Exploration Brief

Bending Under Pressure

Context

Maintaining proper pressure inside a spacesuit is essential to astronaut survival during a spacewalk. A lack of pressure will cause body fluids to turn to gas, and resulting in death in a few seconds. While making spacewalks possible, pressure produces its own problems. An inflated spacesuit can be very difficult to bend. In essence, a spacesuit is a balloon with an astronaut inside. The rubber of the balloon keeps in oxygen that is delivered to the suit from pressurized oxygen tanks in the backpack. But, as pressure inside the balloon builds up, the balloon's walls become stiff, making normal bending motions impossible. Lack of flexibility defeats the purpose of the spacewalk–mobility and the ability to do work in space.

Spacesuit designers have learned that strategically placed breaking points at appropriate locations outside the pressure bladder (the balloon-like layer inside a spacesuit) makes the suit become more bendable. The breaking points help form joints that bend more easily than unjointed materials. Other techniques for promoting bending include stitching folds into the restraint layer that spread apart and contract with bending and building joints into the restraint layer like ribs on vacuum cleaner hoses.

Objective

• To observe how an external joint in a spacesuit arm segment increases bendability of the segment.

Materials and Tools Checklist

Two long balloons
3 heavy-duty rubber bands

Procedure

Step 1. *Inflate a long balloon and tie it off. The balloon represents the pressure bladder of a spacesuit arm. Let students try to bend the balloon in the middle.*

Step 2. *Inflate a second long balloon. As you are inflating the balloon, slip heavy-duty rubber bands over the balloon at intervals so that as inflation continues the balloon is pinched by the rubber bands. It is easier to accomplish this by pre-inflating the balloon. It may be necessary to double the rubber band to pinch the balloon enough for the demonstration. Have students compare the force required for bending this balloon with the force needed for the first balloon.*

Extensions

- Compare the stiffness of the balloons to other inflated structures such as air mattresses, inner tubes, beach balls, etc.
- Use a Slinky® as an alternative to the rubber bands. Place the Slinky® on a desk top and pick up one end. Slip in the balloon and inflate it. As the balloon inflates, it will be pinched in a spiral pattern by the Slinky®. The pattern will achieve the same result as the rubber bands.