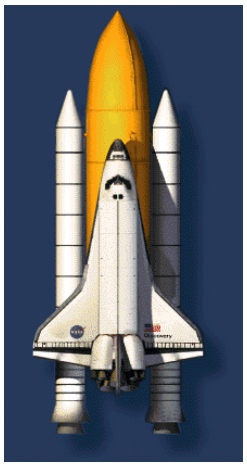

Living in a Vacuum-
Teacher Demonstration:
A Demonstration for
Living in Space PowerPoint

Web links
Northern California Chapter of the American Vacuum Society PDF of their strange experiments with vacuums.
http://chapters.avs.org/nccavs/pdf/effects.pdf.

Objective: Students will understand how living and working in the vacuum of space is hazardous to humans.

Demonstration Materials:
1 vacuum pump with lid
2 water balloons w/o water
1 can of strawberry carbonated drink
2 marshmallows
1 can of shaving cream
2 8 oz. clear plastic cup
1 small funnel

Introduction Script:
Working in the vacuum of space is a very hostile environment for humans. Why? (Have the students define what a vacuum is and how a vacuum could be harmful to humans without the special protection of a spacesuit). A perfect vacuum is a volume of space that has no matter, although there is no perfect vacuum. So for this demonstration, the vacuum pump I'll be using will not create a perfect vacuum, but it can simulate to some degree the effects of a lack of air pressure can have on a unprotected human body, that is a human who isn't wearing a pressurized spacesuit.

<u>Demo 1: The Elasticity of the Human Skin in the Vacuum of Space</u>

Materials
A vacuum pump
2 small water balloons

Script:
You've probably seen science fiction movies where an actor has walked into an airlock of a spacecraft opened the outer door and they blew up, right? (Blow up a balloon to the point where it almost pops. Insert it onto the base plate of the vacuum and seat the cover. Turn on the vacuum and

evacuate the air. The balloon should pop. This may take some practice.) Well that's bad science. An actually human skin is quite resilient. Also humans are mostly water. (Take the other balloon stretch it and let it snap back in place). Instead this would happen to a human without a spacesuit in the vacuum of space. (Carefully fill the balloon halfway with water and then blow air into it. Set it on the vacuum plate, seat the cover and evacuate the air. The balloon will expand slightly but will not pop.) As you can see the balloon expands but doesn't burst. A human's skin is very elastic so in space it would expand but the human wouldn't blow up. Instead some other interesting things would happen.

Demo 2: Shaving Cream Experiment…Air Spaces in the Human Body

Materials

Vacuum pump
Shaving cream
A clear plastic cup

Script:

Consider the air spaces in the human body, like your lungs, spaces in muscle tissue and skin. (Fill a plastic up half way with shaving cream and place it on the base plate of the vacuum and seat the cover. Turn on the vacuum pump and evacuate the air.) Watch this. (The shaving cream will expand, and may even topple over the top of the cup.) Like the first balloon, small and large pockets of air are present in the human body. For instance the lungs are large pockets of air. If you walk into the vacuum of space, the air in your lungs would expand causing the lungs to burst in your chest. Air pockets in muscle tissue would expand and small capillaries in your eyes and nose would burst since they are thin walled. On earth air is pressing down on us on every square inch of our bodies. Our bodies produce a pressure that presses back so we are in equilibrium. But there is no air in space so when the air molecules in are bodies press outward, there is no air pressing back. Hence the lungs burst inside of the human body. What do you suppose would happen to the shaving cream, if I let the air back into the vacuum chamber? (Let the students guess and then release the valve to let air back into the chamber. The shaving cream will liquefy.) So what is shaving cream made of? (Let students guess). It is mostly made of pockets of air. When the pockets expanded they reached a point of elasticity. So when normal pressure was reintroduced into the chamber, the air pockets collapsed making the shaving cream into a thinner fluid.

Demo 3: Life without Pressure ….Demonstration with a Marshmallow

Materials

Vacuum pump
A small clear plastic cup
A marshmallow
A Sharpie

Script:
Here is a marshmallow. What will happen if I put it in the vacuum chamber? (Let students guess. Take a Sharpie and draw a face on the marshmallow. Place a cup upside down on the base plate and sit the marshmallow on the cup, seat the cover and turn on the pump. Evacuate the air. The marshmallow head will expand but not burst). What is happening to the marshmallow astronaut? Right. He is growing. Now watch what happens when I reintroduce regular air pressure into the vacuum chamber. (Turn off the pump and reintroduce air back into the chamber. The marshmallow will shrink.) What happened? (Remove the marshmallow and hold it next to a normal marshmallow. Let students explain what happened to the marshmallow while it was in the vacuum chamber). What is a marshmallow made of? (Mostly air and sugar). So when it was placed in the vacuum chamber, the air pockets inside the marshmallow expanded like little balloons. When I reintroduced air back into the vacuum chamber, the little pockets of air lost their elasticity and popped. So the original shape of the marshmallow could not be obtained, the marshmallow instead shriveled up and became smaller. This shriveled up marshmallow represents what can happen to humans in space without the protection of a spacesuit. After the air pockets burst in your body, your skins would shrivel up like a raisin.

<u>Demo 4: Human Blood in the Vacuum of Space</u>
Materials
A clear plastic cup
1 can of strawberry soda
a vacuum pump

Script:
Here is another interesting demonstration. Consider how the blood in your views would react to a vacuum. (Pour into a clear plastic cup strawberry soda. Fill only half way. Place it on the base plate of the vacuum and seat the cover. Have the students guess what might happen to the soda without air pressure. Turn on the vacuum and evacuate the air. The soda will appear to fizz and boil.) Human blood is full of gases, like this soda. In space gasses in human blood would come out of solution. You've seen little bubbles rise to the surface of a soda. The soda has CO_2 in it. Eventually all the CO_2 will escape the soda over time leaving the soda flat. I have accelerated the process by quickly removing the air pressure around

the soda in the vacuum chamber. Without air pressing down on the soda, the CO_2 comes out of solution faster. The soda appears to be boiling. So without a spacesuit, gases in your blood like nitrogen will rise to surface areas within your body and squeeze their way out. Pretty painful because it would feel like your blood is boiling. Of course it isn't. You've got the "bends", something SCUBA divers experience when sometimes if they fail to decompress from deep dives.