ADVANCED: POWER PLANTS

DESCRIPTION OF SESSION
In this session, participants will expand on their discussion of the activities in the Introductory: Power Plants session by exploring Newton's Third Law.

CATEGORY
- Exploring: Aviation
- Exploring: Engineering & Technology
- U.S. Department of Education: STEM

OBJECTIVES
By the end of this session, participants will be able to:
- Explain Newton's Third Law in practical terms using everyday examples.
- Understand the equation F = MA and use it to further explain those same everyday examples.

SUPPLIES
- **Activity 1 supplies**—skateboard, balls of various sizes (basketball, medicine ball, beach ball, etc.)
- **Activity 3 supplies**—computer with internet access

ADVISOR NOTE: Text in italics should be read aloud to participants. As you engage your post in activities each week, please include comments, discussions, and feedback to the group relating to **Character, Leadership,** and **Ethics**. These are important attributes that make a difference in the success of youth in the workplace and in life.

ACTIVITIES
Activity 1
Newton's Third Law
Have one of the participants sit on the skateboard facing one end and catch a basketball (not with their arms outstretched but into their chest). Ask: *What happens? How far did the skateboard travel? Why?*

Then have the participant on the skateboard throw the basketball to someone who is standing. Ask: *What happens? How far did the skateboard travel? Was it different from when the sitter caught the ball?*

Extend this experiment in a variety of ways by using medicine balls, beach balls, or other balls to see how they change the reaction; throwing with different forces (harder throws, softer throws); and placing the skateboard on gravel, carpet, grass, or hardwood floors to incorporate friction (drag) into the experiment.

Then ask a participant to stand on the skateboard and step off. (Be sure to offer a hand to the person stepping off the skateboard.) Have the participants discuss what happens. Ask: *How is this similar to the ball experiments?*

Other items can be used if a skateboard is not available, like a wagon, tricycle, or other wheeled toy.

Discuss the scenario as it applies in aviation, incorporating the concepts of friction and thrust. Friction is drag. Different balls thrown with different forces are thrust. Discuss how a different engine or a different shape of fuselage can change flying characteristics. Discuss icing and its effect on how a plane flies.

Activity 2
Newton's Third Law Math
Present this problem to participants*: If a big person and a small person were each on skateboards, facing one another and pushing off with equal force, how can you figure out which person will travel farther?*

If two skateboards are available, try it! Then discuss the following:

- F = MA (Force = Mass x Acceleration)
- To figure out the acceleration of each, solve for A, so that A = F/M.
- With equal force, set up the equation for the two people like this: $F/M_{big} = F/m_{small}$

Without having to measure anything formally, you can tell that if F is the same for both, dividing by a small number will yield a bigger acceleration. The small human moves a lot farther than the big human.

Activity 3
Experiment With Plane Design
The National Air and Space Museum has a great web-based simulator (http://howthingsfly.si.edu/activities/forces-flight) where participants can experiment with different wing shapes for lift, different fuselage shapes for drag, and different engine types for thrust. Have participants take turns deciding which choice to make and discuss the results.

ADVISOR NOTE
Some sample questions are below. They are designed to help the participants apply what they have learned to their own interests. You are welcome to use these questions or develop your own questions that relate to your post or specific focus area.

REFLECTION

- *What other real-life examples can you think of that illustrate Newton's Third Law?*
- *Consider the flight simulator you used in Activity 3. Do you think that flying faster and flying higher are necessarily opposing goals? Why or why not?*
- *Think about what you know about airplane design. What are some of the engineering trade-offs in designing an airplane. Is it possible to design one perfect all-around plane? Why or why not?*

ADVISOR AND OFFICER REVIEW
After the meeting, address the following:

- Identify what was successful about the meeting.
- Identify what needed improvement.
- Schedule an officer and Advisor planning meeting to prepare for the next post meeting or activity.

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