Physics Demos & Videos

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I want to share with you many of the demonstrations and video clips that I have collected over my 45 years of teaching Physics. I have used these demos to help the students relate the physics concepts to real life, to engage them in thinking and not just memorizing, and to make learning fun. Most of these demos require equipment that is either fairly cheap or readily available.

Inertia

1. Hovercraft-Plans www.amasci.com/amateur/hovercft.html
   I recommend using a Black and Decker battery powered leaf blower. Including the battery and charger, it costs about $75. The pattern of holes on the bottom of the hovercraft can be adapted from that illustrated on the plans.

2. Tablecloth and Dishes- Pulling the table cloth out from underneath the dishes is not difficult, but I would recommend a smooth table cloth, and using dishes with more mass that plastic ones. Pull straight back, palms down and without hesitation.

3. Bowling Ball in hallway- Find a long, hopefully level, hallway. Roll the bowling ball at a moderate speed. Ask the students to predict how far it will roll and then afterwards ask if it slowed down much, and what kept it going. They will say that "momentum" or "inertia" kept it going, but the answer is that absolutely nothing keep it going. This principle is called "inertia", but inertia is not a force.

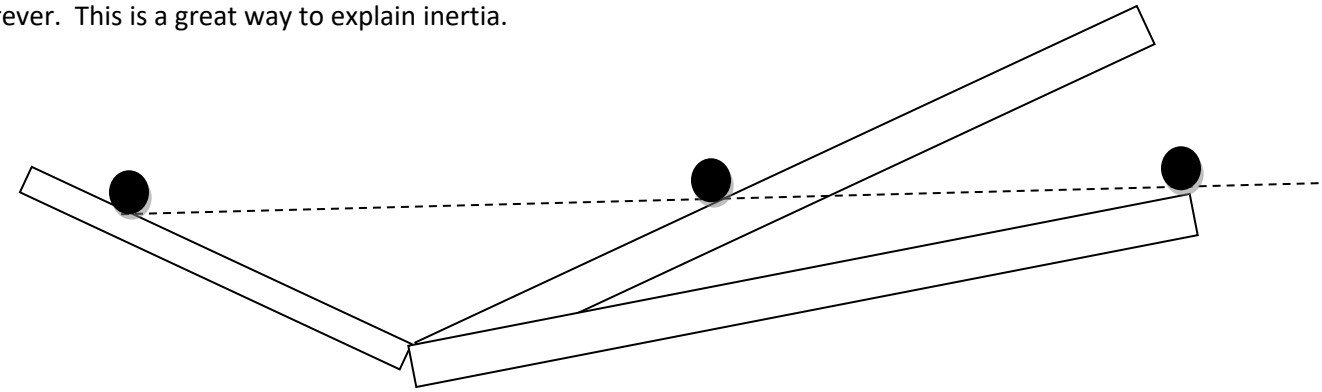
4. Pull a large cart across the floor at constant velocity with spring scale. This illustrates that if the net force (pull of the spring scale minus the friction of the cart) is zero, an object will move at a constant speed in a straight line. Large demonstration scales made by Ohaus, can be purchased from Sargent Welch, Nasco, Scales Galore, School Specialty or Amazon. The numbers are Ohaus 8016-00 for a circular dial scale with a maximum of 20 N or 3018-50 that has a maximum of 50 N. These scales average about 60 to 70 dollars, depending upon vendor. These scales can also be used in a number of other very visible demos. I would suggest getting two scales of the scale type.

5. Support force: A meter stick suspended between two fingers with a weight, about 10 N, hung in the middle. As you move your fingers toward the weight, the sag becomes less apparent. Ask the students, when the sag will disappear. A similar question, is does the concrete floor beneath my feet sag when I stand on it. The answer is absolutely yes, it is just not easily visible. Compare with standing on a trampoline, the stiffer the springs, the less the sag, but it never disappears.

6. Rotational inertia: bike wheel, or other rotational object with good bearings, continue to spin.

7. Bowling Ball dropped from ceiling onto a cushion at the same time as a koosh ball. Both fall the same. Have a student film it in slow motion with their phone. Use a cushion on the ground. It doesn't need to be a koosh ball, but I high encourage any teacher to have at least two koosh balls. They can be a part of a lot of great physics. You can buy Koosh balls online for about 4 or 5 dollars.

8. Roll ball down one inclined plane onto another. Ball rolls further as second planes angle is lowered.
   This illustrates the law of inertia. I often use two classroom tables, or you can use a long board with a groove in it so that ball goes in a straight line and a table. Without friction, the ball should roll to the same height as it was released, but as the table is lowered, it will roll a greater distance. Then if it is perfectly flat, the ball should roll forever. This is a great way to explain inertia.



9. Stand on two bathroom scales and shift weight. The two scales always add to the total.
   If you stand straight up, then each will show half of your weight. If you shift you weight to the left, the left scale will go up and the right scale will go down, but they will still add up to your weight.

10. Two spring scales hold up a bar with a hanging weight. As the weight is shifted the two scales
    Readings vary, but always add up to the total. (Here is another use for the spring scales)

11. Air cannon knocks -- Styrofoam cups. Objects in motion stay in motion. You can buy an air cannon, but it is easy to make one. https://www.beano.com/posts/how-to-make-a-vortex-cannon. There are lots of other ideas online as well. If you have a smoke generator, perhaps in the drama department , the cannon blows great smoke rings.
12. Running and dropping a ball. Now walk and toss the ball up. You can have a lot of fun with this.
    It doesn't matter, of course, if you are running or walking slowly, the ball always drops at your feet when you just let go. I will blindfold myself and toss as ball straight up in the air as I walk or run, and then the ball will land right back in my hand (that is if I toss it straight up). It's also fund to walk, toss the ball straight up, and then run really fast while the ball is in the air, and the ball will land where I would have been, if I hadn't changed my speed. The same is true for running while tossing and then suddenly stopping while the ball is in the air.

13. Egg on a pie plate, drops into a glass of water. http://www.sciencefun.org/kidszone/experiments/egg-drop/ I like to do it with the water container close to the edge of a table, so that I can use a broom to acceleration the pie plate. (Put you foot on the straw end, then pull it back and let it rip). Its fund to include multiple eggs, once you get it down pat.

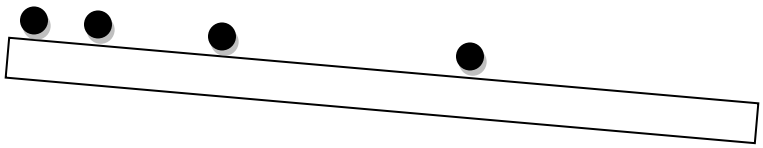
Movies:
1.Hammer and feather on moon.
https://www.youtube.com/watch?v=5C5_dOEyAfk

2.Rosencrantz and Guildenstern are Dead-Gravity
https://www.youtube.com/watch?v=maI53H4Zbrs

3.Motorcycle and Tablecloth: BMW
https://www.youtube.com/watch?v=xAXy1ur9QQc
Motorcycle Tablecloth trick: Mythbusters (2:41 through 4:56)
https://www.youtube.com/watch?v=lK1ci50DUgc

Linear Motion

1 Stopwatch timing a bowling ball rolling at constant speed. Equal times for equal distance intervals.
2. Speeds: Usain Bolt 100 m in 9.58 seconds= average speed 23.4 mph (top speed 27.8 mph)
Cheetah (70 mph) Spinetailed Swift (106 mph) Sailfish (68 mph)
Dodge Viper 0-60 in 3.5 seconds $90,000
Matt Biondi World's Record in 50 m freestyle in 1988 Olympics 22.14 s (5.1 mph)
100 m freesytle (4.6 mph)
3. Cue ball on inclined plane to illustrate acceleration. Its best to have an inclined plane, where a smooth ball can roll down in a groove. Choose a fairly small angle. Have someone clap at a regular rhythm. Make a chalk mark at every clap. I measure the distance between chalk marks with my hands. Typically it is 2 hands for the first interval, then 3, then 4, etc.



4. Ball on string swung in a circle. Illustrates constant speed but also an acceleration.

5. Relative velocity:
a. Motorized bulldozer /car on a sheet of poster paper. Move the poster paper and have the car go in the same direction, opposite direction or perpendicular.
b Run forward and toss a ball backward. Run forward and toss the ball forward. Run backward and toss the ball forward.

6. Projectile: throw a koosh ball horizontally and drop another at the same time. Have them guess which will hit first. It helps to stand on top of a table to give the demonstration more time. Both balls should hit at the same time. Gravity only affects the vertical motion of the balls and not the horizontal motion.

7. Land in the Midwest is often divided up into sections. A section is 640 acres and one mile by one mile.
Flying over Colorado, I used these one mile markers to measure the speed of the jet that I was on.
33.4 seconds for 5 miles, 45.2 seconds for 7 miles, 32.7 seconds for 5 miles. This is an average of 6.6 seconds/mile
.152 miles/sec * 3600 sec/hr= 547 miles/hour. Another trip: 10 miles in 67 seconds on 12/18/10 equals 537 mph

Movies:

1.Bugatti Veyron lake Crash 8.0 liter W16 engine. Average speed around an oval 268 mph. 1200 horsepower. 0 to 62 mph in 2.5 seconds. Standing quarter mile in 0.2 seconds. 1.7 million dollars. Galveston, TX. Motor was running for 15 minutes. $2 million insurance claim. He claimed that swerved to avoid a pelican while trying to pick up his cell phone that dropped. Convicted on insurance fraud. (Mute the sound!)
https://www.youtube.com/watch?v=4NJmB1F2mdE

2. Slam dunk contest: hang time less than 1 second. Contest: In one second of hang time, your center of mass would go up 1.25 meters. Michael Jordon (1.22 m) Spud Webb (1.17 m) I challenge them to jump 1 meter to qualify for points on a test.
https://www.youtube.com/watch?v=jYbx_PV3318

3. Relative Velocity: Endless pools. (0 to 45 seconds)
https://www.youtube.com/watch?v=LvqGEOOlUf8

4. Water slide into a small pool. (this is faked!) Also Mythbusters Water Slide
https://www.youtube.com/watch?v=ZsQSlNtzLcA
Mythbusters water slide (0-2:45): https://www.youtube.com/watch?v=iHu6LVg-0Hs

Newton's Second Law

1. Bowling ball and bowling pin. Hit the bowling ball with the bowling pin. If hit in the same direction of motion, it speeds up, but only when hit. In the opposite direction of motion, it slows down. Hit at right angles it changes direction without changing speed. Hit at an angle it changes both speed and direction. (You should be able to get used bowling pins from a bowling alley)
2. Water Balloon catapult/slingshot outside. Try different balls (masses) golf ball, tennis ball, baseball, crochet ball and different pulls on the catapult to illustrate N2 Law. You can buy one or make one using surgical tubing, here is one example https://www.instructables.com/id/Water-Balloon-Catapult/

3. Skate board or roller cart propelled by a long bungee cord, held by about 6 students total. The further the stretch, the greater the acceleration. If a second person is added to the cart, the acceleration is less.

4. Free Fall=weightlessness
    a. Pogostick with Jester's hat. Tips of the cap rise up in the air, when off the ground.
    b. Koosh balls tossed at an angle matches a parabolic curve on the white board

5. Coffee filters (terminal velocity) v is proportional to the square root of the mass. So four as much mass, but the same area, produces twice the terminal velocity. They float very smoothly to the ground Just next them on top of each other to increase the total mass. When you nest them like that, the cross sectional area remains the same.

6. Terminal velocities:

	maximum speed	distance to reach 95% of speed
16 lb shot put	325 mph	2500 m
Skydiver	135 mph	430 m
Penny	100 mph	
Baseball	94 mph	210 m
Tennis Ball	69 mph	115 m
Basketball	45 mph	47 m
Ping pong ball	20 mph	10 m
Raindrop (r=1.5 mm)	16 mph	6 m
Parachutist	11 mph	3 m

7. Jack LaLane: At the age of 65, in 1979, he towed 65 boats in a lake near Tokyo, Japan. He was handcuffed and shackled and the boats were filled with 6500 pound of Louisiana Pacific wood pulp.
8. Golf ball: a dimpled spinning golf ball will travel 230 years, but 160 yards in a vacuum. This is caused by the lift. Dimples improve the lift and decrease the drag.
9. Fast moving projectiles (satellites): if traveling at 5 miles/sec (8 km/s) , they will fall 5 m (16 ft) in one second. This is the curvature of the Earth. (every 8km, the Earth curves away by 5 m)
10. Cat is less likely to be injured falling from a 20 story building than a 5 story building. Cat reaches terminal speed in 6 stories. Body is an accelerometer not a speedometer. If cat senses acceleration it is frightened and keeps its feet underneath its body, its head tucked in, and its spine bent upward, making surface area small and terminal velocity large and injury likely. Once it reached terminal velocity, acceleration vanishes, cat relaxes somewhat stretching its legs and neck horizontally and straightening it spine, like a flying squirrel. This increased surface area, which increases air friction and the cat slows because air friction is greater than weight. This reduces the risk of injury. Just before landing the cat pulls legs back beneath its body to prepare for landing.

11. Large mass hung by a string and with a string underneath. When pulled gradually stronger, the top string breaks because the tension in the top string will be greater than the tension in the bottom string. But when jerked, the bottom string breaks, because you are trying to accelerate the large mass quickly, and the string (if its not too thick) can't provide the force to do that..
12. Egg thrown into sheet, doesn't break. The force required to stop the egg, depends upon the stopping distance. The sheet moves a lot more than the floor will move when stopping the egg. You can call this, and other "egg" experiments, eggciting physics.

Movies:

1. OK Go "Upside down and Inside out" Weightlessness filmed in a Vomet Comet
https://www.youtube.com/watch?v=LWGJA9i18Co

2. Pulling a Jumbo Jet: Mark Kirsch.
https://www.youtube.com/watch?v=tls-Jli6eQE

3. Monkey and Hunter video
https://www.youtube.com/watch?v=JNYSeIBA5Gk

4. High Dive into 12 inches of water
https://www.youtube.com/watch?v=N-woF3BVmlo

5 Death by Falling Penny
https://www.youtube.com/watch?v=PHxvMLoKRWg

6. Dropped Slinky: Have students predict what will happen. It's very surprising.
https://www.youtube.com/watch?v=wGIZKETKKdw
This second video should happen automatically
https://www.youtube.com/watch?v=eCMmmEEyOO0

Newton's Third Law

1. Bowling ball and bowling pin. Roll the bowling ball at a relatively high speed into the pin and ask which one was hit harder. They will probably all decide that the pin got hit harder. The forces are of course the same, but the mass of the bowling is so much greater than the pin, that it has a much smaller acceleration.
2. Basketball and tennis ball. Have the tennis ball on top of the basket ball and drop them both together. You can also use a baseball on top, but just be sure you don't hit yourself or a student. It's fun with an egg on top, but if you use an egg, the ball has to be slightly deflated. Action and Reaction
3. Tug of war. Pick a small student, then at the last minute you must sit on a skateboard. Ask who pulled harder on the rope. It's of course, who pushes harder on the ground.
4. Scales to pull on each other and of course both also read the same thing, whether or not you are looking at them. Or whether one or two people are doing it.

5. Click clack balls or newton's cradle.

6. Rocket balloons (buy on-line) These two devices are great Newton's Third Law demonstrators. They work particularly well outdoors. Inside, they tend to find a wall and

keep trying to go forward. You will definitely want a pump, as it is illustrated above. Just Google "Rocket Balloons" to find them

7. Walk on Cart and the cart goes backwards and you go nowhere. (If you have a wide cart, that is long enough to get a step or two.

8. Breaking boards. Get a 1x12 pine board , cut in 3 to 5" segments. Someone holds the board and you give it a Karate chop. It's really impressive. The easiest to do is, of course, the 3" segment, but the 5" is not too bad. Just make sure to follow through. I like to use the heel of my hand. When you cut it into strips, they will be 12 inches long and 3 to 5 inches wide and you will naturally be breaking them with the grain.

   Videos:

   1. Flyboard (water jet pack) (2:40 to 3:30)
      https://www.youtube.com/watch?v=LHL16av4C9k

   2. Rosencrantz and Guildenstern- Newtonian Physics (1:43 +)
      https://www.youtube.com/watch?v=w5_ayuaCzZs

Energy

1. Lifting a weight with a spring scale to illustrate work. (spring scale comes through again). You can illustrate that as you move up at a constant speed, the force stays the same and W=F*D
2.Push really hard against the white board for a few seconds, to illustrate that getting tired and doing work are not necessarily the same thing. I like to try to get red in the face by really pushing.
3.Pull a weight up an inclined plane with a **spring scale**. If the angle of the incline is 30 Degrees, the force will be half the weight and the distance will be twice the distance of just lifting it up. This is better with a cart with wheels, so that the lack of friction will keep the results as expected.
4.Illustrate simple machines with a lever and a pulley system. It's easy to lift someone with one hand. If a metal rod is place on the table, with 1/10 of the metal rod off the table, it will be virtually impossible for someone to push down on the rod if someone has just one finger on the other end. (This is also a good torque demo.) Try placing a plank on the ground, and having a student lift you with one hand.
5. Show energy conversion by lifting a koosh ball (Wheaties to PE) , dropping it (PE to KE) and having it hit the ground (KE to heat). Also discuss "solar Powered" world. We are all solar powered: We eat food that grew using the sun's energy, fossil fuel was once living plants, hydro power is there because the sun evaporated the water than rained on the land upstream from the reservoirs, etc.

6.Efficiency: incandescent bulb 5% car engine 20%

7. Wheels on suitcases weren't invented (patented) until 1972. No work is required to move a suitcase horizontally, so why hold it off the ground, which is not easy.
8. Hang a 1 kg mass from the ceiling with a strong string. Pull it back to your nose and Let go. This big pendulum is an example of the Conservation of Energy. . (If you let a student do this, make sure that they don't lean in for a better look.)

Movies:

1.OK Go: "this too shall pass" Rube Goldberg Device
https://www.youtube.com/watch?v=Y8cuuP4Jmio
It actually worked 3 times all the way through, but it took 60 trials to get there.

2.Toppling Dominos (2 videos)
Falling Dominos: Conservation of Energy
https://www.youtube.com/watch?v=y97rBdSYbkg
World's Record Toppling Dominos
https://www.youtube.com/watch?v=JcJv7l2W_h8 (2:55-3:28)

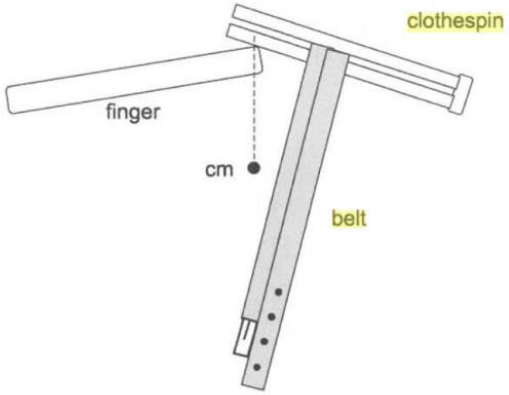
3. Case of the Powerful Pulleys-simple machines
NAS Sci Files (17:45 to 21:04)
https://archive.org/details/case_of_the_powerful_pulleys

Rotation

1. Two coins on a rotating table. The inner and outer coins have same angular velocity but different tangential or linear velocities

2 . Torque: Use socket wrench, look at where you hold onto a crescent wrench.
Handle is far away from hinges on a door, to give better torque. Have one student put two hands on the middle of the door and then you open the door at the handle with only one hand.
3Center of mass tricks: Try to pick up a dollar bill while standing against the wall with your heels against the wall. Stand with your left hip, left shoulder and left foot against the wall and try to raise the right foot.

4Clothes pin and belt.



5.Ball on string in a circle and strings can only pull. YOU CAN'T PUSH A ROPE. This is centripetal force, or force in toward the middle.

6.Cup of water on a board swung around the head. Cup stays on the board. Because of inertia, the cup is moving forward, but the board keeps pushing it inward in a circle. Maybe let the student start with a Koosh ball and graduate to a cup of water.
https://www.phys.vt.edu/outreach/projects-and-demos/demonstrations-wiki/mechanics/centripetal-acceleration-wiki.html
https://www.youtube.com/watch?v=O85EpbO9cxA I make mine out of a pegboard.

7 The old figure skater Trick (Conservation of Angular Momentum)
Find a chair that rotates easily. (the student's chairs in my physics lab work great)
Take something massive in both hands. It could be 2 kg mass, or 5 lb sacks of sugar, etc. You can also do it without the added masses in the hands. Take your feet off the ground, and put your hands and feet out as far from the center of rotation as possible. Have a student start you spinning fairly slowly or you can use your feet to get you spinning. When you bring your hands and feet in close to your body, you will be begin to spin faster. When you put your legs and feet out again, you will slow down. I've done this on a stool before, but I prefer a much more stable chair.

Movies:

1. Case of the Phenomenal Weather-Centripetal Force and Center of Mass
   NASA Sci Files 19:00-21:04
   https://archive.org/details/**case_of_the_phenomenal_weather**

2. 2001 Space Odyssey: artificial gravity
   https://www.youtube.com/watch?v=1wJQ5UrAsIY

3. Spies like us: g force training
   https://www.youtube.com/watch?v=0dlG5B6eQHg

Fluids

1. Cartesian Diver: You can make it with a cheap pipette, a water bottle, and a nut.
   https://buggyandbuddy.com/cool-science-kids-make-cartesian-diver/
2. Water tank: toss in various objects and see which ones float. If you use the big tank, a 10 lb bowling ball will float. Diet sodas will float and regular sodas will sink
3. Block of Slate or a brick: laid on different sides will produce different pressure
4. Two different pieces of granite, one large and one small. (You can use any two objects of the same material but different volume) Ask which one has the greatest density. Students will usually guess that the heavier object is dense. Its hard to sense density directly.
5. Densities: Water 1, Seawater 1.03, Dead Sea 1.3 Granite 2.7, Sand 2.8 Basalt 2.9 Limestone 2.5 Slate 2.7 Marble 2.6 Glass 2.6 Carbon 2.6 Cork 0.225 Gasoline 0.72 vegetable oil 0.92 Motor 0.85 Aluminum 2.7 Iron 7.8 Gold 19.3 Lead 11.3 Magnesium 1.7Mercury 13.6 Platinum 21.5 Uranium 18.7 Douglass fir 0.6 Alder 0.5 balsa 0.1 Maple 0 .7 Oak 0.9 White Pine 0.4 Ebony 1.

Movies:
Falkirk Wheel
https://www.youtube.com/watch?v=ucg1O-5jsnM

Great Salt Lake 14% salt in the south, 30 % in the north Dead Sea 33%
https://www.youtube.com/watch?v=N0fGByigs2M

Spinning ball drop off dam
https://www.youtube.com/watch?v=QtP_bh2lMXc

Temperature

1. Different kinds of thermometers: mercury, electronic (variable resistance), infrared, hand

boiler. Kids love to try the hand boiler, or to have their temperature taken with the infrared thermometer. It's amazing how different hand temperatures are. I like the type illustrated above. You should be able to find it in number of different places. When you put your hand around one bulb, the fluid seems to boil in the other one. Actually you are just causing the volatile fluid to evaporate, which increases the pressure on the one side. Some student's hands are so "cold" that it won't work.

2. Blow torch that heats up first a metal ball so that it won't fit through the ring, then heats up the ring. The ball and ring demo is found in a lot of places.
3. Bimetal strip: Two different metals expand at different rates and cause the strip to bend. You will need a blow torch or something similar for these last two demos.
4. One person puts hand in hot water then in warm water. The other puts hand in cold water then in the same warm water. They will both give conflicting ideas of what the second container of water feels like.

Convection, Conduction and Radiation

1. Dust explosion with Lycopodium powder (do it outside). You can order lycopodium powder, but it must be delivered to the school. I used to purchase "dragons breath" through magic shops, but it comes in very little bottles. See the beginning of the viral video, to see how you blow it from a funnel through a flame. I always do this one outside. https://twitter.com/its_riccaa/status/1204834518089289729?lang=en First on the video
2. Place a small ice cube on a large piece of metal and another ice cube on the table top and see which one melts first. (Conduction). Have them touch metal and touch wood, to see which one feels "colder".
3. Blow through an open mouth (warm), then blow through pursed lips (cool)

Movies:
1.Firewalking-David Willey and Bristol Firewalk
https://video.search.yahoo.com/yhs/search?fr=yhs-adk-adk_sbnt&hsimp=yhs-adk_sbnt&hspart=adk&p=david+willey+firewalking#id=4&vid=4f58733dc9a4b4f6388fd69a9e728a10&action=view short version----Tossing coal back and forth
https://www.youtube.com/watch?v=hl5OpffxVg4 long version- tossing coal and walking on coal. David Willey (Skeptical inquirer begins at 9:45 and runs for about 3 minutes)
https://www.youtube.com/watch?v=-iBFwpKV6ak Bristol Firewalking

2.Jearl Walker-Hand into molten lead
https://www.bing.com/videos/search?q=johnny+carson+and+david+willey+molten+lead&view=detail&mid=BD667932FB62258ADD31BD667932FB62258ADD31&FORM=VIRE

Electrostatics

1. Scotch Tape. Two pieces of tape put on the table and the "ripped" off quickly will repel each other. However, f you put one piece on the table and the other piece on top of that one, then they will be charged oppositely and attract.
2. Rub the plastic rod with the fur (or use a comb and your hair) and it will attract neutral objects (small pieces of paper, soda cans laying on their side, rice krispies, etc.) Rub a balloon on your hair and then stick it to the wall. These all illustrate Polarization, however, they don't work on a really humid day

Electricity

1. Light a bulb with a battery, then two batteries, then three batteries.
2. Light a bulb with a hand held generator. The faster the crank, the brighter the bulb.
3. Set up one bulb in a series circuit with two batteries in series. Now add a second bulb and then a third bulb to the circuit. Watch the bulbs get dimmer.
4. Do the same thing with a parallel circuit, adding one light at a time.
5. Conservation of energy: use the hand crank generator to light the bulb, then unscrew the bulb and it becomes much easier to turn. The faster you turn the crank the brighter the bulb. Here you are increasing the voltage by turning faster.
6. Genecons: If you add bulbs in parallel, one at a time, and turn the crank at the same speed, the bulbs will grow equally bright, but it will get harder and harder to crank. If you put bulbs in series one at a time and turn at the same speed, it will get easier and easier to crank. Since power is work divided by time, and the cranking is the same speed, the less force to turn the crank, the less work done, and the less the power needed. Genecon's are really cool. If you have two, one will function as a generator and the other as a motor. Genecon's can be purchased for about $50 from Arbor scientific or Nada scientific.

7. Price of electricity: It's 8 cents per kilowatthour in Idaho, 10.5 cents in Virginia, 15 cents in California and Rhode Island, 18 cents in New York and 33 cents in Hawaii.
8. Comparison of energy usage in various types of bulbs
   60 watt incandescent produces the same amount of light as a 14 watt Compact Fluorescent bulb and a 7 watt LED bulb. The average lifetimes are 1200 hours for the incandescent, 8000 hours for the CFL and 25,000 hours for the LED.

Waves

1. Use a long spring to illustrate velocity. It's independent of frequency or amplitude. But if you stretch it and increase the tension, the wave speeds up..
   You can buy a long spring (about 6 feet long) for about $20 from Pasco Scientific (called a Snakey) or from Educational Innovations. These springs can stretch to 30 ft.
2. Use a long spring to show standing waves. Try to get the harmonic, second harmonic, third harmonic etc.
3. Use guitar to illustrate that half the string gives twice the frequency or one octave.
4. Also play with singing glass, singing aluminum rod.
   Any stemmed glass should work. Hold it by the stem, and rub your finger along the top. It takes a little practice. You can change the pitch by putting different amounts of water in the glass. (See Dance of the Sugar Plum Fairies)
   A standard aluminum lab rod can be made to vibrate, if you hold it at the middle (a nodal point) and stroke it with your fingers that have been made sticky with rosin. It makes a really loud high pitch. You must press fairly firmly with your fingers, and you can't use a "fat" aluminum rod.

Movies:

1.Dance of the sugar plum fairies-glass harmonica
https://www.bing.com/videos/search?q=glass+musical+instrument&&view=detail&mid=03BC79A80AA1E2B8611403BC79A80AA1E2B86114&rvsmid=12701561C42F5919660A12701561C42F5919660A&FORM=VDQVAP

2.Tacoma narrows bridge collapse (2 videos)
https://www.youtube.com/watch?v=XggxeuFDaDU
https://www.youtube.com/watch?v=qbOjxPCfaFk (0-45 sec)