

Mission Superchill

Show Script

PLUTO EDITION!

Watch experiments with liquid nitrogen, which simulate the super cold conditions on Pluto!

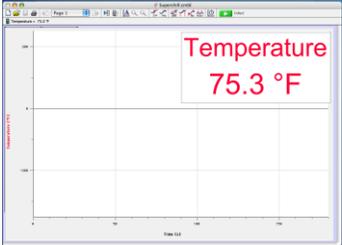
This show takes place on the Galaxy Stage. New Horizons flew by Pluto in July of 2015 providing us with more information about what it is like on the super cold dwarf planet. In this show, we explore what those conditions are like, and what we would have to do if we sent a robotic lander or even humans to Pluto in our next phase of exploration. The demonstrator does a series of experiments using Liquid Nitrogen to explore these extreme conditions. **You must complete the training requirements listed in the Training Manual before performing this show.**

Note: **CUE** means to press the button on the remote control “pickle” or to step on the foot pedal. (Both have the same effect.)

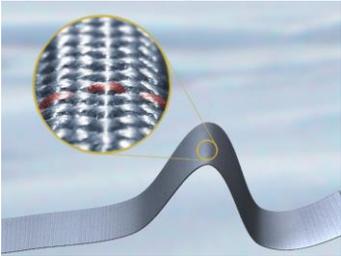
SLIDE/ MEDIA	Script	Media/Blocking/Manipulation
Title Slide 	Preshow 1) BOOT up “Special Presentation” show on AMX panel. 2) Change SPACE TODAY sign on DEMO DESK to MISSION SUPERCHILL. 3) Get COMPUTER CART set. 4) Get PROP CART stocked with rubber ball, rubber tubing, balloon, etc. 5) Get on lab coat and face shield, gloves. 6) Fill RED THERMOS #1 and RED THERMOS #2 to half full line. 7) Place LARGE GLASS DEWAR ON DEMO DESK and turn light on. 8) Place PURPLE TUB #1 on DEMO DESK. 9) Place GLOVES on DEMO DESK. 10) Put metal plate on floor where you will be shattering the rubber ball.	MUSIC CUE – Title screen Put empty glass Dewar on center demo desk.

0. Welcome		
		<u>CUE</u> - START MUSIC
		<u>CUE</u> -STOP MUSIC
	Hi, my name is XXXXXXXX. This is a show about the dwarf planet Pluto. We'll be doing a bunch of experiments to show you what it is like on Pluto and some of the things scientists and engineers would have to consider if we ever sent a robotic or human mission there.	
		<u>CUE</u> – Solar System Animation
Animation of solar system 	As you know, the planets close to the Sun, like Mercury and Venus are extremely hot. Earth is “just right.” As you move away from the Sun, temperatures get colder and colder. Mars, Jupiter, Saturn, Uranus, Neptune and Pluto. By the time you are way out by Neptune and Pluto, it is very, very cold.	
		<u>CUE</u> – Pluto Animation
Pluto New Horizons Image rotating 	Pluto was discovered in 1930 but it wasn't until the Hubble Space Telescope imaged the dwarf planet in the 1990's that we knew much about its surface features. Even then, all scientists had was a very pixelated image of the dwarf planet. In July 2015, the New Horizons Spacecraft flew by the Pluto System which allowed us to see the dwarf planet in stunning detail. By the way, a moment ago I mentioned that Earth is just right. What I meant was just right for water, which is essential for life. On Earth, the temperature is just right to have liquid water, solid water (in other words, ice), and gaseous water (in other words, steam.) Pluto is so cold that it snows solid Nitrogen.	
		<u>CUE</u> LIGHT CHANGE

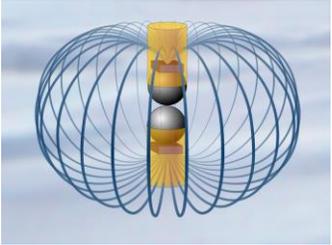
1. Present and describe LIQUID NITROGEN		
<p>Title Slide</p> 	<p>It is so cold on Pluto, that the only way we can show you what it's like is to use Liquid Nitrogen.</p> <p>Because Liquid Nitrogen is extremely cold, we have a couple of safety rules. First, we ask that everyone sits no closer than the first row and that no one comes up on the stage. If something happens to roll off the stage (it shouldn't), then please just leave it. I'll pick it up at the end of the show.</p> <p>To find out what it would be like on Pluto, let's go into my lab.</p>	
	<p>It looks like it's boiling, and it is, but not because it is hot. It is actually very cold. We don't think of room temperature as being hot, but compared to liquid nitrogen, it is.</p> <p>By the way, most of the air in this room is nitrogen. So this is really liquid air. It is so cold on Pluto that the air in this room would literally liquefy.</p>	<ol style="list-style-type: none"> 1. Put face shield down. 2. Get thermos of LIQUID NITROGEN from prop cart. 3. Add LIQUID NITROGEN to a depth of about 6 inches to LARGE GLASS DEWAR and replace RED THERMOS JAR back to STORAGE CART.
2. How cold is it?		
	<p>OK. So, just how cold is it? If you are a scientist, you want to <u>measure</u> to see exactly how cold it is.</p>	
		<ol style="list-style-type: none"> 1) Get digital thermometer from computer cart. 2) Make sure computer has the temp graph showing. 3) Click on "Collect".
		<p>CUE – Temperature Graph</p>

<p>Temperature Graph</p> 	<p>Let me grab this digital thermometer. It's hooked to this computer so you can see the readings it takes up on the side screens.</p> <p>Right now, it's measuring the temperature of the air. As you can see on these screens, it's now registering about 70° Fahrenheit. If I wrap my hand around it, what do you think will happen? That's right; you can see the line on the graph rises as the temperature goes up.</p> <p>How cold do you think it is? Colder than water ice, which freezes at 32° F? Or what about the North Pole in the middle of winter which is 120° BELOW ZERO?</p> <p>Let's see what happens when I put the probe into liquid nitrogen.</p>	
		Dip temp probe into LARGE GLASS DEWAR.
	It's settling down at minus 324° Fahrenheit. And that would be a warm day on Pluto!	
<p>Title Slide</p> 		
3. What happens to different materials?		
	<p>We've just had a successful flyby of Pluto and its moons by the New Horizons Spacecraft. But say we wanted to send rovers, or even a human mission as our next stage of exploration. Let's see what would happen to some equipment we might bring with us in this extreme cold environment</p>	
		Get out rubber ball from PURPLE TUB #1 and hold it up.

	Here's a rubber ball. It bounces great. You might think about using rubber like this in a space suit for gaskets around your helmet, or for rover tires, gloves or seals on the hatch. Let's see what happens if we make this as cold as Pluto.	Bounce Ball
	See how it's bubbling? You can tell when it's all the way cooled down because it stops bubbling.	Lower rubber ball into LARGE GLASS DEWAR
		Get out rubber tube from PURPLE TUB #1 and hold it up.
	You might need some flexible tubing, like this rubber tubing, to carry your oxygen in a space suit for instance. Let's see how it would do in a place like Pluto.	
		Wrap rubber hose into pretzel shape. Put rubber hose into LARGE GLASS DEWAR.
		Get out nylon webbing from PURPLE TUB #1 and hold it up
	Here is some nylon webbing, like you would use for camping or as a strap on your backpack. This could be used to help lift heavy samples or even as a fabric of a spacesuit. Let's see how this holds up.	
		Put webbing into LARGE GLASS DEWAR.
		Get protective shield and position it on the floor to protect against rubber ball shattering shards. (The metal plate should already be on the floor.)
	Let's see how this rubber ball does at Pluto temperatures. So far, so good. It's the same color; it's roughly the same shape and size...	Using tongs, remove the rubber ball and drop it on floor behind the protective shield. React to the shattered ball.
	You probably don't want to use this on your rover.	

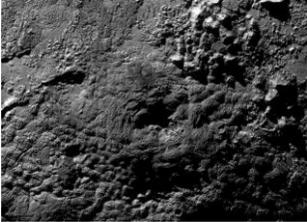
		<p>1) Replace protective shield into cart.</p> <p>2) Sweep pieces of shattered ball towards back of stage with your foot.</p> <p>3) OK to leave metal plate on the floor.</p>
	<p>Let's check out the rubber tubing.</p> <p>Look how stiff it is. Not very good if you need flexible tubing.</p>	Using tongs remove rubber tubing and show how stiff it is.
		Replace rubber hose into PURPLE TUB #1.
	Now let's check out the webbing.	Using tongs, remove webbing and show how it is still flexible and strong
		CUE – Webbing pic
<p>Nylon webbing</p> 	<p>It's cold, but it's still flexible and strong.</p> <p>So, why does this webbing stay strong?</p> <p>It's not because of the material itself, but because of the way it is woven together from tiny threads.</p> <p>For instance, if you took a thick piece of glass and tried to bend it, it would break. But if you took very thin threads of glass, in other words fiberglass, they would bend. The same is true with this webbing. It is not because nylon is so special. It is because the webbing is made up of thin nylon threads.</p> <p>Sometimes, instead of finding new materials, you have to think outside the box and come up with different way to use the materials that you already have.</p>	Set webbing back in PURPLE TUB #1
		CUE – Title slide
<p>Title Slide</p> 		Replace rubber hose into PURPLE TUB #1.

4. Machinery.		
	<p>If we were to send a lander to Pluto, we would probably need machines with moving parts. Let's do some experiments to see how they would stand up to the super cold temperatures of Pluto.</p>	
	<p>I'm going to use plastic containers for the liquid nitrogen instead of the glass one because we'll be using metal objects, and I don't want the glass to break.</p>	<ol style="list-style-type: none"> 1) Transfer PURPLE TUB #1 to storage cart. 2) Transfer PURPLE TUB # 2 to Demo table. 3) Transfer LARGE GLASS DEWAR to storage cart. 4) Transfer RED THERMOS JARS #1 and #2 to DEMO DESK. 5) You may need to even out the liquid nitrogen in the two thermos jars. 6) Pick up ball and ring from TUB #2.
	<p>Here is a ball and ring made out of brass. The ball just fits through the ring. Make believe it is an important piece of equipment. Maybe this is a door latch, and the metal ball is the key that stays in my heated spacesuit. It works perfectly here on Earth. But, we need to know if it will work when we get to Pluto.</p> <p>I'm going to put just the ring into liquid nitrogen to see what happens. We'll come back to it in a few minutes.</p>	<p>Demonstrate that the ball goes through the ring easily.</p>
		<p>Place the ring into the RED THERMOS # 1</p>
		<p>CUE – Bicycle bearing</p>
<p>Ball Bearings</p> 	<p>This spinner is made with a bearing, like you would find on your bicycle. It has small ball bearings and grease inside. It spins just fine. Make believe that this is part of a robot arm or rover wheels and it has to be able to turn easily.</p> <p>Let's cool it down to Pluto temperatures.</p>	<p>Spin the bearings.</p>

		Place bearings into RED THERMOS #2.
		CUE - Magnetic bearing
<p>Magnetic bearings</p> 	<p>Here is another kind of bearing. It is a magnetic bearing. It's just two magnetized ball bearings held together with a powerful magnetic field.</p> <p>I'll let that cool too and we'll come back to it.</p>	Hold up magnetic bearings and spin them.
		<p>1) Place magnetic bearings into RED THERMOS JAR #1.</p> <p>2) And at the same time, remove the brass ball from this THERMOS of liquid nitrogen.</p>
	<p>Let's go back and check out the ring. The ball won't go through because the super cold temperature made the metal shrink. Now the ring is too small to allow the ball to fit through it.</p> <p>Would this be a good design for machinery on Pluto? I don't think so.</p>	Demonstrate that the ball will not go through the ring.
		Place ball and ring back into PURPLE TUB #2
	What about the bicycle bearings?	
	<p>The grease in these bearings caused them to freeze up. Not good.</p> <p>You might think that to solve this problem you need to come up with a better lubricant. That's one approach. But that could take years to develop, and be very expensive. But what if you took a totally different approach? Let's see how that magnetic bearing is doing.</p>	<p>Remove the bicycle bearings and show that they're stiff.</p> <p>Place the bearings back into PURPLE TUB #2</p>
		Pick up the magnetic bearing and demonstrate that it still works.

	<p>It still spins great. That's because, even if the balls contract and get smaller, it doesn't matter, because they are only touching at one point and they are being held together by magnetism.</p> <p>It just goes to show you that sometimes the best way to solve your problem is to come up with a completely new idea. Now THAT'S creative thinking.</p>	
		CUE Pluto New Horizons Approach
5. Solid Nitrogen		
<p>Pluto during New Horizons Approach</p> 	<p>OK. Back to Pluto.</p> <p>Here's a series of images of Pluto taken by the New Horizons Spacecraft. As the spacecraft got closer and closer to the planet, we began to see more details.</p>	
		CUE Pluto Photo 2
<p>New Pluto Picture (will be updated semi-regularly as New Horizons sends back better images)</p>	<p>One thing that has become more obvious is that there are distinct light and dark areas on Pluto. Scientists believe that the lighter areas are ices that flow like a glacier. But this isn't water ice like the glaciers on Earth, these are glaciers made up of nitrogen, methane (natural gas), and other elements!</p>	
		CUE Artist's picture of Pluto
<p>Artist's view of Pluto's surface</p> 	<p>This is an artist's drawing of what is might be like on the surface of Pluto. That's Charon and another one of Pluto's moons in the background.</p> <p>The white ice, and potentially snow. But remember, it's not snow and ice made from water, its snow and ice made of nitrogen!</p> <p>Right now, I'm going to make solid nitrogen snow here in the lab.</p>	

	In order to cool the liquid nitrogen down to solid form, I will use a vacuum chamber.	<ol style="list-style-type: none"> 1). Get Video Camera from computer cart. 2) Transfer the vacuum jar and base plate to the demo cart. 3) Get vacuum hose from storage cart and attach it to the vacuum jar base plate.
	I'll use the camera so you can see it better.	<ol style="list-style-type: none"> 1) Focus TV Camera on dish. 2) CUE Video camera image on screens
<p>TV Camera image</p> 	[Describe exactly what you're doing here step by step.]	<ol style="list-style-type: none"> 1). Pour LIQUID NITROGEN into a Styrofoam dish. 2) Place the jar over the dish. 3) Turn on the vacuum pump.
	<p>The vacuum causes the liquid nitrogen to evaporate quickly, which cools it down. How many of you have been swimming on a hot day, gotten out of the pool and still been extremely cold? That is evaporative cooling, and is similar to what we are doing to cool down our liquid nitrogen to make solid nitrogen.</p> <p>Can you see the liquid nitrogen on the video screens?</p> <p>(Observe the first appearance of solid Nitrogen) You can see it turn to SOLID nitrogen snow. That's 346° below zero Fahrenheit.</p> <p>That's what the surface of Pluto is like!</p>	
	Watch what happens when I let some warm room air back in.	

		<ol style="list-style-type: none"> 1) Turn off pump. 2) Remove vacuum hose and let air back in. 3) Replace hose onto hook on storage cart.
		<ol style="list-style-type: none"> 1) Replace TV camera back on COMPUTER CART. 2) CUE Wright Mons Image
6. Geyser		
<p>Wright Mons on Pluto – A cryo-volcano</p> 	<p>Some scientists have <u>speculated</u> that Pluto may have cryo-geysers, like another cold body in our solar system-Neptune's moon Triton. They have hypothesized that this could be one possible fueling mechanism for Pluto's atmosphere.</p> <p><u>Geysers have not been yet observed on Pluto.</u> The closest thing we have seen are features like Wright Mons, shown here. Scientists are hypothesizing that these features might be cryovolcanos.</p> <p>So, for my final demonstration, let's see if I can make a liquid nitrogen geyser.</p>	<p>Indicate picture of geyser.</p>

		<p>1) Transfer GEYSER FLASK from STORAGE CART to DEMO DESK. You will need the rubber coaster to keep it from freezing to the desk.</p> <p>2) Remove rubber stopper from GEYSER FLASK.</p> <p>3) Place funnel into flask.</p> <p>4) Pour LIQUID NITROGEN into GEYSER FLASK.</p> <p>5) LOOSLEY replace rubber stopper into GEYSER FLASK.</p> <p><u>IT IS EXTREMELY IMPORTANT THAT THE STOPPER IS LOOSE IN THE FLASK.</u></p> <p>6) Align glass spout on GEYSER FLASK with GEYSER TUBE.</p>
		<p>1. Pick up GEYSER FLASK with both hands.</p> <p>2. Aim it away from the audience and yourself.</p> <p>3. Hold your finger over the glass spout.</p>
		<u>CUE</u> Music and Title Slide
<p>Title Slide</p> 	And that, Ladies and Gentlemen, is MISSION SUPERCHILL.	
		1) Put GEYSER FLASK onto DEMO DESK. Take Rubber Stopper out of GEYSER FLASK, and place in Funnel.

	<p>Thanks it for coming to see Mission Superchill. You are welcome to come up to ask questions, but for safety reasons, I will ask you not to come up onto the stage.</p> <p>Have a good visit in Space Odyssey and come back soon.</p>	<p>Walk to front of stage so that you are between audience and equipment and so you can keep people off of the stage if you need to.</p>
		<p>CUE Music and Title Slide OFF</p>
		<p>POST SHOW:</p> <ol style="list-style-type: none"> 1) Consolidate all Liquid Nitrogen into one RED THERMOS 2) Using funnel, pour any remaining Liquid Nitrogen back into Metal DEWAR backstage. 3) Place all props back in their places on the PROPS CART. 4) Reset stage to SPACE TODAY configuration, including the sign on the front of the DEMO DESK 5) LOG out of SUPERCHILL using the BLUE APPLE MENU on the left of the screen.