Surface Area – Stage Presentation
Science Museum of Minnesota
Running Time: 15 minutes

<u>Props:</u>

*** Five signs:**

1. **Surface Area is how much exposed area an object has.**
2. **Chemical reactions take place on the outside of objects.**
3. **The more outside you have, the more things can react.**
4. **The prefix "nano" simply means really, really, really small.**
5. **"How Tall Are You?" NISE Net nano height chart**

*** Silver box with Velcro pieces with pictures of the e coli bacteria, and two large foam/Velcro pieces**

*** Nano silver socks**

*** Glass graduated cylinders**

*** Two alka seltzer tablets**

*** Two small containers of water with green food coloring**

*** Steel bar**

*** Steel wool**

*** tongs**

*** 12-inch length of plastic tubing**

*** funnel**

*** spoon for lycopodium**

*** lycopodium**

*** alcohol burner**

*** matches/lighter**

*** sand bucket**

*** goggles**

Thank you all for coming out today! My name is _____ and today we're going to learn about Surface Area and chemical reactions and the science of small, but before we get too "talky" about things, I think we should start off with a fireball – what do you think? (pause for audience response) That's what I like to hear!

<u>Fireball 1 of 2</u>

I have here an alcohol burner. I am going to light my alcohol burner and here in this tube is something called Lycopodium. Now we're going to blow another fireball at the end and we'll talk more about Lycopodium then, but what I need to do now is make sure that everyone stays seated so that we don't end up with any flaming skeletons of visitors. If we have a deal, say, "deal!" (pause for audience response) Good! So then on the count of three – count with me – one, two, three (blow fireball). Now that is an example of a chemical reaction!

Definition of Surface Area

Surface area has a lot to do with chemical reactions. Surface area is how much exposed area an object has. And since chemical reactions take place between atoms on the surfaces of objects, the more outside you have, the more things can react. So for example, if you go to the beach in the summertime and spend too much time in the sun without enough sunblock, what happens? (wait for audience response) That's right – you get sunburned. Do you get sunburned on your lungs? (No!) Do you get sunburned on your kidneys? (No!) Do you get sunburned on your brain? (No!) No? – where DO you get sunburned? (On your skin!) That's right – on your skin. Your skin is your surface area.

So here's a little test: let's say I'm holding a watermelon in one of my hands, and I'm holding a grape in my other hand – which of these has more outside - more surface area? (watermelon!) That's right, the watermelon. Now let's say I have that same watermelon in one hand, and a giant bunch of grapes that is the same size of the watermelon – NOW which one has more surface area? (mixed answers) That's right – the bunch of grapes, because they have all those extra little outsides versus the watermelon's one big outside.

Intro to Nano

Now let's look at Nano for a minute. Has anyone here ever heard of nano? (raise your own hand to inspire others to give a show of hands) Good! Well, nano simply means really, really, really small! How small? In scientific terms of measurements, nano means "one billionth." So a nano-meter is a billion times smaller than a meter – which is about three feet, or (by holding out arms) from here to here. Well, it's kind of hard to imagine something that small, isn't it? So let's do this: hold a piece of your hair in between your fingers and feel how thin that is – that piece of hair is about 100,000 times wider than a nano-meter. Or, imagine a marble – now imagine the entire planet earth. A marble is a billion times smaller than the entire planet earth. So when we're talking about nanometers – we're talking about something REALLY small – so small you can't see it with your eyes or even a normal microscope. We have to use special tools that can feel things on the nanoscale.

Why does nano matter? Because materials on the nanoscale behave differently on the nanoscale than on the macroscale – the scale we see and interact with on a regular basis, and some in ways we've never expected. And scientists are using those unexpected properties to create new products or improve on old ones. For example, gold – what color is gold? That's right –

gold, or yellow. But in the nanoscale, gold can be a whole spectrum of colors, from red to blue, depending on its size and has been used for hundreds of years in stained glass windows. Or silver – is anyone here wearing anything silver? Yes, you all know what silver looks like. Well, silver is naturally antibacterial. But when you increase its surface area – and get it way down on the nanoscale, it is much, much more effective at killing germs.

<u>Nano Silver</u>

Here I have a box that's filled with little Velcro pieces with a picture of the e coli bacteria on them. E coli can sometimes be present in food and make you very sick if you ingest it. Now I also have these bigger foam pieces, and we're going to pretend that they're silver particles. How many sides does this big foam particle have? (mixed audience responses from zero to three) That's right – this has three sides – let's go ahead and count them – we've got two faces plus one edge, for a total of three. Now I'm going to place this particle in the box, close it up, and to complete this experiment, I need a volunteer from the audience. (choose someone with hand raised from the audience) Hi there– what is your name? (name given) Thanks for volunteering today ____. I want you to take this box and give it three good shakes, like this (demonstrate miming). Now your turn. Excellent. (while opening the box to

take out silver particle:) Let's see how many pieces of e coli bacteria we killed with our silver (hold up foam particle), ____, can you tell the audience about how many pieces that is? Just an estimate is fine. (usually about 10 pieces) Yes – 10 pieces looks about right. Everyone give ____ a round of applause, and ____ you can go ahead and take a seat.

Let's see what happens when we increase the surface area of that silver particle. I'm going to take the same size particle and break it down into smaller pieces. So if one of these pieces has five sides, and we have six pieces, that means we have 30 sides total, versus our original three. So again, we'll put these in the box and see what happens – and I'll need another volunteer (choose from raised hands). Hi there– what is your name? (name given) Thanks for volunteering today ____. So same as before - take this box and give it three good shakes, like this (demonstrate miming). Now your turn. Excellent. (while opening the box to take out silver particle:) Let's see how many pieces of e coli bacteria we killed with our silver (hold up foam particles), ____, can you tell the audience about how many pieces that is? Just an estimate is fine. (usually about 25-30 pieces) Yes – 30 pieces looks about right. Everyone give ____ a round of applause, and ____ you can go ahead

and take a seat. You can see that by increasing its surface area, we increased the effectiveness of the silver in killing the bacteria.

Nanotechnology exists and is being used to create new products. I have here two pairs of socks made by competing companies, and these socks have nano-sized particles of silver in them – the point of which is to keep your socks from getting really stinky when you go to the gym. Sounds like a good idea, right? (audience usually nods "yes") Well, maybe not. When you wash these in the washing machine, the silver nanoparticles wash off the socks and end up in the water. Then, because they're so small, they bypass any wastewater filters and ultimately end up in your rivers and streams. Now silver nanoparticles don't know good bacteria from bad bacteria – they just kill all bacteria. And the effects of those nanoparticles might work their way on up the food chain – we don't know yet, because it hasn't been studied enough. On the other hand, they're working on nanosilver water filters that can be used to provide third world nations with drinkable water for very low cost. So nanotechnology in itself is neither good nor bad, it's just what you do with it.

<u>Alka-Seltzer + Water</u>

Let's go back and take a look at another example of how surface area affects chemical reactions. Here are two graduated cylinders and two identically-sized tablets of Alka Seltzer. How many sides does this tablet of Alka Seltzer have? That's right – three. So I am going to take this whole piece and put it in this first cylinder. Now I have my second piece of Alka Seltzer, and the only thing I want to change about it is its surface area. Now how might I go about doing a thing like that? (answers vary from cut it in half to break it up to smash it) I think I'll go ahead and smash it with this rubber mallet. (pour the crushed tablet into the cylinder) How many sides does this tablet have? Yes, a LOT.

Based on what we learned with our silver nanoparticles over there – which of these cylinders will have the stronger, faster reaction? Raise your hand if you think it's the whole piece! Raise your hand if you think it's the crushed-up piece! I think you're right with the crushed-up piece, but let's test it to be sure. Here's a little water with some green food coloring in it, just so you can see it better in the back. (pour water into graduated cylinders)

As you can see, the crushed up piece is having a stronger, faster reaction. However, that also means that the reaction will die down faster. Who knows the story of the Tortoise and the Hare? – right, so this stronger faster one is like our hare, and the slow and steady one eventually winning the race is our tortoise. It's also like a campfire – who here likes to go camping? Yes, so you know that you can't just take a whole log, toss it in the firepit, throw a lit match at it and you have a fire, right? What do you need? (answers vary) Yes! You need kindling – those little pieces that can start the bigger pieces on fire. This crushed up piece is like our kindling, and this whole piece is like our big log that will burn all night.

<u>Steel Bar v. Steel Wool</u>

Speaking of fire, let's test the affect of surface area on flammability. This is a steel bar – it's very hard, I can't bend it. How many sides does this have? Yes, six – two faces plus four edges. What do you think will happen when I hold this over the flame for 10 seconds? (wait for responses – usually things like it'll melt, bend, get hot, etc.) Let's try it out! As you can see, nothing really happened. Sure, it got a little warm, but not hot – I can hold it on my face, that's how not-hot it is.

But what if we were to increase its surface area? (hold up the bar again) This is steel. (hold up the steel wool) This is also steel. Something better known as steel wool – your parents might keep it next to the kitchen sink to scrub out pots and pans and the like. This bar had how many sides? (six!) This piece of steel wool has how many sides? A LOT. And you can see that it almost looks like a cotton ball when I pull it apart – many, many strands of steel, many many sides.

Now let's hold this steel wool over the fire for ten seconds and see what happens. (start to count, but no need to bother finishing due to the immediate chemical reaction). As you can see, the steel wool is having an immediate chemical reaction – because chemical reactions take place between atoms on the surfaces of objects, and because this steel wool has so many more exposed surfaces than the bar of steel. And when you get steel down on the nanoscale, it's actually explosive. (extinguish steel wool in a sand bucket).

<u>Fireball 2 of 2</u>

And speaking of explosive, let's finish things off with one last fireball – shall we? I am filling this tube with something called Lycopodium. Lycopodium is

in the moss family and grows in forests around the world. It kind of looks like little baby ferns when you see it on the forest floor. The spores of lycopodium are so small that most of the atoms are on the outside, and therefore available to interact with the flame – creating a huge fireball.

We're going to blow this fireball on the count of three – count with me so you don't blink and miss it! One…two…three! [blow fireball] Thank you all for coming out to Surface Area – and if you'd like to see how tall YOU are in nanometers, come on up and give yourself a measure. Enjoy the rest of your day at the museum!