# The Wonders of Physics 2023

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# Goals:

1. Honor the life of Peter Weix
2. Return to our pre-COVID form
3. Celebrate 40 years of shows
4. Remind the current cast of the history
5. Let our fans know what is happening
6. Formally hand over the torch
7. Provide a sense of closure for Sprott

# Premise:

The Physics Department is fed up with Prof. Sprott's tomfoolery and is interviewing candidates for his replacement. Each candidate will do three or four of their favorite demos.

# Demo List - UPDATE AS YOU GO:

Interviewer (Opening) 10 min

Applicant #1 (Mike Randall) 10 min
- Van de Graaff
- Hovercraft
- Hydrogen balloons

Applicant #2 (Michael Winokur) 10 min
- Methane Bubbles
- Bed of Nails
- Fire Tornado
- Exploding Foil

Applicant #3 (Terry Craney) 10 min
- Electromagnetic induction -
    - Simple generator,
    - Guillotine,
    - Magnetic vs. steel ball copper tube race (Audience participation)
- Heat transfer by conduction and heat capacity (Specific Heat) -
    - Boiling water in a paper cup,
    - Burning handkerchief

Applicant #4 (Grad students) 10 min
- Tesla Coil
- Bowling Ball Pendulum
- Vortex Cannon
- Nitrogen Cannon?

Applicant #5 (Haddie) 10 min
- Faraday Cage
- Inertia (tablecloth)
- Index of Refraction
- Nitrogen Cannon (if time allows)
- Ping Pong Cannon

Sprott (Closing) 5 min
- Liquid Nitrogen Cloud

# The Wonders of Physics 2023

## ***Opening*** **( Mark [Mic #1] )**

***Lights: Main Lights only***
***Audio: Science Songs***
***(ON A&C) - Cameras {Crowd Shots on A & C }***
***(ON B) -** RGB **{T1 Computer 1}: PPT intro (Who will prepare this?)***
***Lights: Change to Stage & Floods***

**Mark:** Welcome to the (333, 334, 335, 336, 337, 338, 339, 340) presentation of *The Wonders of Physics*... Before the show begins, I want to assure you we make all our demonstrations as safe as possible provided you remain in your seats. ***(Last day only: You will also notice that we are videorecording the show. If you don't want to appear on the video or want your children to appear, don't volunteer for any of the demonstrations.)***

**Mark:** I'm Mark Eriksson, Chair of the Department of Physics. As you probably know, Prof. Sprott has been doing these shows for 40 years, and the Physics Department is finally fed up with his tomfoolery and has decided that he must be replaced. Physics is a serious endeavor and not something to be made fun of. So today we'll be interviewing candidates to replace him. But before doing that, let me remind you of some of the crazy things he's done over the years:

1. There was that time he put our new Chancellor, Donna Shalala, in the Faraday cage and nearly electrocuted her with the million volt Tesla coil:

***(ON B) - {Lectern Computer 1 - PPT Slide #?}:*** 2023-1.mp4 ***[5s - shorten]***

2. And who can forget when he decided to build a time machine and go back to the first show he ever did, but it went too far back and found a young version of himself:

***(ON B) - {Lectern Computer 1 - PPT Slide #?}:*** 2023-2.mp4 ***[1m07s]***

3. And then there was that time he was arrested for breaking the laws of physics and had to talk his way out of going to jail:

***(ON B) - {Lectern Computer 1 - PPT Slide #?}:*** 2023-3.mp4 ***[1m5s]***

We simply cannot tolerate any more of his shenanigans. And so, who better to replace him than that unforgettable character from The Physics Experience, Mike Randall...

# 1st audition ( Mark [Mic #1], Mike [Mic #2] )

***(Enters stage. Dressed as White Rabbit)***

**Mike R:** Goodbye Professor Sprott! I wanted to honor him by wearing a top hat and tails…
***(Turns around to show off bunny tail)***

**Mike R:** …but this is the closest outfit I have.

**Mark:** Yeah…well…close enough. So Mr. Randall, can you demonstrate how you would proceed with The Wonders of Physics?

**Mike R.:** Certainly! First, let me give you my definition of physics. Physics…is the study…of stuff. This floor is made of stuff. ***(Stomps on floor).*** The ceiling is made of stuff. YOU'RE made of stuff ***{Pointing to audience}.*** But scientists have a different word for everything. Scientists don't call stuff "STUFF". They call stuff "MATTER". On the count of three, I want you all to say it with me. One…two...three…MATTER! So physics is the study of matter, or stuff.

**Mike R.:** But wait! There's more! Physics is also the study of how you move stuff around. What gives YOU the ability to move stuff around? It's a one word answer, it starts with the letter "E"...

*{Audience response}*

**Mike R.:** Right! Energy! Energy is the ability to do work. Energy is the ability to do ANYTHING. So physics is the study of matter and energy, and how those two things PLAY with each other - how they interact. This covers a LOT of things. It covers MOVEMENT, like throwing a ball. SOUND you can hear. LIGHT you can see. HEAT you can feel. ELECTRICITY. MAGNETISM. And a whole bunch of other stuff lumped into a category called MODERN PHYSICS.

**Mike R.:** Now, YOU know that to get something moving, you have to push or pull on it. Physicists call that push or pull a FORCE. I need a helper from the audience.

***{Mike selects a kid from the audience and seats them on the hovercraft. Mark positions himself onstage}***

***Demo: {Hovercraft }***

***(ON A&C) - {Cameras 6 or 4}***

**Mike R.:** *{to kid}* Push against my hands. Hmmm…you pushed against me, and nothing happened. The only way that's possible would be if there was an EQUAL and OPPOSITE force pushing BACK against YOU! In this case, the opposing force was FRICTION. Friction is the force that, when things are touching, makes them stick together. ***<Kid's name>***, there's a LOT of friction between the bottom of the board you're sitting on and the floor.

**Mike R:** But we can make that friction go away! ***<Kid's name>***, you're sitting on a HOVERCRAFT. When I turn on this leaf blower, it will push air under the board, lifting the board and YOU up a tiny bit. Enough that the board and the floor aren't touching anymore. And all that nasty friction just…goes away. It looks like this.

***{Mike turns on hovercraft, pushes on kid's hands, sending them across the stage to Mark. Mark stops the kid, then pushes them back to Mike.}***

***Audio: Ta Da***

**Mike R:** Thank you ***<Kid's name>***! Let's give ***<Kid's name>*** a big round of applause!

**Mike R:** Let's talk about energy. There are many forms of energy. Some of my personal favorites are the types of energy released in EXPLOSIONS! ***{Evil laugh}***

**Mike R:** What do you think is in this balloon? ***{Audience response}*** This is a balloon filled with hydrogen. It's the lightest gas. AND it burns REALLY FAST! When I light it on fire, it will make a REALLY loud KABOOM.

***Demo: {Hydrogen balloon}***

**Mike R:** SERIOUSLY! SERIOUSLY! When I tell you to, COVER YOUR EARS!

**Mike R:** OK, I'm starting the countdown. COVER YOUR EARS! 5 - 4 - 3 - 2 - 1
***(Detonate hydrogen balloon)***

***Audio: Ta Da***

**Mike R:** WOW that was LOUD! Energy was released as heat, which you could feel, light that you could see, and sound that you could hear.

**Mike R:** Another of my favorite types of energy is electricity. Electricity is the movement energy of little, teeny, tiny particles called electrons. There are several ways to get electrons moving. Here's one I'll bet you know. On a dry, cold winter day, have you ever rubbed your feet on a carpet, then touched something metal like a doorknob? ZAP!! You get a spark of electricity! What you're REALLY doing is rubbing electrons off the carpet onto your body. Then, when you reach for the doorknob, they jump off and make the spark that you see.

**Mike R:** I have a machine that does this for me. It's called a Van de Graaff generator. It looks like this.

***(ON B) - {Lectern Computer 1 - PPT Slide #?}: Van de Graaff***
***(ON A&C) - {Cameras 5 or 6}***
***Demo: {Van de Graaff }***
***Audio: Ta Da***

**Mike R:** These sparks look like a baby version of lightning. And the sound you hear is a baby version of thunder. Real lightning is made in a similar way. Now these sparks are harmless. BUT, if you ever see REAL lightning, or hear REAL thunder, get indoors quick, because lightning is DANGEROUS!

**Mike R:** Now I'm going to use the Van de Graaff generator to give someone SUPERPOWERS!

***(Chooses two volunteers from the audience, one with long, straight hair}***

**Mike R:** Hi! What's your name? ***(Kid #1}*** And you are? ***(Kid #2}***

***(ON A&C) - {Cameras 5 or 6}***
***Demo: {Van de Graaff superpowers}***

**Mike R:** ***(Kid #1}*** I want you to climb this ladder all the way to the top. Now put your hand here ***(Kid #1 places hand on top of Van de Graaff}***. Keep your hand there until I tell you to take it off. ***(Kid #2}*** Stand right here ***(directs Kid #2 to stand nearby}***.

**Mike R:** OK ***(Kid #1}*** I'm now going to give you SUPERPOWERS! ***(turns on Van de Graaff}***. Notice what's happening to ***(Kid #1}***'s hair. Right now you're getting covered in electrons. Electrons have something called a negative charge - like a little force field. If you put two negative electrons next to each other, they push apart with ENORMOUS FORCE for their size. So right now, the electrons on THIS hair are pushing apart from the electrons on THIS hair…and carrying the hair with them!

**Mike R:** Now that's not the superpower! ***(Kid #2}*** come over here. ***(Kid #1}*** with your free hand, make a tight fist, stick one finger out, and point it at ***(Kid #2}***'s nose. ***(Kid #2}***, ***(Kid #1}*** is SHOOTING AN ENERGY BEAM AT YOUR FACE! Shooting energy beams off your fingers is a GENUINE SUPERPOWER!

**Mike R:** Can you feel it? Feels like wind, right? You can hear a hissing sound. You can even smell something called ozone! IT'S REAL!

**Mike R:** What's happening is the electrons are jumping off your finger onto the air atoms nearby. Electric air is called ions. These ions fly away from your finger and hit ***(Kid #2}*** in the face. ***(Kid #2}*** give me a knuckle bump. ***(Small spark happens}*** See? The electrons flew over to you. Then when you gave me a knuckle bump, they jumped over to ME and made a spark!

**Mike R:** ***(to Kid #1}*** Keep your hand on the Van de Graaff. ***(Mike turns off the Van de Graaff, lets it run down to a stop}*** Now, take your hand off. Look! Your hair is still standing up! That's because of this plastic ladder. Electrons have a hard time moving through materials like plastic. It's called an insulator. So as long as you stay on the ladder, the electrons will be trapped on you, making your hair stick out. Now, I want you to jump down. ***(Kid #1 jumps off the ladder}*** Look at that! Your hair went down! Electrons' favorite place to go is into the ground. So as soon as your feet hit the floor, WOOSH! Down went the electrons, down came your hair. And, I'm sorry to say, the superpowers went with them.  Let's give a BIG round of applause for ***(Kid #1}*** and ***(Kid #2}***!

***Audio: Ta Da***

## 2nd audition **( Mark [Mic #1], Michael [Mic #3], Akire [Mic #4] )**

***Lights: Spotlights only { On Mark }***

**Mark:** Thank you Mr. Randall for that nice presentation, but we haven't forgotten that time you set Peter Weix's beard on fire with your rocket demo:

***(ON B) - {Lectern Computer 1 - PPT Slide #?}:*** 2023-4.mp4 ***[35s]***

Of course Prof. Sprott has had his own adventures with rockets:

***(ON B) - {Lectern Computer 1 - PPT Slide #?}:*** 2023-5.mp4 ***[38s]***

**Mark:** The next candidate from our own Physics Department is Prof. Emeritus ***(put the emphasis on the "i" and use the pronunciation "eye")*** Michael Winokur…

***{ Michael walks on }***

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**Michael:** Thank you Mark…I think. I may be officially retired from the department but it should not sound like some sort of debilitating medical condition. I am emeritus not emer-eye-tus.

**Mark:** Well, someone is a little touchy today.

**Michael:** It's really all good Mark, you know I wrote that part in…***(to the audience)***.

**Michael:** And I even wore my best tuxedo (just as Prof. Sprott would); it **is** the 40 year anniversary And, in honor of Valentine's Day; a new hat. And a very special treat. One of my surviving former graduate students is here to help. Akire, would please join me. Oh, and I have a matching hat for you.

**Akire:** So we have put together a list of some of Prof. Sprott's favorite demonstrations. The first one uses a number of physics properties. The most important one is density or, in the words that Mike Randall just mentioned, how much mass or stuff is contained in a particular volume. Here we have two balloons. One is filled with helium and the second is filled with air. I'm sure someone can tell me which one is which.

***Demo: {2 Balloons -density}***

**Michael:** *(Someone provides an answer)*. Good. Less stuff in a fixed volume means lower density and, if that stuff sits in a higher density surrounding on the Earth, then because of gravitational forces, there will be net buoyant force upwards and the balloon floats. Now helium isn't all that exciting but another gas, methane or natural gas, is just a little less dense than air and so it also floats.

***(ON B) - {Lectern Computer 1 - PPT Slide #?}: Hot air balloons ?***

***(ON A&C) - {Camera 6 ? }***
***Demo: {Methane bubbles.}***

**Akire:** But rather than balloons I think floating ***methane bubbles*** are more interesting. What do you think about a bubble duel?

**Michael:** We just need to open a valve and let the methane gas flow through our special soap solution. Aren't they pretty?

**Akire:** Now methane has different chemical properties than helium. Methane is very flammable and burning methane involves very important physics principles. They are too complicated to talk about now but mostly they involve thermodynamics. Better to just show you.

***(Note: Once the bubbles form a rising string candles are used to ignite them.)***

***Audio: Ta Da***

**Michael:** That was fun. Now we have a demonstration that combines buoyancy with a special type of circular fluid motion, vortex flow. Vortices are an everyday occurrence. In your house, just look at the swirling water that forms around a sink or bathtub as it goes down the drain. There are vortices in the air as well but you can't see them directly. If they are really, really strong and reach the ground you can see the dirt and other things they pick up. Weather events such as tornadoes and hurricanes are perfect examples of vortices.

***(ON B) - {Lectern Computer 1 - PPT Slide #?}: Vorices***

**Akire:** Now hot air is less dense than cold air and so it rises like the methane did. Hot air balloons are an example of this. Using a swirling motion and the heat from burning lighter fluid we can make our very own tornado, a fire tornado! The hot air rises and when Professor Winokur spins the screen it starts the vortex. That draws in cold fresh air from the bottom and things can really take off. Let's see.

***(ON A&C) - {Camera 6}***
***Demo: {Fire Tornado}***
***Audio: Merry-go-round***
***Audio: Ta Da***

**Michael:** Ooooo..... Fire tornadoes can occur in nature and they can be very destructive.

***(ON B) - {Lectern Computer 1 - PPT Slide #?}: { Fire tornados }.***

**Michael:** Now for a bit of a different twist. Shifting gears, we have an electrifying demonstration that shows something one can do with electricity and a device called a capacitor. It stores energy and electric charges but it is not a battery. Batteries store energy by chemical means. Capacitors store energy simply because of their geometry, just two metal plates held close together but not touching, and the fact that there are two types of electrical charges, positive and negative, which attract one another.

**Akire:** Capacitors can provide their power much more quickly than batteries. That is if we provide a conductive path for the charges to neutralize. Here it is just a thin strip of aluminum foil.

***(ON A&C) - {Camera 6}***
***Demo: {Exploding Foil}***
***Audio: Jeopardy ?***

**Akire:** Using this power supply, I will slowly charge the capacitor while this button is pressed. Once the capacitor is fully charged, at fifty on the meter, I will let go of the button and the capacitor will discharge. Our very own lightning strike.

**Michael:** You may want to cover your ears. ***(This will be Loud and very bright !!)***

***Audio: Ta Da***

***(ON A&C) - {Camera 5}***
***Demo: {Bed of Nails}***

**Michael:** Finally, a chance to say something about force and area. I want to show off my ever so relaxing bed of nails. It's just the thing I need when I need a nap. That's what happens after you retire and become an emeritus professor. Just ask Prof. Sprott.

**Akire:** How about using just a single nail?

**Michael:** I don't think so. Now a bed from a single nail would be dangerous; lots of force but not much area. But with many nails the force exerted by each nail is reduced. We even have a blanket of nails so I don't get cold. To prove how comfortable it is, Akire will use a sledge hammer and shatter a cinder block on top.

**Akire:** You may want to take off your new tux jacket.

***(Note: Find an audience member up in the front row or Mark that can assist you on to the nails. Microphone wires have a tendency to get snagged take "it off" if not Under clothes. )***

**Michael:** Good idea.

***Audio: Ta Da***

**Akire:** Well I finally got the chance to put the squeeze on Professor Winokur. That was worth the trip back to Madison.

## 3rd audition ( Mark [Mic #1], Terry [Mic #5] )

*Lights: Spotlights only { On Mark }*

**Mark:** Thank you Prof. Winokur and Akire. We liked your presentation, but those costumes are too much. I think they have to go:

***(ON B) - {Lectern Computer 1 - PPT Slide #?}: { Winokur Photos}*** (2019/008.jpg), (2018/026.jpg), (2016/015.jpg), (2015/037.jpg), (2013/015.jpg), (2012/021.jpg), (2011/015.jpg) ***[11.25s]***

**Mark:** They're not becoming to the decor of the halls of our Department of Physics. They're even worse than some of the crazy costumes Prof. Sprott has worn. We cannot tolerate any more such silliness:

***(ON B) - {Lectern Computer 1 - PPT Slide #?}: { Sprott Photos}*** (2016/024.jpg), (2015/049.jpg), (2013/049.jpg), (2012/004.jpg), (2004/004.jpg), (2001/005.jpg), (1999/0002.jpg) ***[12s]***

**Mark:** Our next candidate is another familiar character (and I mean a **character**!) from recent years, Terry Craney…

***{ Terry walks on }***

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**TLC:** Thank you Mark, yes I am auditioning for Prof. Sprott's position. I am the most qualified because I have the endorsement of the "National SteamPunk, Retired Physics Professors, Humorous Puns Association." The NSPRPPHPA. Even Professor Sprott never had their endorsement!.

**Mark**: Wait, there is no such organization! How many members does it have?

**TLC:** One –me - I'm the President and Chair of the Endorsement Committee.***(pointing to himself)***

**Mark:** Get on with your demonstrations. You are wasting our ***" TIME !!! "***
***(Mark emphasizes the word "time" )***

**TLC:** OK, OK, but speaking of time, did you hear about the very hungry time-traveler at the local buffet restaurant? She went back for (four) seconds.
***Audio: Crickets***

***Demo: {Inductance}***

***(ON A&C) - {Camera 5}***

**TLC:** So, let's start with a few of Professor Sprott's favorite demonstrations from past shows. I do them equally as well as Professor Sprott, except my jokes are a lot better.

**TLC:** Here we have a coil of copper wire. One of the properties of copper is that it's an excellent conductor of electricity -- the ability to move electrons from one atom to another without much resistance. Now, let's start with a very simple demonstration. One way of producing electricity is by moving a magnet through a conducting coil of wire. We can see electrical current with this galvanometer. When I push the magnet in the current goes one direction and when pulled out goes the opposite direction- a simple alternating current. Three things are happening: a current is produced in the wire; the new current creates its own magnetic field: and this new magnetic field opposes the original bar magnet- like two opposing bar magnets. So, for this process to happen, I must use energy or do mechanical work for the current to be produced. Ultimately, that tuna fish salad sandwich I ate from a couple of days ago is producing electricity. Most of the household and industrial electricity we use is produced by this method- using natural gas, coal or nuclear power to produce steam to move a coil through a magnetic field.

***Audio: Ta Da***

**TLC:** ***(Joke)*** By the way, speaking of electrons and atoms, did you hear about the two atoms talking? One said, "I think I lost an electron. The second said, "Are you sure?" The first said, "Yes, I'm positive."

***Audio: Rimshot***

**TLC:** Now let's see how these three laws applied on other apparatus.

***Demo: {Guillotine }***

***(ON A&C) - {Camera 5 or 6}***

**TLC:** What is this machine called? No, not a guillotine but the UW Physics Department's own vegetable chopper. And if you order in the next 30 minutes free shipping is included. ***(Blade drops in free fall and cuts the carrots)***

***Audio: Ta Da***

**TLC:** Watch what happens when I add a few strong magnets at the bottom of the frame ***(Blade slowly drops)***
***Audio: Ta Da***

**TLC:** An electrical current is created in the blade which creates an opposite magnet and slows down the blade and the carrot is saved..

**TLC:** During the French Revolution if someone was condemned to the guillotine, just make sure they have huge magnets on the back of their shoulders. Physics saves lives!

***(Joke -- Ask audience member in the front row)***

**TLC:** Do you like my coat? I originally purchased a different one, but it built up a lot of static electricity. So, I sent it back. They gave me a new one free of charge!

***Audio: Crickets***

**TLC:** Before I show the last electromagnetic demo, let me start heating up some water in a paper cup by putting it on this Bunsen burner., It will need it in a couple of minutes.
***(Look surprised as the audience looks puzzled. -Let the water start to heat up.)***

***Demo: {Eddy Currents }***

***(ON A&C) - {Camera 5 or 6}***

**TLC:** So now, I need a young volunteer from the audience to help me in a copper tube race. What is your name? Do you like my hat? I have two identical copper tubes. Look down the tubes to make sure there is nothing in them. Now take this ball and I will take the other ball, and when I say "1, 2, 3, go" drop the ball down the tube and I will drop mine also. "Go". Wow, you won the race-- way to go. How was the volunteer able to win the race? Both tubes were the same. But the difference was that my ball was magnetic while theirs was not. As the magnetic ball passes through the copper tube, a current is produced in the tube that creates an opposing magnetic field which slows down the ball, like two magnets opposing one another. Let's give our volunteer a big hand. ---Thank you.

***Audio: Ta Da***

***Demo: {Paper Cup}***
***(ON A&C) - {Camera 5 or 6}***

**TLC:** Now let's get back to my paper cup. The water is boiling or turning into a vapor! Because the paper is thin and can transfer the heat readily into the water. Water has what physicists call a high heat capacity or "specific heat". A material with a high specific heat can absorb a large amount of heat energy without raising much in temperature. The water is absorbing the heat from the burner instead of raising the temperature of the bottom of the paper cup to its ignition point. This is why water is such a great cooling agent - used in many industrial cooling processes - it can absorb a lot of heat without rising much in temperature. Now, to show there's no trickery with my cup - an empty cup does burn.

***(Light cup on fire with burner).***

***Audio: Ta Da***

***Demo: {Handkerchief}***

***(ON A&C) - {Camera 6}***

**TLC:** Now moving on, Oh, I spilled some of the water, so let me clean it up. I need a handkerchief.(Ask for one from the audience). It looks like a normal cotton handkerchief, correct? It is a regular cotton handkerchief - no tricks, so far. I will mop up the spilled water and then rinse it in this water solution. ***(put in $H_2O$ and isopropyl alcohol bath)***. I am now going to dry this handkerchief over this lighter before I give it back. ***(Act like it "accidentally" started on fire.)***

**TLC:** Help Mark-- Get the fire extinguisher!

***(Put out the fire and then have the audience member examine the handkerchief)***.

***Terry also plugs in the fog machine at this time***

***Audio: Ta Da***

**TLC:** So what happened? Why didn't the handkerchief ignite?

**TLC:** Well, my water solution was only 50% water but also 50% rubbing alcohol (isopropyl alcohol) like you may have in your medicine cabinet at home. The alcohol will start on fire at a lower temperature than the cotton in the handkerchief. So, what you saw burning was the alcohol. But more importantly, the water in the solution, again, has a high heat capacity and is able to absorb a great amount of heat. Further, if some of the water did reach its boiling point, the vaporization process (turning it from water to steam) also absorbs a tremendous amount of heat energy. Therefore, the heat from the burning alcohol went into heating the water and turning it into steam rather than igniting and burning the cotton cloth. The handkerchief was saved.

***Lights: Spotlights only { On Mark }***

**Mark:** Good job Mr. Craney, but the Physics Department cannot tolerate corny bad jokes, OK? ***(TLC throws up his hands and goes "eh".)***

**TLC:** But I understand you installed a large metal door knocker on your front door- you are trying to win a "No-Bell" prize. OK, OK, I'm out of here. **(As Mark points to have him leave)**

**Mark:** Prof. Sprott has made a few bad jokes and rhymes over the years, and we don't want any more of that:

***(ON B) -** {Lectern Computer 1 - PPT Slide #?}:* 2023-6.mp4 ***[22.7s]***

## 4th audition ( Mark [Mic #1], GS1 [Mic #2], GS2 [Mic #3], GS3 [Mic #4] )

***Lights: Dim***
***Audio: ["Let's get ready to rumble"], - Fade-out***
***(loud and drawn out like this: https://www.youtube.com/watch?v=0e_-8ShpF1I)***

***(Off-stage on mic, "Dramatically !!")***

***Student 1:*** It's the moment you've all been waiting for… Ladies and gentlemen, boys and girls, put your hands together for the future hosts of The Wonders of Physics, ***[Student 1's name]***, ***[Student 2's name]***, and ***[Student 3's name]***!!!
***Lights: Rise as students come on stage***
***Students come on stage waving to the crowd.***

***Mark:*** whoa, whoa, whoa! What's going on here?

***Student 2:*** What does it look like? We're grad students and we're auditioning for Prof. Sprott's job.

***Mark:*** Aren't you all a little… young… to be auditioning?

***Student 3***: Look, just because we didn't go to school with Isaac Newton like you did doesn't mean we aren't qualified for this job. Everybody who has auditioned so far looks like they knew Galileo personally:
***(ON B) - {Lectern Computer 1 - PPT Slide #?}: (london02/021.jpg***).

***Student 3***: We think it's high time there were some fresh faces and ideas around here! The Wonders of Physics needs to be explosive, in your face, and electric!

***Mark***: Alright, show me what you got then!

***Demo: Vortex Cannon***

***Student 1***: Our first demonstration is going to be the vortex cannon! ***(Students 2 and 3 "ooo" and "aaaah" to hype up the demo.)*** We will need a volunteer from the audience to join us for this part! ***(Choose a volunteer, preferably a kid.)***

***Student 1***: Here I have our vortex cannon ***(shows smallest vortex cannon)*** and my friendly volunteer here is going to create a vortex for us! Go ahead and give this end here a flick/tap!
***Audio: Ta Da***
***(Volunteer flicks/taps, but nothing happens because there's no fog in it.)***

***Student 2:*** That's it?

***Demo: Smoke Rings***

***Student 1:*** Hold your horses! We're getting there. The problem is that our vortex isn't visible, but if we add some smoke to our cannon, then we'll see it! ***(Adds smoke.)*** Could you flick/tap again? ***(Volunteer flicks/taps, now with rings made.)***

***Student 1:*** Let's give our volunteer a hand! ***(Applause.)*** What's happening here is when we flick/tap one side of the cannon, we push air through this hole on the other side. The air moving through the middle goes really fast, but the air on the edges gets slowed down and has a higher pressure, creating a ring of smoke around the faster air.

***Audio: Ta Da***

***Student 3***: That's cool, but those rings were kind of small!

***Student 1:*** Well, we can do better!
***(Takes out large cannon, Students 2 and 3 "ooo" and "aaah" again.)***

***Student 1:*** Do you guys want to see what this one can do?
***(Said to the audience, then fills up the cannon with smoke and fires rings into the audience.)***
***Audio: Ta Da***

***Demo: Fire Rings***
***Student 2***: That's a bit more impressive.

***Student 1:*** Of course it is. But what if we lit those rings on fire? ***(Students 2 and 3 "ooo" and "aaah" again).*** Here we have a half-ring of fire. Let's see what happens when I fill up this cannon with butane instead of smoke.

***Lights: Dim***

***(Fires cannon at half-ring to create fire rings.)***

***Audio: Ta Da***

***Demo: Bowling Ball Pendulum***

***(ON A&C) - {Camera 6}***

***Mark***: That was a good show, but I thought this was going to be "in your face".

***Student 2:*** Oh we can get in your face. For this next demonstration, we are going to need a volunteer, preferably someone tall and with bad reflexes. (*Picks someone, preferably a taller adult.*) I want you to stand right here. Okay, see this bowling ball here? I'm going to bring it close to your face and then let go. What do you think is going to happen? ***(Audience member responds and Student 2 repeats as necessary for the audience to hear.)***

***Student 2:*** Ok, I'm going to let go and whatever you do, don't move. Do you trust me?

***Audio: slide whistle ??***

***Student 2:*** Is everyone ready to see what happens? Drum roll please…

***(Students 1 and 3 drum roll. Student 2 lets go and ball swings, but doesn't hit the audience member. Student stops ball after swing.)***

***Audio: Ta Da***

***Student 2:*** Let's give a big hand to our audience member!

***Audio: Ta Da***

***Student 3***: You were really cutting it close there! You could have hurt somebody!

***Student 2:*** No, they were fine! The conservation of energy says that when we lifted the ball off the ground, we gave it gravitational potential energy. As it swung down, that energy got transferred into kinetic energy, and as it rose again, that kinetic energy went back to potential energy. But the key here is that no energy was created or destroyed, so the ball could only ever get back to the same height it started!

***Student 1:*** You know, I was reading a book about anti-gravity the other day, I just couldn't put it down. ***(Student 3 facepalms/shakes head while Student 1 grins.)***

***Demo: Tesla Coil***

***(ON A&C) - {Camera 6} ??***

***Student 3:*** Right. We have one more demonstration, and we really want to bring some energy to The Wonders of Physics, so we are going to use this million volt ***Tesla coil*** here to do just that!

***Student 1:*** Don't be *shocked* when we don't get the job…

***(ON B) - {Lectern Computer 1 - PPT Slide #?}: Tesla***

***Student 3:*** C'mon [Student 1], be more like the proton and be positive! ***Nikola Tesla*** was a brilliant, *young* physicist who showed that we can transfer energy through the air, no wires needed. To show this, we need a volunteer to hold this fluorescent light for us! ***(Chooses volunteer "close to the coil")*** Normally, when a light bulb isn't connected to anything, it doesn't light up, but with this million volt Tesla coil, we can turn it on from across the room! ***(Students 1 and 2 "ooo" and "aaah").***

***Lights: Dim***

***(Tesla coil turned on. Light bulb lights up.)***

***Audio: Ta Da***

***Student 3:*** ? ***We could do other things here, like Faraday cage or other Tesla coil things, but I do not know what is available. ?***

***Mark:*** You all really put on a show there, but you were also pretty reckless! I think we'll probably need to keep looking for other candidates.

***Student 1:*** Your loss!

***Student 2:*** ***(Said as the students walk away)*** You know, my parents always said I was kinetic.

***Student 3:*** Why's that?

***Student 2:*** Because I have no potential…

***Audio: Rim shot***

## 5th audition ( Mark [Mic #1], Haddie [Mic #5] )

*Lights: Spotlights only { On Mark }*

**Mark:** We've had many physics graduate students in the show over the years, and I hope they'll continue to be involved:

***(ON B) - {Lectern Computer 1 - PPT Slide #?}:*** (2008/DSC_6174A-8511.tif)

**Mark:** Our last interviewee is the newest member of The Wonders of Physics team, our own Haddie McLean...

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*{ Haddie walks on }*

**Haddie:** Thank you, Prof. Eriksson! I'm so excited to be auditioning today! Prof. Sprott started an amazing program and I'm thrilled it will continue. In fact, I know I can build on what Prof. Sprott created and make it even better! I'm going to start big, with this cage. It's called a Faraday cage. Basically a box made out of metal, used to protect its contents from electric fields and electromagnetic radiation. How? You may be wondering? Because the cage is made from a conducting metal, it distributes the charge around the outside of the cage. It's easier for the charge to flow through the metal than escape the metal and go into the air inside the cage. Now, for this demonstration, I'm going to bring in a special guest to make my audition really stand out. I'm sure you all know him. He wears a sweater, even in the summer, and he's everyone's favorite mascot: **Bucky Badger!**

***Bucky comes on stage to On Wisconsin***

**Haddie**: Bucky, are you ready for some physics? Great! Let's get started!

***Demo: { Faraday Cage }***

**Haddie**: Bucky, your job is very easy. You just have to sit in that cage while I turn on the million volt tesla coil. It's OK Bucky, I promised the UW (chancellor?) that you would be 100% safe. I'm going to show everyone how physics can protect you from getting the shock of your life.

***(ON A&C) - {Camera 6}***

***Audio: Match -As you lead Bucky into the cage.***

***Audio: Shocking -As Bucky sits.***

*****Remember to move Tesla coil lever toward cage***

**Haddie**: Don't worry Bucky! It's physics. Physics always works. Just double-checking though, is the UW all paid up on your life insurance policy? Bucky, just remember to stay seated and keep your paws inside the cage until the demo is over.

**Haddie**: I'll just turn on the power and activate the motor which produces the high frequency current. Are you ready? Now to crank up the voltage.

***Audio: Ta Da***

**Haddie**: See, completely safe! Bucky, I've got your back! Everyone, give Bucky a big round of applause for being such a good sport.

**Haddie**: Now, this Faraday Cage may seem like a strange contraption, but you've all likely been in a Faraday Cage before. Raise your hand if you've ever ridden in a car. Bucky, have you ever ridden in a car? The frame of the car acts as a Faraday cage that could protect you from a lightning strike. Same as an airplane hull. The cool thing about Faraday cages is that the blocking is a two-way street. Any electromagnetic fields created inside the cage are prevented from escaping to the outside world. It's why we can safely stand close to a microwave oven when it's running. You see, Faraday cages are all around us. It's not shocking, just science!

**Haddie**: Parents, you could also use this science to your advantage at home. Have you ever wanted your kids to stop playing on their phones or tablets? Daily, right? You could block the wifi signal by putting a Faraday Cage around your router.

**Haddie**: Pull out your cell phone (if you have one). Under settings go to Wi-Fi and check to see if our lecture hall router shows up. It's called CH 2103. You don't need to connect to it for this demonstration. It's password protected and only Bucky knows the password. We all know he isn't talking.

***Give Bucky my phone to hold***

**Haddie**: Bucky, hold my phone and keep an eye on the screen. I'm going to go over here by the router. I have a simple plastic storage box covered with aluminum foil. I'll put the router in the box and secure the cover with a weight to make sure the cover makes a good connection with the box.

**Haddie**: Now, if you recycle your Wi-Fi by turning it off and then on again, you'll notice that our router doesn't appear. The signal is too weak to reach most of the room, with the exception of maye the first few rows on this side of the room. So parents, next time use science to shut down the screens. However, I can't help you if you have an unlimited data plan.

***Get phone back from Bucky***
**Haddie**: Thanks for your help Bucky! I'll see you at the next game!

***Audio: Ta Da***
***Bucky exits stage***

**Haddie**: My next demonstration is about Inertia. You know, I've come up with a new theory on inertia! But, it doesn't seem to be gaining any momentum.
***Audio: Crickets***

***(ON B) - {Lectern Computer 1 - PPT Slide #?}: { Newton's laws.}***

**Haddie:** ***Newton's first law*** of motion is the law of inertia. It states that objects in motion tend to stay in motion unless acted upon by an outside force. Likewise, objects at rest remain at rest, unless acted upon by an outside force.

***(ON A&C) - {Camera 6}***

***Audio: Ta Da*** ??

**Haddie:** I hope Professor Sprott won't mind that I took these fine dishes from his office. I promise to return them.

***Demo: {Tablecloth pull}***
***(ON A&C) - {Camera 5}***

**Haddie:** I have a red tablecloth and I'm just going to put the plate and glass right here. Now, according to the law of inertia, if I just pull really hard on the tablecloth, I should be able to move it without moving the plate. Because I'm putting the force on the tablecloth and not on the plate.

**Haddie:** Now, there's something else you should know about inertia–it depends on mass. The more mass an object has, the more inertia it has and the more likely it is to keep doing what it is doing. More mass=more inertia.

***(While I'm talking, Mark will add another plate and glass to the stack)***

**Haddie:** Whoa! Prof. Eriksson, what are you doing?

**Mark:** I'm just adding more mass. You said "More mass=more inertia" so I'm just helping you out.

**Haddie:** Ok. Yes, you are correct. Please tell me that is the last glass.

**Mark:** Yes, this is the last glass.

**Haddie:** Ok. More mass does equal more inertia. This is making me nervous. I can do this. The dishes will stay at rest as long as I don't put any force on them. So if i just pull only on the tablecloth…

**Haddie:** Ahhh! Prof. Eriksson, you said that was the last glass?

**Mark:** I did. This is a goblet. I just wanted you to have the best chance at succeeding, so I thought you needed just a little more mass.

**Haddie:** Ok. Whatever you say. I can do this! Can you help me by giving me a countdown? We'll count down from 3 to 1. 3-2-1!

***Audio: Ta Da***

**Haddie:** This next demonstration is one of my favorites because it highlights some of the cool research that we're doing right here in Chamberlin Hall. We've partnered with the Chemistry department to develop a special solution that repairs broken glass. You see, sometimes science is messy and ***we break a lot of glass around here***…

***? (ON B) - {Lectern Computer 1 - PPT Slide #?}: { Video of the glass breaker) ?***

**Haddie:** …Instead of just throwing it away, we thought we could come up with a process to restore it to its original shape. Kind of like putting Humpty Dumpty back together again.

***(ON A&C) - {Camera 6}***
***Demo: {..Index of Refraction...}***

**Haddie:** In this container, I have the solution that we've developed. We think it's pretty good. ***(Show audience the beaker and then break it)***

**Haddie:** I'll just put all of the pieces of this broken beaker into the solution. It works pretty fast. I just need to stir it around a bit and then look at this! Well, almost! (Pull chipped beaker out of oil) Let's just put that piece back in and try again.

***Audio: Ta Da***

**Haddie:** Now, I must confess. We wanted to patent this solution, but someone beat us to it. It is just plain old Wesson vegetable oil. I had these beakers hidden in the oil the entire time. The beakers are made of pyrex glass and they have the same index of refraction as vegetable oil. What does that mean and how does it make the glass disappear? When light hits a substance, whether it's glass, water, or oil, the ray of light is bent. Pyrex glass and vegetable oil bend light at the same angle, so that is why the beaker appears to disappear when it's in the oil.

*Demonstrate index of refraction with the whole beaker putting it back in the oil.*

**Haddie:** By the way, do you know what happens when a physists is arrested for crimes against refraction? He gets 20 years in prism.
*Audio: Grown*

**Haddie:** I wanted to end my audition with a bang! I have a demonstration about air pressure, something I know just a bit about.

*Demo: {..Ping Pong Cannon...}*
*(ON A&C) - {Cameras 5 & 6}*

**Haddie:** This is the UW-Madison ping pong cannon. It does only one thing, shoots ping pong balls. Let me describe how it works. The atmosphere around us is pressing in on us, with a force of about 14 lbs/square inch. It doesn't seem like a lot, but I'm going to show you it can produce huge effects. A ping pong ball is inserted into the long tube and then it is sealed off on both ends with tape. The tube is hooked up to a vacuum pump which will take all of the air out of the tube. We'll remove all of the air so the pressure is 0 inside the tube.

**Haddie:** Prof. Eriksson, can you be my assistant?

**Mark:** I'd love to.

**Haddie:** There is a safety clip that protects the cannon from being accidentally set off. After Mark removes the clip, he can hit this button to puncture the tape. When that happens, the air around the cannon, from the room, will go rushing into the cannon and push the ball through the tube. It happens really fast, so you'll have to watch carefully.

**Haddie:** At this end, I'm going to hold a ping pong paddle. This will be our target. Mark and I will just play a little game of ping pong.

*Mark activates the cannon*
*Audio: Ta Da*

**Haddie:** Look at the paddle! The ball went right through it! Did you see it? It was really fast. We have calculated the speed of the ping pong ball in the tube and it's several hundred m/s. That's faster than the speed of sound in air!

**Haddie:** And this ends my audition. I told you I was going to end with a bang!

# Closing (Mark [Mic #1], Sprott [Mic #6] )

*Lights: Spotlights only { On Mark }*

**Mark:** Thank you Haddie. But we haven't forgotten about last year when you started the curtain on fire with your rocket demo:
***(ON B) - {Lectern Computer 1 - PPT Slide #?}:*** Movies/2023-8.mp4 ***[10.2s]***

**Mark:** Of course the Department is not really firing Prof. Sprott ***{perhaps mention seeing the show as a child}***. On the contrary, he's been working for a number of years to put The Wonders of Physics program in the hands of others so that it can continue, even bigger and better, for many years in the future. All the presentations we heard today were wonderful, but I'm pleased to announce that in future years, The Wonders of Physics annual show will be in the capable hands of Haddie McLean. However, Prof. Sprott has no intention of disappearing. You may see him from time to time in the show, and you can know that he'll be working behind the scenes to ensure that The Wonders of Physics continues its 40-year tradition. In fact he's here today to do one last demonstration...
***{Sprott enters clad in his signature black tuxedo - 5 sec of theme music}***

**Sprott:** Welcome to The Wonders of Physics. When I did the first show 40 years ago, I never imagined that we would still be doing it 40 years later, but seeing your smiles and enthusiasm has been a highpoint of my life year after year. But all good things must come to an end, and at 80 years old, this seems like the right time to leave the annual show to a younger generation, something our politicians might consider. And so I'm delighted that in future years The Wonders of Physics will be in the capable hands of Haddie McLean as well as those she'll recruit to help with the program. Let me shake your hand and wish you the very best. ***{shake hands}***

**Sprott:** And now I'd like to end the show the same way we've ended every one of the shows over the past 40 years, for the 340th and last time, by making for you a cloud. Haddie, you know a lot about clouds. Perhaps you could join me…

***(ON B) - RGB {Lec Computer 1}: PPT SLIDE # 48 - Clouds / Thank You***
***(ON B) - DVD Video: Theme music video***
***Audio: WOP Theme-long-3m22s.wav***
***{Cast enter and bow in unison.}***

## Resources:

- 2018 PowerPoint Slide Show (where is the 2019 version?)
- Physics Lecture Demonstrations
  - +An old Physics 103 Demo List
  - An old Physics 104 Demo List
  - WoP Demos from Previous Years
  - 85 Video Clips from Physics Demonstrations Book
- WOP sound library
- 2019 WOP script (Steve: Please update these links)
- 2018 WOP script
- 2017 WOP script
- 2016 WOP script
- 2015 WOP script
- 2014 WOP script
- 2013 WOP script
- 2012 WOP script
- 2011 WOP script
- Free Sound Effects Archive