Wonders of Physics 2012

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Opening (Peter, Sprott, & Melissa):

(ON B) - ***RGB {T2_G1}: Intro PPT Slide Shows***
Audio: Science Songs
(ON A&C) - **Cameras 5 & 6: {Crowd Shots on A & C }**

{Mute all as Peter walks out}

Peter: Welcome to the (237, 238, 239, 240, 241, 242, 243, 244, 245, 246) presentation of *The Wonders of Physics*... Before the show begins, I would like to assure you that we make all of our demonstrations as safe as possible provided you remain in your seats.

Prof. Sprott has just returned from Northern Wisconsin where he was using his knowledge of physics to help the farmers improve their milk production, and he didn't have time to change into his usual formal attire. However, the show must go on, and so please give a welcome to that physicist of farming, that analyst of agronomy, that Houdini of horticulture, that Wizard of Wisconsin, Professor Clint Sprott....

Audio: WOP Theme-Short

{Sprott enters stage left in farm clothes with manure boots, a straw hat, and a pitchfork.}

(ON C) - ***RGB: {PPT SLIDE - The Wisconsin Idea Page}***

Sprott: Welcome to *The Wonders of Physics*. This is the year of the Wisconsin Idea at the University of Wisconsin. The Wisconsin Idea is that "the boundaries of the University are the boundaries of the State," or more generally that the research we do at the University should benefit society. And so I thought we should show you some of the many ways that physics has influenced your lives.

Sprott: An example is the weather. Accurate weather prediction would not be possible without computer models that rely on principles of physics. We can even warn when and where a tornado is likely to occur. Would you like to see me make a **tornado**? For this I will need a volunteer...

{Melissa (Breeden) from Chicago is planted in the audience and comes down to help demonstrate the fire tornado.}

Demo: {Fire Tornado}
Audio: Merry go Round
Audio: Ta-Da
{Just as the flame extinguishes, there is a loud noise and the lights go out.}
****
{FLASHY AND FAST --- LIGHTS OFF -- NOISE & GRAPHICS}

***** All Lights OFF *****

(ON A&C) - DVD Video: Twister

***** All Lights ON *****

{The lights come on a few seconds later. Sprott is gone}
{Melissa is sprawled on the floor near the Geyser or Mousetraps. She gets up in a daze and looks around.}
****

Melissa: I don't think I'm in Chicago anymore. Excuse me. Where am I?

Peter: Why, you're in the marvelous land of physics of course!

Melissa: The land of physics? How will I ever get back to Chicago?

Peter: Well, I have an idea of how we can get you back to Chicago. We can use balloons. Here I have two balloons.....
Demo: {Helium & Hydrogen Balloons }
.....{after hydrogen balloon explodes}...
Audio: Ta-Da
Ok, so maybe we won't use hydrogen balloons to get you back home.

The person who can help you get back home is The Wonderful Wizard of Wisc. He's

a big Green Bay Packers fan and a real cheesehead. If you follow the Yellow Cheese Road, that will lead you to the City of Green and Gold, where he can help you return home. But you must learn some physics along the way. And so off you go...

Melissa: Okay, wish me luck! I'll need it..

Audio: YellowBrickRoad

{Melissa exits stage left (with cheesehead? and music).}

Transportation (Mike Randall):

~~*RGB: {PPT SLIDES - of Wisconsin First's } (Create slide)*~~

Peter (narrating): There have been significant advances in transportation. Many of which have come from Wisconsin, including the first city-to-city auto race in the U.S., the first outboard engine, and the first snowmobile. Here to tell us more about the physics of transportation, is the "King" of transportation himself Mike Randall.

{Mike enters rear stage right, singing}

Audio: Lion

Mike R.: 'fi...'fi....were KIIIIIING....just KIIIIIIIING!

Mike R.: Physics is part of everyday life. It's the study of how things move, how they push and pull on each other, and how they exchange energy.

RGB: {PPT SLIDES - Newton } and leave up the whole time.

Mike R.: To get something moving, you have to push or pull on it. Physicists call that push or pull a FORCE. My favorite dead guy, **Sir Isaac Newton**, came up with three laws that describe how this works. Have you heard of the Three Laws of Motion?

{Audience interaction}

Mike R.: Let me demonstrate. I need three volunteers from the audience.

{Mike R. selects two large kids and one small kid from the audience, and has the two large kids sit down on a board}

Mike R.: Let's pretend these kids represent two large cheese wheels. Hey, we're in Wisconsin...

(ON A) - **Cameras 6: {Board}**

Mike R.: Everyone look...what are they doing?

{Audience: "Just sitting there"}

Mike R.: Right! Sir Isaac's First Law says that an object at rest stays at rest - UNLESS acted on by an unbalanced force. <Small child's name>, I want you to apply a force to these "cheese wheels" by pulling on this rope.

{Small child picks up rope handle and pulls. The board with the kids stays put}

Demo: {Board W/O Rollers}

Audio: Oh Dear!

Mike R.: Are you having any luck moving them?

{Audience: "No"}

Mike R.: (to small child) Who knew that cheese was so heavy? Anyway, the reason you couldn't move them is because the friction between the floor and the board is too great. Do you know what friction is?

{Audience interaction}

Mike R.: Friction is the force that opposes movement, by turning the energy of movement – or KINETIC ENERGY – into HEAT ENERGY. I'll show you: everyone, put your hands together. Now rub them like this.

{Mike R. encourages audience to rub their hands together.}

Demo: {Audience Hand Rubbing}

Mike R.: What do you notice?

{Audience: "My hands are getting warmer!"}

Mike R.: Right! Throughout history, people have been looking for ways to reduce friction. In ancient times, people solved this with rollers.

{Mike R. has the two large kids stand up, produces a set of rollers, sets the board on the rollers, then sits the kids back down on the board.}

Mike R.: (to small child) Give it another try.

{Small child picks up rope handle and pulls. The board with the two large kids rolls easily.}

Demo: {Board W/Rollers}
Audio: Ta-Da

Mike R.: Wow! That was amazing! You didn't have to pull very hard at all! The rollers greatly reduced the friction force, meaning you didn't have to use as much pulling force.

{Mike. R. thanks the kids, picks up the rollers and board, and sends the kids back into the audience.}

~~**Lectern Computer 1 {2012WOP-Slides.ppt}:** ***"Trans & forms of energy"***~~

Mike R.: Now, if you were trying to get somewhere, like the City of Green and Gold, you COULD use rollers. But they're a bit old-fashioned. There are LOTS of other ways you can reduce friction. You could ride a bike, use roller skates, ski… But what if you were tired? All those things sound like hard work!

~~***RGB: {PPT SLIDE - Tranportation and forms of energy ??? }***~~

Mike R.: Well, who said that the forces used in transportation had to come from YOU? Sir Isaac's Second Law says that to make something accelerate - or go faster - you need to increase the force, or decrease the mass - mass is the amount of stuff there is in something. **Throughout history**, people have been using OTHER forms of energy to move them around. Horses can pull carts. Wind can push the sails on boats. Do you know how a car engine works?

{Audience interaction}

Mike R.: Let me demonstrate. You car engine uses fuel, like gasoline, or this - ETHANOL. Fuel is sprayed into a cylinder - kinda like this bottle - and ignited with a spark. Like from this Tesla Coil.

{Mike. R. shows how the spark from the Tesla Coil leaps over to a fluorescent tube, lighting it up}

Mike R.: The burning fuel makes a small explosion, which pushes up on a piston with tremendous FORCE. This cork will represent the piston in your car engine. Ready? 3...2...1...

Demo: {Small Ethanol Bottle w/Tesla Coil}

{Mike. R. sparks the bottle, causing an explosion that shoots the cork into the air.}

Audio: Ta-Da

Mike R.: Did you see the cork fly? What you may not have realized is, as the cork was pushed UP, the bottle was pushed DOWN. Newton's Third Laws says that, for every action, there is an equal and OPPOSITE REACTION.

{Melissa enters stage right.}
{Melissa spots Mike, and goes over to talk with him.}

Melissa: Excuse me....

{Mike jumps back in surprise}

Mike R.: AAAAAGGGHHH! Oh my gosh.... You scared the DAYLIGHTS out of me!

Melissa: I'm sorry. I didn't mean to.

Mike R.: That's OK. It's not your fault. We physicists sometimes get lost in our thoughts. My name is Mike Randall. Who are you?

Melissa: My name is Melissa, and I'm trying to find The Wizard of Wisc.

(ON B) - RGB LecC1: {PPT SLIDE - Airplane}

Mike R.: Hi Melissa, I'm Mike. I know the Wizard! Did you know that he is an **airplane pilot (slide),** and so you might look for him at the airport.

Melissa: But I'm exhausted! I've been walking for hours. I think I turned my ankle when my heel got caught in the Swiss. *(pause)* There's GOT to be an easier way to get to the City of Green and Gold!

Mike R.: Maybe I can help you there too! Using my knowledge of physics I built a hovercraft. The hovercraft floats on a thin cushion of air, so there's very little friction. It's propelled by a fire extinguisher: by Newton's Third Law, as the gas rushes backward, the hovercraft should move forward! But...I haven't had enough courage to try it....

Melissa: (ignoring Mike R.) This is AMAZING! This hovercraft will get me to the Green and Gold City in no time!

{* HEAT UP THE GEYSER ****} start time may need adjusting..**

Mike R.: Uhh…I'm not sure…

Melissa: Thanks for your help. Bye!

{Melissa flies hovercraft off stage left. A loud crash is heard. }

Demo: {Hovercraft}

Audio: YellowBrickRoad

Audio: Crash

Mike R.: Well, I guess physics isn't a substitute for driving lessons.

{Mike R. exits stage right.}

Audio: Ta-Da-Proud

(? ON C ?) - **Camera #1 or #2: "On the top of the Geyser"**

Environment (Marty Lichtman):

Peter (***narrating***) There have been many pioneering environmental ideas from Wisconsin.

(ON B) - *RGB LecC1: {PPT SLIDE - Limnology }*
(ON B) - *RGB LecC1: {PPT SLIDE - John Muir}*

Peter (***narrating***) For example, right here at the University of Wisconsin we started the first ever Department of **Limnology**, which is the study of freshwater lakes. And **John Muir,** the famous conservationist and "Father of the National Park Service" attended UW-Madison. Here to explain some aspects of physics in the environment, is our environmentally friendly Marty Lichtman.

Audio: Brain
{Marty is dressed as a scarecrow in a labcoat.}

Marty: Our environment consists of the elements and life that surround us, and also the flow of energy through that system. Within the Earth itself there are many radioactive elements, such as uranium, whose decay releases heat.

(ON A) - **Cameras 6: {Geiger Counter}**
Demo: {Radioactive samples and Geiger Counter}

Marty: The heat from radioactive decay maintains a layer of molten rock, called magma, underneath the Earth's crust. But sometimes we see that heat at the surface. One way is in the explosion of a geyser. I happen to have a model of a geyser here.

(ON B) - *RGB LecC1: {PPT SLIDE - Geyser}*
Demo: {Model Geyser}
Audio: Ta-Da

Marty: A geyser forms when magma heats water from below. If the plumbing for the water is narrow and constricted, then the hot water is trapped below the cooler water. The water at the bottom heat and heats and heats. Under pressure it can reach far above the normal boiling point of water. We call it superheated. But eventually it boils into steam. As some of it becomes steam and begins to rise, it release the pressure on the water, and it all goes at once. This explosion forces the water out the top of the plumbing, making a geyser!

Marty: We're going to heat up this water in this tube and simulate a geyser! We'll hear more from this later.

(ON A) - **Cameras T2V1: {IR Camera}**
Demo: {IR Camera}
Demo: {Greenhouse Effect Aquariums}

Marty: Another source of heat, far larger and more powerful than the Earth's core, is the sun. The sun's radiation heats the Earth's surface during the day. Then the during the night,

the dark side of the Earth releases that energy. This cycle repeats again and again, hopefully returning to its same state. But this cycle can be disrupted by something we call the greenhouse effect.

Marty: The piece of metal just melted! Not as hot as magma though: Gallium has a melting point of only 30 degrees Celcius, which is above room temperture, but less than human body temperture. How come one melted first? What's the difference?

Marty: Well, I have a secret, I've filled one aquarium with a heavy gas called sulfur hexafluoride, or SF6. It's five times as dense as air so the SF6 sinks and stays in the aquarium.

Marty: The SF6 absorbs infra-red radiation, that's electromagnetic radiation of slightly longer wavelength than visible light. So you'd think it would actually keep the cheese cooler. But the visible light still gets in, it gets absorbed by the cheese and the bottom. Then the cheese re-emits light. We can't see it, because it re-emits it in the infra-red. But since the SF6 reflects infra-red, that energy can't get out. Visible light keeps entering and adding energy to the cheese, and then that energy can't leave. Just like how glass on a greenhouse keeps heat in.

Audio: Ta-Da (After the use of the IR Camera)

Marty: The cheese is emitting light? Sure it is. Infra-red radiation is part of the same electromagnetic spectrum as visible light. It's wavelength is just slightly too long for our eyes to detect.

***(ON A) -* Cameras ##: {Rainbow}**
***(ON C) -* Cameras 6: {Meter}**
Demo: {Carbon Arc-lamp Blackbody and Prism}
Audio: Ta-Da ???

{Melissa enters.}

Marty: Look, we can make a paper boat and float it on top because the air inside the boat is lighter than the SF6 that it displaces.

{Buoyancy}
Demo: {Floating a Balloon or Boat on SF6}

Marty: And what if I dip my head in and take a breath?

Demo: {Breathing SF6}
Audio: Ta-Da

Marty: "Let the beat drop!"

Marty: The velocity of sound in the SF6 is 44% of that in air. The speed of sound in SF6 is slower, causing my nasal cavity to resonate at lower frequencies. It's the exact opposite of what happens when you breath helium!

{Melissa breathes helium.}
Demo: {Breathing He}

Audio: munchkin laugh
Melissa: Can you tell me how to get to the Wizard of Wisc?

Marty: Wow, and your voice sounded higher because the speed of sound in helium is 3 times higher than in air, creating shorter wavelength resonances in your nasal cavity. You know, we can easily see the speed of sound.
***(ON B) -* RGB - T3C1: {O-Scope}**
Demo: {Speed of Sound w/scope}
Audio: Ta-Da

Melissa: So, how will this help me find the Wizard of Wisc?

Marty: SF6 is fun to play with, but it isn't the only greenhouse gas. Much more common are chlorofluorocarbons, methane, and especially carbon dioxide. It's because of the carbon dioxide that we're all trying to reduce our carbon footprints. The Wizard of Wisc likes to ride his bicycle (PPT **slide**) to reduce his carbon footprint. Here, take his rocket powered tricycle powered by two carbon dioxide fire extinguishers, and maybe you can catch him.

Melissa: Which way do I go?

Marty: I think it's this way. Or that way! ***{Marty makes crossed scarecrow arms.}*** Good luck!

(ON B) - RGB LecC1: {PPT SLIDE - Sprott on Bike}
Demo: {CO2 Rocket Tricycle}
{Melissa rides out stage left on the rocketcycle, and Marty exits stage right.}
Audio: YellowBrickRoad

Energy (Kenny Rudinger):

Peter: Energy is another area that physics has greatly influenced. Here at the physics department we have been operating a fusion research experiment funded by the Department of Energy in hopes that one day it will give us a sustainable clean energy source. Now, here to talk to us about the physics of energy is the electrifying Kenny Rudinger!

Audio: TurbineStartup-8s.wav
***(ON A) -* Cameras 6: {Board}**
***(ON C) -* Cameras 5: {Bike}**
Demo: {Exercise Bike w/incandescent}

Kenny: Well, I have some light bulbs here that I want to turn on. Normally, we turn a light bulb on just by throwing a switch, which allows electricity to flow through the bulb. That electricity has to come from somewhere, though, and usually it comes from a power plant, which can be many miles away.

However, that electricity doesn't have to be generated at a power plant. We can make it ourselves! Let's take a look at this bicycle.

Now, a bicycle is a clever machine that uses the power you generate with your legs to make the bicycle wheels rotate, making you and the bicycle move. However, we've taken this bicycle and modified it.

Who likes to ride bikes? Who would like to help me with this bike?
{Audience member is selected; they are instructed to start pedalling}
And your name is?

Kenny: Instead of powering yourself down the road, you're powering the lights! In this bike is a device called a hub dynamo, which is a kind of electric generator. It coverts the mechanical energy of your legs pedalling into electrical power, so electricity flows through the incandescent light bulb, making it glow.

Audio: Ta-Da

Kenny: This is all a lot of work, huh? However, I bet we can get a lot more light without having to work any harder.

{Kenny switches bike to LED mode)
Demo: {Exercise Bike w/LED}

{Audience member Leaves - Thank you!}
Audio: Ta-Da-Proud

Kenny: What's happened? The light is so much brighter, even though we don't have to work any harder! Instead of using an old incandescent bulb, we've switched to an LED, or

light-emitting diode. When we used the incandescent bulb, only a very small amount of the electrical energy went to lighting up the bulb; most of the energy was lost to heating up the bulb.

Kenny: Now, LEDs are much more *efficient* at converting electrical energy into light. That's why they're so much brighter, but we don't have to work any harder. It's the same reason people today are switching from incandescent bulbs to compact fluorescent bulbs; the fluorescent lights are more efficient than the incandescent bulbs, so using them saves energy and money!

Melissa: What are all these mouse traps and ping pong balls for?

Kenny: That's a great question! There are many different ways to generate power. We just saw one way with our bicycle. This device is going to demonstrate another way we can generate power. We call this box a mouse trap chain reactor. This is called one and this device will demonstrate and one of them is called *nuclear fission*; this device is going to model that for us. Before I can explain how this device works, I need to tell you about atoms and fission.

An atom is a very tiny building blocks that make up all the matter that we see. Each atom is made up of particles called protons, neutrons, and electrons. ***{Atomic graphic}*** We see that the center, or *nucleus* of an atom is made up of protons and neutrons, while the electrons surround the nucleus.

If a neutron hits an atom, it can cause it to split apart, releasing energy. In a chain reaction, a very large number of atoms split, or undergo what's called *nuclear fission*. This is the principle behind nuclear reactors, which we use as power plants. ***{Nuclear power plant graphic}***

Melissa: Nuclear fission.. is that what makes soda fizzy too?

Kenny: Not exactly. We're going to model such a chain reaction with this mousetrap chain reactor. Each mousetrap in this box represents an atom. Each mousetrap is set with a ping pong ball, which represents a neutron. When a trap goes off, that represents an atom undergoing nuclear fission in which a neutron, or ping pong ball, are ejected. Each ping pong ball will fly off and hit another trap, setting it off. This represents neutrons hitting other atoms and causing them to split as well. We're going to set off the chain reaction with just a single ping pong ball, and we'll be able to see all the energy that we can release. Now, it's going to happen pretty quickly, so watch closely.

(ON C) - **Cameras 6: {Traps}**
Demo: {Mouse Trap Chain Reactor}
Audio: Ta-Da

Melissa: Wow!
Kenny: Let's see that again!

(ON C) - ***DVD Video: Slow Motion Capture of Reactor***

{At some point, Melissa enters stage right and interacts with Kenny.}

Kenny: Another type of nuclear energy under development here at the University of Wisconsin is controlled nuclear fusion. The Wizard of Wisc used to work on it. Look for a very large aluminum doughnut (**slide**), called the Madison Symmetric Torus, and he will probably be somewhere nearby.

(ON B) - ***RGB LecC1: {PPT SLIDE - MST}***

Melissa: I'll keep an eye out for that, how hard can it be to find, right? Thank you!

{Melissa exits stage left, and Kenny exits stage right.}

Audio: YellowBrickRoad - Exit mix

Communications (Michael Winokur & Paul Nonn):

Audio: crickets.wav

??RGB: {PPT SLIDE - more Wisc First's} {Next 4 Slides}
{Peter taps the microphone with his finger feigning similarity with the well known Verizon commercial }

Peter: (walking in with my cell phone) "Can you hear me now?"....."Can you hear me now?".....Can you hear me now?" Well there have been many advances in communication over the recent years. How many people remember having a phone with that funny cord attached to it? How many of you remember having to crank the handle on your phone? Now we have cell phones and two way radios. Here to demonstrate the role physics plays in communications is our "5G Professor" Michael Winokur.

Audio: Osc-7s.wav

Please give a warm welcome to Professor Winokur.....(a pause)....Professor Winokur?
{Pete goes out looking for Michael while Michael pushes Paul Nonn (alias the Tin Man) on a cart along the yellow cheese road under the Telsa Coil). The main result of the Tesla Coil is the production of light, electricity and sound all important elements in communication technology. }

Michael W.: Sorry Pete.....Pete.....Pete.....oh, well. He'll figure it out.
So I found this standing out on the yellow cheese road and it seems appropriate that we should try and communicate with him....and find out why he's here and what he's about.
{Michael wheels Paul over, talks to the audience & sets Paul under the Tesla coil.}

Michael W.: Communication really only requires the manipulation of energy. As a first attempt we'll try waking him with some directed energy from that Tesla coil over there.
{to the audience}
I suppose some of you have seen one of these before.....just so you know my CPR training is still up to date

(ON B) - RGB LecC1: {PPT SLIDE - Of Tesla}
Demo: {Large Tesla coil}
{Paul becomes the human lightning rod for all to see.}
Audio: Ta-Da

Paul: Thanks, I needed that.
Michael W.: It talks, great, now we can communicate!
Paul: Sorry, with all this excess energy, I can't just stand around talking all day...gotta go!
Michael W.: Well, that was pretty heartless of him....
Paul: But not for long!
Michael W.: If he'd stayed I could have told him that communication often involves energy as **sound** or l**ight**, two things that this Tesla coil produces. But we really need to control it better. For this we need three things:
1. Create a disturbance
2. Direct that energy over a distance

3. Maintain the signal even if there is noise.

I'll talk about sound first.
Sound is created by "pushing" the air molecules together and then pulling them apart.

For example we can use this piston, just like a bicycle pump, to **compress** (squeeze the air molecules closer together) or **rarefy** (move the molecules farther apart) the air.

This pressure gauge keeps track; when the molecules get closer the pressure goes up and when they move further apart the pressure drops.

The display above shows the pressure.
{Michael pushes down and holds it there}
Michael: When I pushed down the pressure went up. Now to lift up.
{Michael pull up and holds it there}
Michael: See the pressure decreases.
To make a real sound that can be heard we just have to do this about a hundred times every second. But that's not easy with your hand.

(ON B) - RGB T3C2: {Pasco Computer}
(ON A) - Camera #6: "On Piston"
Demo: {Pasco Piston w/Pressure }
Audio: Ta-Da
{Michael pushes and pulls as fast as he can}
Michael: Now to direct this energy. This slinky shows a "longitudinal" wave moving along a soft spring (just like sound in air). Notice that coils alternately move close together and then farther apart transferring the energy the energy of motion along.

Did you hear that that?
Of course not, it was too slow!
(ON A&C) - Camera T3V1: "On Slinky"
Demo: {Slinky}
Audio: Ta-Da

Michael: To "see" the sound wave energy we will form a "standing wave" inside this tube filled with cork dust. You have to look carefully but the cork dust moves really fast where the pressure is low and slowly where the pressure is high. I just have to turn on the speaker. (Michael explains speaker pitch off the cuff, not too hot and not too cold)
{Set Frequency Meter to "A"}
(ON A&C) - Camera ????: "On Tube"
Demo: {Kundt's Tube w/Speaker}
Audio: Ooo..Wow {Ooh..aahh.}

Michael: Finally we need to transfer the sound energy a long, long distance....say across the room....even when everyone else in the room is talking (like at party). And while this

happens I will need a volunteer on the first row to speak the magic message hidden in this envelop.

{Sound clip of a party happening while voluteer says "I like physics" and then silence.}

Audio: (AUDIENCE)

Someone: {I like physics.....I like physics.....I like physics}

{While this is happening someone is unrolling the orange sound tube...top down.}

So did anyone in the back row hear that?

I didn't think so.

Let's try it again but now with a device that keeps the sound energy confined, just like the tube. That orange one looks likes a huge Kraft macaroni & cheese noodle.

Would someone on top row please listen into the cheese tube while we try it again.

{Party noises again as volunteer listens to the magic message}

Audio: (AUDIENCE)

Demo: {Whisper Tube}

Someone: {I like physics.....I like physics.....I like physics}

Michael: (To the the volunteer) So can you tell us what you heard?

Audio: Ta-Da

Michael: Ad lib to audience.

We'll leave the sound tube out for kids to play with after the show.

Now for really long distances sound travels too slow. A one word phone call to California would take four hours...

But light energy travels about a million times faster. We just need to control it the same way but with a light pipe instead of a sound pipe.

Here the physics of **refraction** and **reflection** allows us to redirect laser light. This plastic bar shows that if the light beam has the proper angles then the physics of **refraction** and **reflection** directs all of light energy into the bar,

(ON A&C) - **Camera T3V1: "On Plastic Bar"**

Demo: {Reflection/Refraction Demo}

Audio: Ooh..aahh.

Michael: This is just how "fiber optic" communications work.

Michael: But physics allows us to transfer energy of any type.

I would like to end by transferring the Tesla coil's energy through the air in order to light up this fluorescent bulb. Would someone in the first row like to hold it?

{Michael hands out fluorescent tubes to near by audience and asks room to be quiet}

***** All Lights OFF *****

Demo: { Tesla coil - lights light bulb}

Audio: Ta-Da

***** All Lights ON *****

Melissa: I heard a loud sound, did I miss anything?

Michael W.: Oh, just our study of communication and physics.
Melissa: Would that help me find the wizard of Wisc?
(ON B) - RGB LecC1: {PPT SLIDES - Sprott w/Radio}
Michael W.: Sure, that's easy! The Wizard of Wisc is an amateur radio operator (**slide**). I'll use this radio to send out radio waves and see if we can contact him... **{tunes the dial}**
Audio: **Morse code sound**
"Wiskey Nine Alpha Victor, Wiskey Nine Alpha Victor, are you there?"...
I guess not, but you might look for him in a house with a very tall antenna on the roof (**slide**).
(ON B) - RGB LecC1: {PPT SLIDES - Sprott w/Radio}
Melissa: Well then, I'll look, see you later....
{Melissa exits stage left, and Michael exits stage right.}
Audio: YellowBrickRoad - Exit mix

Military (Blaine Law):

{Peter introduces Blaine as General Relativity, who explains and demonstrates how physics has influenced the military.}

Peter: The military isn't something that usually comes to mind when we think of physics. But being an old navy sailor I can tell you how important it was that my 100,000 ton aircraft carrier stayed afloat. Here to explain more on how physics has influenced the military is our own General of Relativity, Blaine Law.

Audio: MilitaryCadence-7s.wav

Blaine: Thank you, soldier. Dismissed! I'd like to show you how physics has influenced the military. One of the first ways was in the science of ballistics, or the way that projectiles move. Earlier today I caught a flying monkey sneaking around in here, no doubt trying to steal army secrets! To show you how ballistics work, I'm going to place the monkey up here. I've set up a small cannon that will launch monkey food at him, and I want to see if he will catch it. However, I know that when the cannon goes off it will startle the monkey, and he will fall off the post. I'm an expert shot, and I'm going to aim right at him. Since we know that he will fall down, do you think the food will pass under him or sail over him? Let's find out!

Demo: {Monkey & Coconut}
~~***Audio: Oz-Flying Monkeys {Can't Find it}***~~
(ON B) - RGB LecC1: {PPT SLIDES - Flying Monkey photo ??}
Audio: Ta-Da

A direct hit! How did I know to aim right at him, instead of under him? The answer is gravity. Gravity is pulling the monkey down with the same force that pulls on the monkey food; this means that the monkey and the food are falling at the same rate. I could fire the ball a little faster or slower, and it would still hit. This is because motion in the horizontal and vertical directions are independent of each other. Knowing this made cannons a lot better!

The military led the way in advances in radar technology too.
Demo: {Doppler Ball Effect}
To demonstrate radar, I'll activate a sound switch on this ball. Can you hear that? It's a steady tone right? But now I'm going to spin the ball around over my head. What do you hear? The pitch rises and falls as it goes around!

This is the same thing that happens when a fast car goes by;
Audio: Doppler Car Horn

The pitch sounds goes higher as it gets closer to you and lower as it travels away. This

is called the **Doppler effect**, and

(ON B) - ***RGB LecC1:{PPT SLIDES - of Doppler}***

it's used in radar to correct for objects in motion relative to each other. The radar sends out a signal, and then "listens" for the signal to bounce off anything and return. Correcting
for Doppler shift allows us to know the speed, size, and distance from other objects very accurately.

I love cannons, and I have one bigger than my monkey food launcher. Would anyone like to see me fire it? I'd like to demonstrate recoil for you. Be careful to watch the cannon during this demonstration!

(ON A&C) - **Camera #5: "On Cannon"**

Demo: {LN2 Cannon - recoil}

Audio: Ta-Da

Did you notice the cannon rolled backward? This is because every action has an equal and opposite action. So the action that pushes the shell forward out of the cannon also pushes the cannon backward. Since the cannon is much more massive than the shell, it doesn't travel nearly as far.

{Melissa enters}

Blaine: And just what do you think you're doing here? Do you have a security clearance little lady?

Melissa: A what? I'm looking for the Wizard of Wisc. I've been making my way to the City of Green and Gold.

Blaine: Well maybe we could use a cannon to get you there! I'm sure I have one big enough some where- I'll go get it now! {wanders off stage right while mumbling excitedly}

Melissa: Oh, my gosh, I think I'll just walk!

{Melissa exits stage left}

Audio: YellowBrickRoad - Exit mix

Medicine (Amy Lowitz):

Peter: How many of you have had an xray or mri? Recently we have had major advances in the medical industry due to physics research. Here to tell us more about how physics has contributed to the field of medicine is our (magical medic?) Amy Lowitz.

Amy: fiddling with some part of an experiment, notices audience) Oh! Hello there! I was just working on some research I've been doing for the Wizard. He's very interested in how physics can help doctors diagnose and treat patients, you see.

{Set Frequency meter to "B"}

For example, did you know that waves can be used in all sorts of ways in medicine? Take sound for instance; sound is made of waves that travel through the air and into your ears. Most healthy children can hear sound frequencies from about 20 Hz to about 20,000 Hz. That's 20,000 waves hitting your hear every single second! But as we age, we lose our ability to hear the highest frequencies.

{have everyone raise their hands, lower hands when they can't hear the sound anymore}

Demo: {Range of Hearing}
Audio: Ta-Da

Amy: That's right, even though some of you couldn't hear it, the sound was still there. Can any of you name something that makes a sound that humans can't hear?

Demo: {Dog Whistle}
{Possible addition!!! Let me know ASAP}
Audio: Dino - Barking

Amy: There goes Toto!

Amy: But waves aren't just for sound... they can do work too. I have here an ultrasonic cleaner...really it's just a pot of water that shakes back and forth at very high frequency. The vibrations are so small and so fast that you can't see them from far away, but you can certainly see the effect they have on this bottle of carbonated water:

(ON A) - **Camera #6: "Cleaner"**
Demo: {Ultrasonic Cleaner}
Audio: Ta-Da

Amy: Well that's a lot of fun, but not so useful. One of the most important uses of waves in medicine is in medical imaging; that's using waves to take pictures of your insides. Two common ways to do this are with x-rays and ultrasounds. Ultrasounds are used for checking on babies before they're born, seeing and diagnosing problems with muscles and tendons, and even sometimes for cleaning teeth!

Ultrasounds rely on the fact that waves change speed and wavelength when they pass from one medium to another. On an ultrasound, that shows up as a color change, but

we can see it here on this wave table:
Demo: {Torsion Waveboards}
Audio: Ta-Da ??
{Melissa wanders in just as the wave table demo is ending}

Amy: Oh, hello! I was just explaining to these fine folks how waves are used in medicine.

Melissa: That's interesting and all, but I'm trying to get to the Wizard, and I still don't even know how I'm going to get into his house!

Amy: Ah, *that* I can help you with. You see, I happen to know that a key to the wizard's house is hidden in one of these blocks of cheese. Maybe we can use this x-ray machine to find it!

(ON A) - **Camera T3V2: "On X-Ray Machine Screen"**
(ON C) - **Camera #6: "On X-Ray Machine"**
Demo: {X-Ray Machine}
{we find a mouse in the cheese instead of a key}
Audio: Mouse Squeaking
Audio: Ta-Da

Amy: Hmm... that's not going to help you get into the wizard's house. Let's try the ultrasound.

(ON B) - ***RGB T2C1:{Ultrasound laptop}***
Demo: {Ultrasound Computer of Cheese}
{we find the key and pull it out of the cheese}
Audio: Ta-Da

Amy: … There's the key to the Wizard's house! I knew it had to be around here somewhere. The Wizard of Wisc has been experimenting with ways to use physics to transport his body across empty space. I think his laboratory is just ahead...

Melissa: Transport his body across empty space! Oh boy..
Audio: Ta-Da-Proud
{Amy exits stage right while Melissa walks toward the curtain at stage left.
{It would be great if we could get the key to actually open the curtains}

Closing (Sprott & Melissa):

***** All Lights OFF or at LOW setting with spot on Melissa*****
{The curtain parts, revealing Sprott's upper body in the mirror.}
Demo: {Pepper's Ghost}

Sprott: The Wizard - The Wizard - The Great and Powerful Wizard of Wisc. I can make myself disappear, and I can make myself reappear. And who are you?

Melissa: I'm Melissa, and I'm trying to get back to Chicago.

Sprott: That's no problem. I've been to Chicago many times and can easily take you there. But with your knowledge of physics, you should be able to go anywhere you wish without my help.

{Melissa steps forward and notices Sprott.}

Melissa: Why, you're Professor Sprott!

Sprott: Pay no attention to the man in the box. ***{Sprott stands up.}***

Melissa: You were playing a trick on us. We were seeing your reflection in this piece of plastic. And you were controlling the lights to make yourself appear and disappear.

Sprott: I see you have learned some physics. This is called the Pepper's Ghost illusion, and it's often used by magicians, but it's not magic; it's physics! I hope we have convinced you that physics is everywhere, and you use it every day.

And now I would like to end the show with one last demonstration, but before I do that, I want to acknowledge Prof. Jim Latimer
(ON B) - RGB LecC1: {PPT SLIDES - of Jim Latimer}
who in collaboration with Frank Ferriano has written yet another version of our theme music that was premiered by the Capitol City Band here in Madison last summer. It runs about three minutes, and we will play it at the conclusion of the show.

We began the show with a tornado, and I would like to end by making for you a cloud...
Demo: {LN2 Cloud}
(ON B) - RGB LecC1: {PPT SLIDES - Thank You}
(ON A&C) - DVD Video: Theme music video Audio: Science Songs

{The show concludes with Sprott disappearing in the Liquid Nitrogen Cloud. Theme music video plays. Cast enters stage right and bows in unison.}

Miscellaneous Notes:

*See **list of demos** we have done in previous years for other ideas*

*See the **movie script** for The Wizard of Oz*

Old Power Point Slide Shows:

- ***2011wop-slides.ppt***
- ***ShowPromos08.ppt***
- ***wop09_powerpoint.ppt***

Cast and Microphone schedule

Sprott - Wizard of Wisc - Mic #3
Peter - MC - Mic #2
Melissa - Mic #1
Mike - Lion - Mic #4
Marty - Scarecrow - Mic #3 (Sprott's Mic)
Kenny - Mic #4 (Mike's Mic)
Michael - Mic #4 (very tight transfer of Mic required)
Paul - Tin Man - Mic #3 (Marty's Mic)
Blaine - Gatekeeper - Mic #3 (Paul's Mic)
Amy - Mic #4 (Michael's Mic - coordinate with Tara)
Sprott - Wizard of Wisc - Mic #3 (Blaine's Mic)