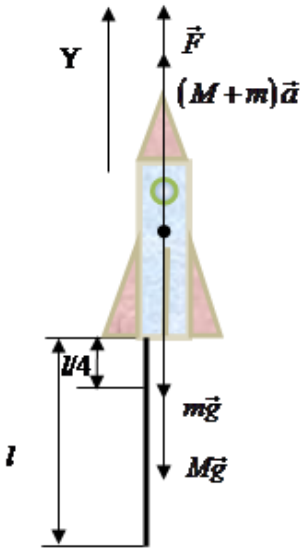

Figure 2. Pairs of Forces Acting on a Rocket

A variety of action-reaction force pairs are evident in nature. Consider the propulsion of a fish through the water. A fish uses its fins to push water backwards. But a push on the water will only serve to accelerate the water. The size of the force on the water equals the size of the force on the fish; the direction of the force on the water is opposite the direction of the force on the fish. For every action, there is an equal (in size) and opposite (in direction) reaction force. Action-reaction force pairs make it possible for fish to swim [1].

References:

1. Force Pairs Replace Interactions – Physics Narrative [Electronic resource]. – Mode of access: https://spark.iop.org/collections/force-pairs-replace-interactions-physics-narrative. – Date of access: 13.03.2021.