Mechanics

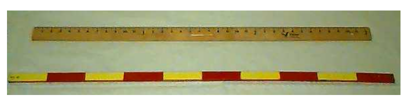
1A MEASUREMENT

1A10 Basic Units

Basic Unit Set - vepd 01-01 - 1A10.10 Show a clock with a second sweep, meter and yard sticks, and kilogram and pound mass.

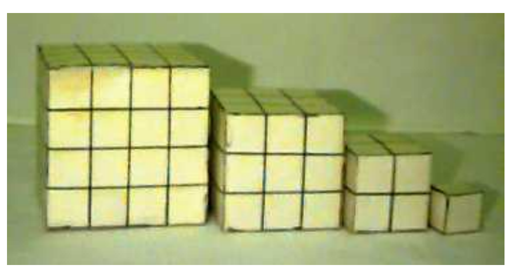
Standards of Mass - 1A10.20 Two Brass bars are used to show the difference in mass between the kilogram and the pound at sea level. The two bars are made of the same material to aid in student understanding. The difference in mass is easily seen by the difference in volume. The bars can also be passed around the room so that the students can inspect them closely. 1Kilogram has a weight of 2.205 pounds at sea level.

Standards of Length - 1A10.30 A meter stick and a yard stick are provided to compare. A nice twist to this demonstration is to request a globe and talk about the original definition of the kilometer: The line from the pole to the equator through Paris was 10,000 kilometers.



Painted Meter Stick - 1A10.35 A standard meter stick is painted on the inch side in alternating yellow and red every 10 centimeters. This allows the class to read the meter stick from their seats with some accuracy. The metric side is not painted allowing the instructor to make a more accurate measurement. This meter stick is used for various demonstrations including, but not limited to, Standards of Mass and Stretching a Spring.

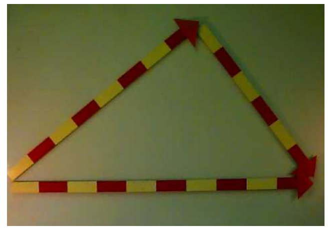
Inch Cubes - 1A10.51 Four cubes are supplied with cross sections of 1 inch square, 4 inches square, 9 inches square and 16 inches square. The cubes are used to help explain volumes.



1A40 Vectors

Meter Stick Vectors - 1A40.11 3 meter stick vectors are available of approximate lengths 61.5 cm, 84.5 cm, and 111.5 cm.

Vector Components - vepd 01-04 - 1A40.14 Animation "For the purpose of vector mathematics, vectors may be broken down into their components along the coordinate axes."

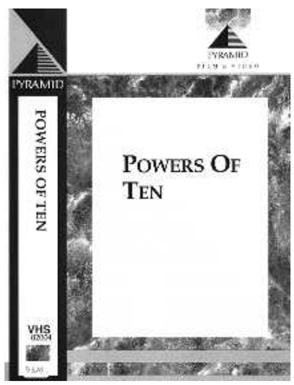


Vector Addition and Subtraction - 1A40.30 Use magnetic vectors on the white board to show head-to-tail or parallelagram addition or subtraction.

Vector Addition (parallelogram) vepd 01-02 - 1A40.31 Animation of vectors being added using the parallelogram method.

Vector Addition (head to tail) vepd 01-03 - 1A40.33 Animation of vector addition using the head to tail method.

1A60 Scalling



Powers of Ten - 1A60.10 This VHS film runs about 10 minutes. Here is the quote from the film: "POWERS OF TEN is an adventure in magnitudes. Starting at a picnic by the lakeside in Chicago, this famous film transports you out to the edges of the universe and in to the micro-world of cells, molecules, and atoms. It is a careful picture of the universe as we currently know it, according to the best available evidence and scientific explanation."

1C MOTION IN ONE DIMENSION

1C10 Velocity

Truck on Moving Sheet - 1C10.10 Demonstrate superposition of velocities by pulling on the sheet below the moving tractor. Place the constant speed battery powered tractor at one edge of the sheet of paper. Turn the tractor on and pull the sheet of paper at a constant speed so that the c ar remains motionless relative to the table. The tractor can also be used to show how boats cross rivers (1E10.10) while their relative velocity to the shore remains zero.

Pasco Dynamics Cart - 1C10.20 1.2 and 2.2 meter tracks are available. These carts are near frictionless. They are very good for showing constant velocity, acceleration, elastic and inelastic collisions. In fact most things that can be shown on an airtrack can be shown with these carts .

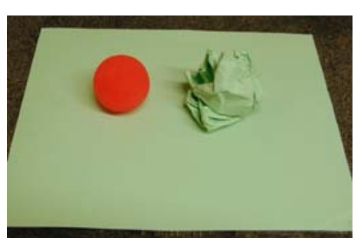
Air Track and Glider - 1C10.25 An excellent demonstration for showing constant velocity. The blower is a little loud, but you can talk over it. If a little friction is not a problem, then a quieter alternative is the Pasco Dynamic Carts . If you are showing collisions, the demo room highly recommends the Dynamic Carts.

1C20 Uniform Acceleration

Penny and Feather - 1C20.10 Shake the lead ball and feather to one end of tube. The tube is filled with air. Quickly bring the tube to a vertical position and watch the objects fall. Connect the tube to the pump. It takes less than 1 minute to pump air out of the small tube. Close valve and disconnect from pump and repeat as with air.

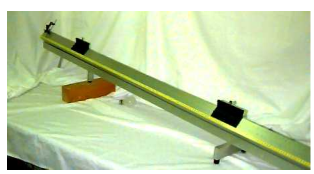
Drop Lead and Cork Balls - 1C20.15 Simultaneously drop a lead and cork ball while standing on the lecture bench or step ladder. This demonstration is used to show that the acceleration due to gravity does not depend on the mass of the object. F = G(Mm)/(r*r) = ma. Solving this for acceleration gives: a = GM/(r*r).

Drop Ball and Paper - 1C20.16 Simultaneously drop a ball and a sheet of paper. The ball falls much faster. Crumple the paper into a ball and repeat the experiment. The crumpled paper experiences a smaller force directed upward due to air resistance. The class will notice that the ball and the crumpled sheet of paper accelerate downward at similar rates.



Equal Time Equal Distance Drop - 1C20.20 The two strings have washers tied at different increments. The first string has the washers tied at equal increments. When dropping the string onto a pie plate a loud clang is heard with each collision. The students hear that the time between the collisio ns gets smaller. You should repeat this part of the demonstration a couple of times so that the students understand what they are listening for. The second string has the washers seperated such that the time between collisions is equal and .22 seconds. The distance for washer placement was calculated using the equation: x=(1/2)a(t*t) where t = .22, .44, .66. Tips for dropping the strings Hold the strings and allow the bottom washer to touch the pie plate. Make sure there is no slack in the line and drop. The students will start mentally timing the demonstration when you let go of the string. If you drop the strings with the bottom washer above the plate, the timing will probably be off.

Inclined Airtrack/Pasco Carts - 1C20.30 THIS WORKS BETTER WITH PASCO DYNAMIC CARTS (1C10.20) Air track will be leveled. Place aluminum blocks under single leg of air track to create desired incline. Sonic ranger can be used to measure acceleration with the Pasco Dynamic Carts.



1C30 Measuring g

Free Fall Timer - 1C30.16 Use an electronic timer to measure the time interval for a steel ball to drop 1 meter and 0.5 meters.

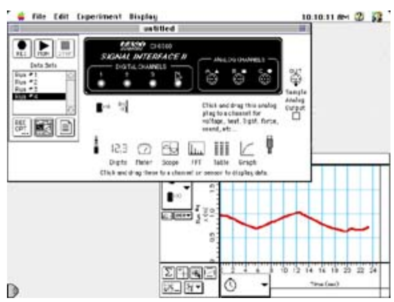
Catch a Meter Stick - 1C30.55 Hold a meter stick up and have a student hold their fingers beside the 50 cm point. At some random time drop the meter stick. Have the student grab the meter stick the instant they see you drop it. Measure the distance from the 50 cm mark to the point where they caught the meter stick. Convert distance to reaction time. t = square root of (2d/g)

Catch a Dollar - 1C30.551 Have a student try to catch a dollar with their fingers starting at the middle point as you drop it. The dollar is out of their reach in about .1 seconds. This is faster than the average reaction time and the dollar will fall to the floor.

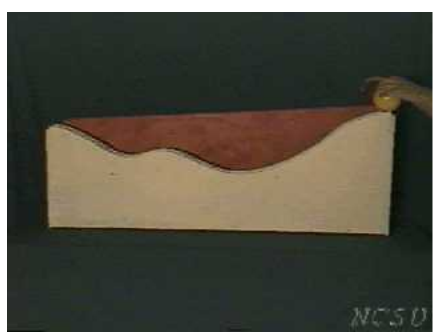
1D MOTION IN TWO DIMENSIONS

1D15 Velocity, Position, and Acceler

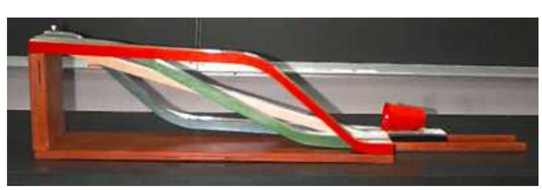
Ultrasonic Ranger and Student - 1D15.10 A student walks toward and away from a sonic ranger. The computer displays graphs of position, velocity, and acceleration vs. time. For best results, hold a book or piece of poster paper. This gives the sonic ranger a good surface to reflect off. The sonic ranger can also be set up with the air track or the Dynamics Carts.



High Road/Low Road - 1D15.20 Both balls begin and end at the same height. One ball travels on a low hilly path and the other on a straight incline. The ball traveling the low path converts more of its potential energy to kinetic energy. This gives it enough extra velocity to make it to the end faster even though it must travel farther.

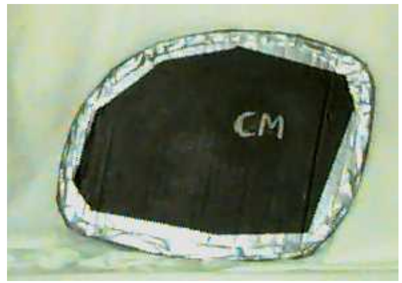


Potential-Kinetic Energy Tracks - 1D15.201 Four tracks of the same height, but with different profiles, are arranged side by side. Despite the initial differences in acceleration, you can show that identical objects launched from the same height will all leave the track at the same speed. A seperate track holds a plasic cup mounted to an eraser for friction. When the ball rolls into the cup, it is pushed back the same amount no matter which track the ball comes off from.



1D40 Motion of the Center of Mass

Throwing Board - 1D40.14 This is an irregularly shaped weighted board. The demonstrator throws this board and the class can observe the rotation around its center of mass. The demonstrator can also point out that the center of mass follows a smooth trajectory even though the board seems to jump all over the place.



1D50 Central Forces

Ball on a String - 1D50.10 A tennis ball is tied to a string. Twirl in a vertical circle so the students can see the path of the ball.

Whirligig - 1D50.20 A small nut and a large mass are connected together by a string that passes through a copper cylinder. When you hold the cylinder, the large mass falls pulling the smaller mass to the cylinder. If the small mass is spun in a circle at a high enough angular velocity, the tension in the string will be enough to hold up the larger mass. If you spin the small mass faster, the large mass will rise. If you slow down, the large mass will fall.

Conical Pendulum Game - 1D50.29 Swing a conical pendulum so it will strike a peg directly under the support on some swing other than the first.

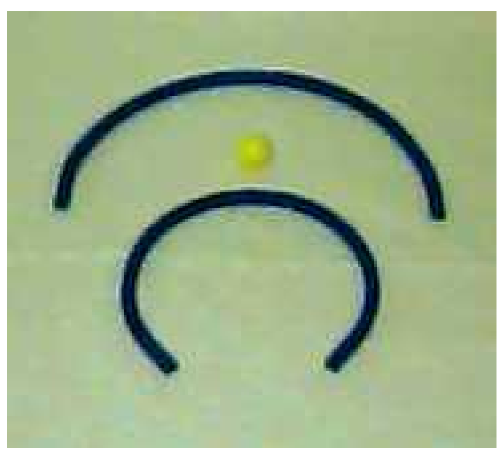
Pail of Water/Pail of Nails - 1D50.40 A platform holding a cup of water is spun in a circle to show central forces. If you get brave, try spinning the platform in a horizontal plane. This demonstration is easy to master, but please practice if you have never performed it (or at least ask for a towel).

Penny on the Coat Hanger - 1D50.45 Balance a coin on the coat hanger as shown. Place the coat hanger on a finger and twirl. With care, the penny will remained balanced upon stopping. This takes some practice.

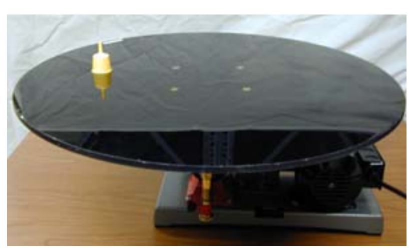
1D52 Deformation by Central Forces

Flattening Earth - 1D52.10 Two metal strips are bent into a circle and mounted on a pole to form a sphere. The tops of the circles are not mounted, but the pole sticks through a hole in each of them. When the pole is attached to a motor and spun up, the sphere flattens out.

1D55 Centrifugal Escape



Broken Ring - 1D55.10 Curve the flexible plastic barrier into an arc. Roll the ball around the arc and have the students observe its path. The arc applies a force on the moving ball causing it to accelerate towards the center thus moving in a curved path. When the ball leaves the arc, no force is being applied and it rolls in a straight line.



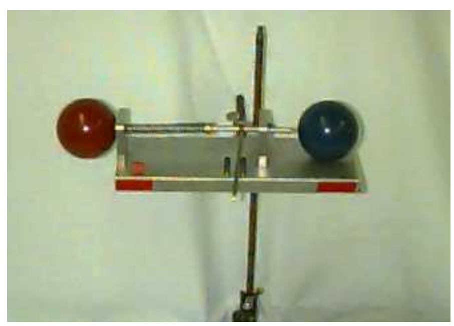
Falling off the Merry Go Round - 1D55.30 Place the object on the turn table and spin the table at various speeds.

1D60 Projectile Motion

Ball to Throw - 1D60.05 Several balls are available for throwing accross the room to show the parabolic path followed by a trajectory: softball, large nerf ball, whiffle ball, basketball, tennis ball and many more.....

Howitzer and Tunnel - 1D60.10 The Howitzer is attached to a Dynamics Cart. The ball is shot straight up when the cart passes a photogate. The ball then follows a trajectory and lands back in the cart. The cart must be moving at a constant velocity for this demonstration to work. If requested, a pulley and mass will be attached. As the cart accelerates, the ball will fall short of its target. Tunnel is optional.

Howitzer and Tunnel on Incline - 1D60.15 The Howitzer is attached to a Dynamics Cart. The track is inclined. The ball is shot when the cart passes a photogate.



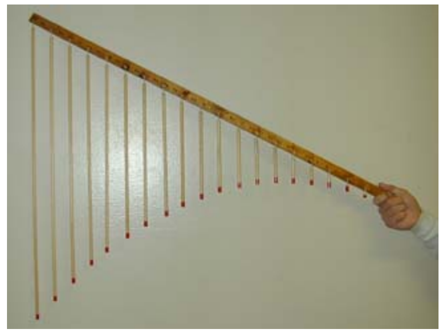
Simultaneous Fall - 1D60.20 Two balls begin with no vertical velocity, but one of the balls has a horizontal velocity. This demonstration shows that if both balls start with the same vertical velocity, that no matter what the horizontal velocity, they will land at the same time. This version uses large balls and can be heard by all classes. The spring on this model is very tight and difficult to reload in class.

Simultaneous Fall Small - 1D60.201 This demo operates similar to the large version. The balls are hard to be seen by students, but the sound of the balls striking the floor can be heard by all. This model is easier to repeat in class.

Simultaneous Fall Pop Gun - 1D60.202 A small toy gun uses a dart equipped with a ping pong ball on the tip. When the ping pong ball is fired horizontally, release the extra ping pong ball you hold in your hand. They will land at the same time. This is very easy to do.

Monkey and Hunter - 1D60.30 Due to the violent and cruel nature of this demonstration, North Carolina State University does not condone the shooting of monkeys. The demo room has two items it considers PC to shoot at; (1) a metal target, (2) the UNC-CH mascot. Aim at the tarheel's chest. Load ball by pushing it to the bottom of the barrel with the stick. Push reset button on black box. Pull string to shoot.

Range of a Gun - 1D60.40 This demonstration can be done using a dart gun or the Pasco projectile launcher.



Parabolic Trajectory - 1D60.60 The pendula show the path of a projectile whose initial angle can be adjusted by pivoting the rod. The length of each dowel is proportional to the square of the distance from the pivot point.

Dropping the Bomb - 1D60.70 A drop rod accessory is attached to the Pasco Howitzer and Tunnel apparatus. When the cart passes the photogate, the Flourescent pink ball will drop into the bucket on the cart. A Flourescent light can be supplied upon request.

1E RELATIVE MOTION

1E10 Moving Reference Frames

Crossing the River - 1E10.10 Place tractor at one edge of the sheet of paper. Turn tractor on and pull sheet of paper at a constant speed so that the tractor remains motionless.

Frames of Reference - 1E10.20 This is a classic 1960 film by Professor Patterson Hume and Professor Donald Ivey of the University of Toronto. The film starts and ends with a Foucault pendulum. This film is available on videodisc and can be projected to a large screen. Running time: 30 minutes

1F NEWTON'S FIRST LAW

1F10 Measuring Inertia

Inertia Balance - 1F10.11 The inertia balance is designed for use in a laboratory experiment in which mass is quantitatively measured independent of the earth's gravitational force. This same method is used in determining the mass of an object under weightless conditions in space flights. The apparatus consists of two small platforms connected by two horizontal, nonsagging, spring-steel blades. A cylinder with a shoulder on which it can rest in a hole in the platform and a hook by which it can be suspended are included. This cylinder may be used as an object of unknown mass.

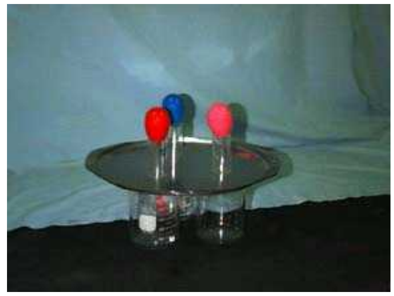
1F20 Inertia of Rest

Inertia Ball - 1F20.10 Insert bar through loop below steel ball and push down with hands out of the path of the falling ball. Push slowly for one ball and with a quick jerk for the other one. Have the students guess where the string will break. Steel ball is about 7cm in diameter and weighs about 1300 g.

Smash Your Hand - 1F20.20 Place the 116 Newton lead brick on your hand. Now smash the brick with a hammer. If done right, it will not hurt:-)

Hit the Nail on the Head - 1F20.22 Drive a nail into a piece of soft wood that is resting on your head. You can make this demo more comfortable if you add a few textbooks or a lead brick to the stack on your head.

Table Cloth Pull - 1F20.30 Leave some slack in the table cloth so your hands will come up to speed before the cloth becomes taut. We will be happy to practice with you prior to class.



Eggs and Pizza Pan - 1F20.35 Use a broom to knock a pie pan from under 3 cylinders holding eggs. The eggs will drop safely into 3 beakers of water.

Pen and Embroidery Hoop - 1F20.36 An embroidery hoop is balanced on top of a soda bottle and a pen is balanced on top of the hoop. The demonstrator snatches the hoop out and the pen falls into the bottle. Care should be taken to push or pull out the hoop in a direction parallel to the plane of the hoop.

Soda Bottles and Dollar Bill - 1F20.37 Two coke bottles are stacked on top of each other with a dollar bill between them. The top bottle is filled with water. When the dollar bill is pulled out, the water will flow from the top bottle to the bottom bottle without the bottles falling. The dollar bill needs to be pulled out very rapidly. It is recommended that you practice this in the demoroom before attempting in front of an audience.

Shifted Dynamic Carts Track Inertia - 1F20.50 Shift Dynamic Carts track back and forth under the cart and it will stay motionless.

1F30 Inertia of Motion

Cart on Track on Track - 1F30.30 A one meter Pasco Dynamics Cart track has wheels attached and is allowed to roll on the two meter Pasco track. Give the track an initial velocity with a cart riding on the small track. Stop the one meter track and show that the small cart continues at the initial velocity of the one meter track.

1G NEWTON'S SECOND LAW

1G10 Force, Mass, and Acceleration

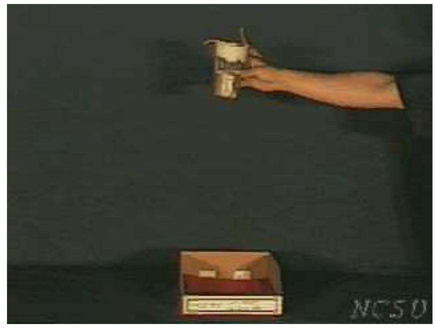
Motion Up an Inclined Plane - 1G10.13 Quantitative studies of the motion of a body on an inclined plane can be made quickly with this apparatus. A cart is pulled up the inclined plane by a mass suspended over a pulley at the top of the incline. The inclined plane is adjustable. The cart has a mass of 575.5 grams. Additional mass can be added to the cart.

Acceleration Block - 1G10.25 A wood block is accelerated by a mass on a pulley. You can add mass to the block or mass hanger.

Mass on a Scale - 1G10.30 Hang different masses on a spring scale and discuss the reaction of the scale to m*g.

Atwood's Machine - 1G10.40 The Atwood machine will be set up with different masses made available. A clock is available upon request.

1G20 Accelerated Reference Frames



Cups and Weights - 1G20.40 Masses hang from elastic cords over the sides of a large Styrofoam cup. Drop the cup and the masses fly into the cup.

Dropped Slinky - 1G20.45 Suspend a partly extended slinky in the air. Release the slinky.

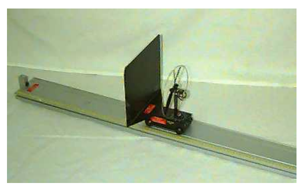
Float Accelerometer - 1G20.76 A cork is floating under water suspended by a string. When you accelerate the container, the cork moves in the direction of the acceleration.

Acceleration Pendulum Cart - 1G20.85 A pendulum is mounted on a moving cart. As the cart is accelerated, the pendulum bob is out to the side. At constant velocities, the bob points downward.

1H NEWTON'S THIRD LAW

1H10 Action and Reaction

Push Me Pull Me Carts - 1H10.10 Have two students stand on the carts and grasp the ends of the rope. Have only one student at a time pull on the rope. Observe that they both move. Use a long stick for pushing



Newton's Sailboard - 1H10.20 The fan on the Dynamics Cart track runs on battery power. Show with and without sail.

1H11 Recoil

Floor Cart and Medicine Ball - 1H11.10 Medicine ball weighs about 37 lbs. Throw the medicine and the cart will roll back slightly. It's not very dramatic so you need to practice this!

1J STATICS OF RIGID BODIES

1J10 Finding Center of Gravity

Map of North Carolina - 1J10.10 Hang map of NC on peg through desired hole. Hang plumb bob in front. Mark the position of the plumb line with a marker on the sheet of paper attached to the back of the state.

Center of Gravity of a Broom - 1J10.25 Support a broom on two index fingers. Slide fingers together. Your fingers will meet at the center of gravity.

Equal Torques, But Not Equal Masses - 1J10.251 Find the center of gravity of the broom. The broom has been severed at this point and is held together by a small dowel. Seperate the broom into two parts. Mass the two parts to show that the masses are different even though the torques were equal.

Meterstick on Fingers - 1J10.30 Slide your fingers under the meter stick to find the center of mass. Add a baseball cap to one end and repeat.

Kneeling Human - 1J10.41 Ask two students, one male and one female, to participate in this demonstration. The demonstrator asks both volunteers to kneel, put their hands behind their backs. The demonstrator places a small object directly beneath the heads of the volunteers and asks them to tip it over with their nose. Most women can do this while most men can not.

1J11 Exceeding Center of Gravity

Leaning Tower of Pisa - 1J11.10 The block stands when the top is off and falls over when the top is on. Adding the top moves the center of gravity beyond the edge of the base.

Tipping Block on Incline - 1J11.15 A mass is suspended from a string connected to the block at it's center of mass. Raise the inclined plane until the block tips over. Observe that the block does not tip over until the center of mass exceeds the base of the block, illustrated when the string and mass clear the bottom edge of the block.

Tower of Lire - 1J11.20 A set of eight wood blocks are stacked so the top block is completely over the edge of the table. The demo staff will be more than willing to build this stack with you sitting underneath. Step lengths go as L/2n

Double Cone - 1J11.50 Place the double cone on the lower end of the "U" and it will roll uphill.

1J20 Stable, Unstab., and Neut. Equi

Fork, Spoon and Match - 1J20.20 Insert a spoon in the prongs of a fork. Place a match in the prongs perpendicular to the spoon-fork match on the lip of a glass of water. Drink from the glass.

Fourteen Nails on One - 1J20.25 Balance the set of nails as shown. You may want to practice.

Spoon on Nose - 1J20.32 Clean the oil off your nose. Blow on a spoon. Hang it from your nose.

Balancing Bear - 1J20.45 A string will be stretched from one end of the lecture bench to the other.

Balancing Bird - 1J20.451 Show this toy bird balancing on its beak. Weights are located in the tips of the birds wings keeping the center of gravity below the pivot point.

Wine Bottle Balance - 1J20.60 A small piece of wood has a hole to hold the neck of the wine bottle. The wine bottle is balanced in an odd position. If you do not want to use a wine bottle, we have a hammer that works just as well.

1J30 Resolution of Forces

Suspended Block - 1J30.10 The sides of the triangle are in the ratio of 3:4:5. Slide the incline out of the way after the forces are balanced. The block will be suspended. The block has a mass of 427 g. The masses needed to balance the perpendicular and parallel forces are 342 g and 256 g respectively.

Tension in a String - 1J30.20 Lift the mass with a Newton meter. The scale reads 5.5 Newtons. What happens if the Newton scale is pulled from two sides with a force of 5.5 Newtons? The apparatus is set up with the scale facing away from the class. An additional mass and scale are provided to show the weight of single mass. Masses are identical.

Rope and Three Students - 1J30.25 Have the two largest students pull on the ends of the rope. A small student can easily deflect the rope in the perpendicular direction.

Booms - 1J30.40 A boom is suspended at various angles by a wire. A Newton meter can measure the tension in the wire.

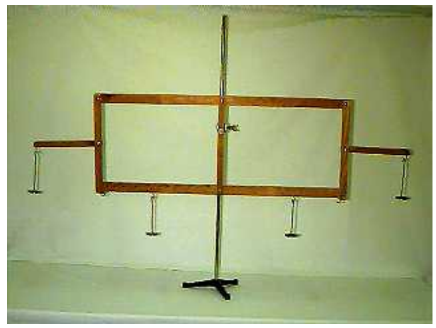
Sail Against the Wind - 1J30.60 First show with the sail set so the cart is blown away from the fan. Then set the sail so the cart moves towards the fan.

1J40 Static Torque

Grip Bar - 1J40.10 By rotating the handle, attempt to raise the masses so that the bar is horizontal. Mass is variable.

Torque Beam - 1J40.20 Use different combinations of masses and distances to show torques in equilibrium.

Different Radii Discs - 1J40.25 Two disks of different radii, but with the same center point are glued together. The demonstrator can show the effect of the radius on the torque by hanging different weights from strings attached to the different disc.



Roberval Balance - 1J40.50 Start with masses equidistant on bottom bar (A). Show the unbalanced condition (B). Move mass to the end (C). Many other variations are possible.

1K APPLICATIONS OF NEWTON'S LAWS

1K10 Dynamic Torque

Tipping Block - 1K10.10 Tip block over by pulling on hook with spring scale (Newtons). Vary angle between force and the block.

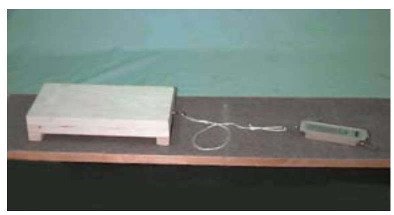
Walking the Spool - 1K10.30 Pull string. Angle between string and table determines which direction the spool will roll. At some angle the spool will remain stationary.

Rolling Uphill - 1K10.50 Disk has a hidden weight. The disk will roll uphill when the disk is placed so that the weight is uphill from the disk's geometric center as shown in the diagram.

1K20 Friction

Friction Blocks - 1K20.10 Measure static friction by noting the scale reading just before the block slides. Pull block along lecture bench at a constant speed to measure sliding friction.

Weight Dependence of Friction - 1K20.15 Measure the force of sliding friction with a block. Mass can be varied.



Area Dependence of Friction - 1K20.20 Slide a block on its flat side and measure the force of friction. Flip the block to its side with feet and measure again. The surface area ratio is about 10:1

Static vs. Sliding Friction - 1K20.30 Pull on a block with a spring scale until just before the block moves. Note the reading on the spring scale. Pull the block slowly across the table. Compare the spring scale readings. The top picture shows static friction, just before the block moves. The bottom picture shows kinetic friction, while the block is in motion.

Angle of Repose - 1K20.35 Raise the inclined plane until the block begins to slide.

Front and Rear Brakes - 1K20.40 The truck has holes drilled into both sets of wheels to allow a metal rod to be inserted to simulate locked brakes. Let car slide down incline and observe which gives more stable braking.

1K30 Pressure

Bed of Nails - 1K30.10 Lie down carefully on the bed of nails. Simutaneously make contact with a large number of nails. The nails are spaced 1 nail every 2 cm.

Balloon Bed of Nails - 1K30.15 Not crazy about laying on a bed of nails yourself? We have a small bed of nails for a balloon.When the balloon is resting on the nails, several books can be stacked on it before it pops. To prove the balloon is not a special balloon, the bed of nails can be replaced with a single nail. The balloon will pop on contact.

1L GRAVITY

1L20 Orbits

Orbits in a Spherical Cavity - 1L20.18 Several 1" Pasco balls can be used to demonstrate orbits in a concave mirror. A flat mirror can be set up to aid classroom visibility.

Conic Sections - 1L20.40 Each cut intersecting the cone produces the shape of a different orbital path; circular, elliptical, parabolic, and hyperbolic.

1M WORK AND ENERGY

1M10 Work

Shelf and Block - 1M10.10 Raise a block to the shelf and discuss the work required.

Pile Driver - 1M10.20 Raise the mass to the desired height and allow it to fall freely. If the mass is raised twice as high, the nail will be driven twice as far into the block of wood.

Pile Driver with Pop Cans - 1M10.25 Raise the mass to the desired height and allow it to fall freely. Three empty coke cans will be supplied.

1M20 Simple Machines

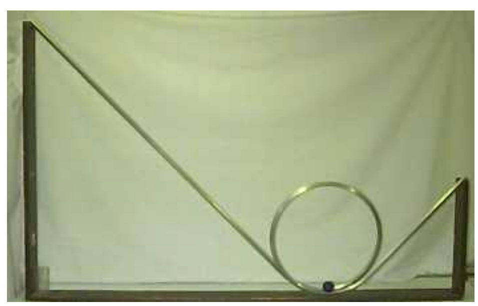
Pulley System - 1M20.10 One and two pulley systems can be hung from a ringstand and used to raise weights. Use a spring scale to find the mechanical advantage.

Levers - 1M20.40 Discuss the advantage of first, second and third class levers.

1M40 Conservation of Energy

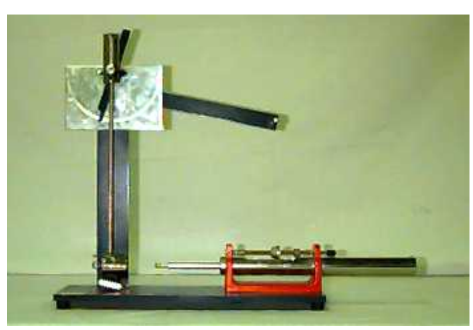
Bowling Ball Pendulum - 1M40.10 Stand straight. Bring the bowling ball up to your nose and release it WITH NO INITIAL VELOCITY. STAND VERY STILL until the ball swings back. DO NOT LEAN FORWARD.

Stopped Pendulum - 1M40.15 Raise the pendulum to one side and release it. The pendulum reaches almost the same maximum height at both ends of its swing. Some energy is lost. The rod used as the stop bar can be set to different heights.



Loop the Loop - 1M40.20 Release the ball near the top of the track. Energy losses make the minimum height (necessary to complete the loop) significantly higher than the calculated value.

Ball in Track - 1M40.30 A ball is released from a point on either incline. The ball loses little energy with each roll and rises to almost the same height on the other end of the track.



Ballistic Pendulum - 1M40.40 Cenco apparatus is available. Ball can be fired with different velocities and the pendulum movement is measured with protractor.

Rattleback - 1M40.90 Place the rattleback flat side up. Press down, quickly release and it will spin counter clockwise. Spin it clockwise to show that it stops, rattles, and spins counter clockwise. Spin the rattleback clockwise.

1N LINEAR MOMENTUM AND COLLISIONS

1N10 Impulse and Thrust

Egg in Sheet - 1N10.20 Have two students hold a sheet as shown. Toss an egg into the sheet. REMOVE THE EGG BEFORE THROWING ANOTHER. Demo Room needs notice to purchace eggs.

1N20 Conservation of Linear Momentum

Walk the Plank - 1N20.70 As the instructor walks along the attached floor carts, they will move in the opposite direction. The velocity of the floor cart is observable to the students by the moving flag. The result can be changed by carrying a medicine ball or placing the medicine ball on the cart.

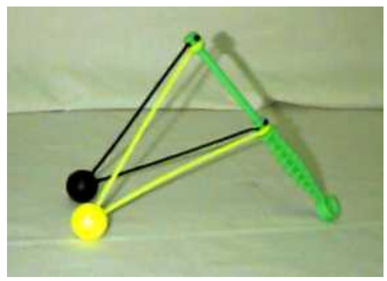
1N22 Rockets

Water Rocket - 1N22.20 Fill the rocket with a cap full of water. Insert pump into rocket, slide catch into position and pump 20-25 times. To release the rocket, aim and slide catch off. You will probably get wet. Pump the same number of times without the water to show the difference in range.

Balloon Rocket - 1N22.25 Blow up balloon and release it in the in the lecture hall.

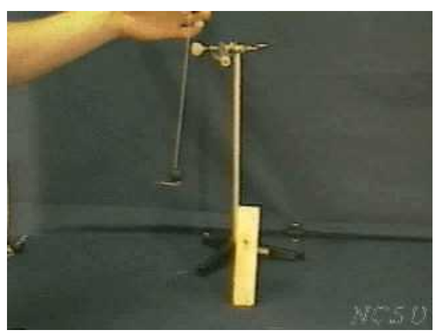
1N30 Collisions in One Dimension

Collsion Balls - 1N30.10 Observe the effect of displacing different numbers of balls. Try one ball first, then two and so on up to five balls at once.

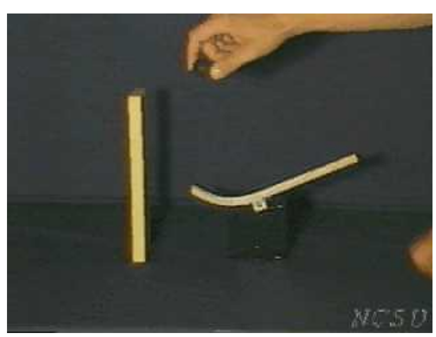


Irritating Collision Balls - 1N30.12 The first ball sits motionless while the second ball rotates around the stick. After the collision, the first ball goes around the stick while the second is motionless. The toy is habit forming to play with, but becomes annoying very fast if you are watching. Crack, Crack, Crack,...

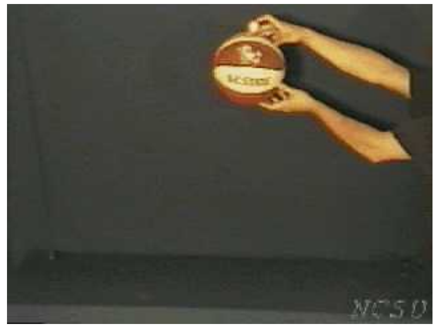
3 to 1 Collision Balls - 1N30.20 Two pendula on bifilar suspension have a mass differential of 3 to 1. Bring the smaller pendula back and release. When it collides with the larger pendula, they both recoil at the same rate to the same height. When they collide again, the large pendula stops while the small pendula recoils. The process repeats several times.



Impulse Pendulum - 1N30.50 Two pendulums are allowed to collide with a piece of wood. One pendulum is made from a super bounce ball. It easily topples the block. The second ball is a non-bouncing ball and fails to topple the block.

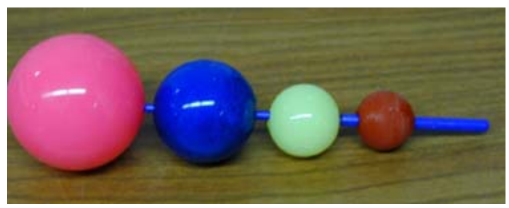


Ball-Block Collision - 1N30.53 Bounce and no-bounce balls are used to discuss impulse. The no-bounce ball rolls down the track and collides with the block of wood failing to knock it over. The bounce ball is then rolled down the track and easily knocks over the block. Both balls are the same size and mass.



Double Ball Bounce - 1N30.60 Place a one small ball on top of a larger ball and drop from a height of about 4 feet. Warn the audience that the balls may fly astray.

Astro-Blaster - 1N30.601 The impluse required to stop the system when striking the ground is applied to the larger and smaller ball equally. The smaller ball will accelerate faster since it has a smaller mass. Use this demonstration to discuss conservation of momentum. The following statement is from the package: "The gravitational collapse of the dying star is illustrated by Astro-Blaster's fall to the surface. The shock wave accelerating outward through the star is illustrated by a wave of increasing speed as the result of the impact which is felt by the lighter balls nearer the top. The supernova explosion and release of cosmic rays is illustrated by the rapid departure of the top ball at high speed" - Stirling A. Colgate, Astrophysicist



1Q ROTATIONAL DYNAMICS

1Q10 Moment of Inertia

Inertia Wands and Two Students - 1Q10.10 Two wands have the same mass. One wand has the mass concentrated at the ends. The other rod has the mass concentrated at the center. Have two students flip them back and forth as fast as they can. This student holds the wand with the mass concentrated at the center.

Balancing a Bat - 1Q10.101 A dowel with a weight attached at one end can be used to show Rotational Inertia. Show that it is easier to balance the dowel with the weight far from your hand and harder when the mass is close to your hand. This is similar to balancing a baseball bat.

Racing Disks - 1Q10.40 Disks and hoop have equal masses. Release both disk and hoop at top of inclined plane at the same time. Also available upon request: PVC tubing, short wooden bar, ping-pong ball, two solid balls of unequal mass and radius.

Racing Soups - 1Q10.50 A variety of soup cans are supplied to roll down an incline. Beef Bouillon, Cream of Mushroom, and Tomato soups are usually compared because of their different moments of intertia.

1Q20 Rotational Energy

Faster Than 'g' - 1Q20.50 Place the ball in the holder. Pull the stick to release. The ball 'jumps' into the cup

Falling Meter Sticks - 1Q20.60 Show the time of the fall varies with the length.

1Q30 Transfer of Angular Momentum

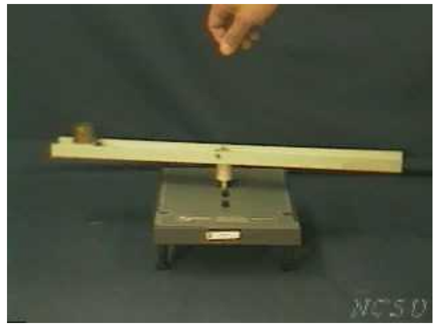
Passing the Wheel - 1Q30.10 Tip the spinning wheel 180 degrees. Hand to a student who turns it another 180 degrees and hands it back. Repeat until spinning too fast to make the hand-off. You can add to or subtract from your angular momentum depending on which direction you flip the wheel.

Drop Bags of Rice - 1Q30.20 While spinning drop 10 lb bags of rice. The changing mass does not affect the speed of the rotation. The bags of rice take their angular momentum with them.

Catch the Ball - 1Q30.30 Catch a bag of rice at arms length

1Q40 Conservation of Angular Momentu

Rotating Stool with Dumbbells - 1Q40.10 Start spinning and bring the masses towards your chest slowly. Your angular velocity will increase.



Stability of Orbits - 1Q40.20 Conservation of angular momentum can be shown nicely with this apparatus. Start the bar rotating and pull on the center string. As the mass is pulled towards the center, the angular velocity increases. This demonstration is similar to the rotating stool with masses demonstration.

Governor - 1Q40.23 The position of the balls can be used to describe the rate of rotation.

Pulling on the Whirligig - 1Q40.25 Spin the ball/cylinder around while holding the hollow tube. Move the lower ball/nut up and down to change the radius of the circle and the angular velocity.

Rotating Stool and Bicycle Wheel - 1Q40.30 The rim of the wheel is weighted. Tip spinning wheel while seated on stool. Stool will rotate. Tip in opposite direction to rotate the other way.

Drop the Cat - 1Q40.33 Turn yourself around on a rotating stool by rotating a mass on a short rope. Approximately 1 Kg of mass is attached to a 40 cm rope. Spin the mass around your head as a cat would spin its tail. Show that a cat can flip from its back to its feet while its total angular momentum remains equal to zero.

Hero's Engine - 1Q40.80 Show that the momentum of the steam is countered by the spinning of the Hero's Engine.

1Q50 Gyros

Bicycle Wheel Gyro - 1Q50.20 Rotating bicycle wheel is balanced on a pole.

Gyro with Adjustable Weights - 1Q50.201 A demonstration sized gyro is at the end of a pivoting rod with an adjustable counter weight.

Double Wheel Gyro - 1Q50.25 Two wheels are mounted coaxially on the end of a pivoting rod. Try the standard demos with the wheels rotating in the same direction and in the oposite directions.

Mitac Gryo - 1Q50.30 The rotor is driven at 150 rpm by a motor. Masses can be added.

Trapeze Gyro - 1Q50.74 Toy gyroscope with string, acrobatic stand and power cord.

1Q60 Rotational Stability

Tippee Top - 1Q60.30 When a top is spinning it flips over to spin on its stem.

Spinning Football - 1Q60.35 Show how a football moves upright when spun on its flat side.

Ellipsoid - 1Q60.37 Ball is spun while resting on a cushion of air.

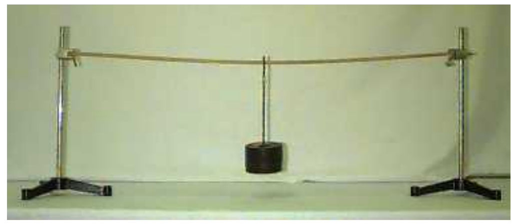
Tossing the Book - 1Q60.40 Spin the book (or board) about its three principle axes. The book will be stable when spinning about the axes with maxumum and minimum moments of inertia. The book will not be stable spinning about the axis with the intermediate moment.

1R PROPERTIES OF MATTER

1R10 Hooke's Law

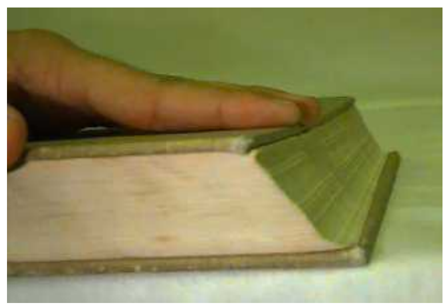
Stretching a Spring - 1R10.10 A 50 gram mass hanger hangs on a spring. Begin with 50 grams on the hanger. This brings the spring into its linear range. Mark the position of the bottom of the hanger with a clamp. Add 50 gram masses to the hanger marking the position after each addition.

1R20 Tensile and Compressive Stress



Bending Beam - 1R20.20 A mass hangs from meter stick resting on two supports. Compare the bending in the meter stick flat and on edge. Lower mass gently when changing sides as the METER STICK MAY BREAK

1R30 Shear Stress



Shear Book - 1R30.10 A large text book will be supplied. Push the text to the side from the top.

1R40 Coefficient of Restitution

Coefficient of Restitution - 1R40.10 Drop balls of different materials onto a plate. Compare the heights reached after bouncing by marking the positions on the meter stick.

Bounce/No Bounce Balls - 1R40.30 Two balls look and feel identical. One bounces and the other does not.