Physics 105 Recommended demos

Kinematics

Ball and Cart - The PASCO Ballistic Cart shoots a plastic ball straight up while in motion. If the cart is moving at a constant velocity, the ball will fall back into the catcher on the cart. The ball is released using a photogate, so there is no impulse given to the cart upon release as there is in other models relying on a string to release the ball. The barrel can be aimed to ensure that the ball is shot vertically. Special no bounce foam prevents the ball from bouncing back out of the catcher cup. *Location*: G4-3. Class time: < 5 minutes.

Shoot the Target - Much like the old "Shoot the Monkey" demo, this photogate-triggered drop box has an electromagnet design for a quick release of the target. The projectile hits the target, proving that the projectile accelerates downward at the same rate as the target. *Location*: G3-4. Class time: 10 minutes.

Newton's Laws

M to 2M Demo (air track) - Uses the frictionless air track (with the PASCO air pump) and 2 strategically placed PASCO photogates. A weight is suspended on one end over a pulley and attached to a mass on the track. The time it takes for the mass to travel between the photogates is measured using the datastudio file "M to 2M.ds" on the demonstration laptop. If the photogates are properly placed, this time will be exactly 1 second. Then the same hanging mass is then used to accelerate a cart that has exactly twice the mass of the original. It can be shown that this time should be a factor square root of 2 longer than the previous time (in the limit m << M, where m is the hanging mass, and M is the original cart mass), or exactly 1.41 seconds. Location: *South side of demo room, on table*. Class time: 20 minutes.

Sailboat and Fan - A classic Newton's 3rd Law demonstration, in which a sail is placed on a movable cart, and a fan can be placed on or off the cart. If the fan is on the cart, it will not move. *Location*: *G4-3*. Class time: < 5 minutes

Friction/Air resistance

Feather and Coin - The "Coin and Feather" experiment is one of the best ways to dispel the "lighter objects fall more slowly" myth.
When the air inside the 75 cm tube is at atmospheric pressure, the feather (in this case a very visible piece of styrofoam) falls significantly more slowly than the coin. The hand-held syringe vacuum pump will bring the air inside the tube down to about 7% of atmospheric pressure, making the feather and the coin appear to drop at the same rate. *Location*: G3-5. Class time: 5-10 minutes.

Work and Energy

Bowling ball on a collision course - For use in E1 lecture center. Hang bowling ball from hanging rope, and dazzle students as you release the ball from chin height and narrowly escape collision upon the ball's return. *Location*: F2-3. Class time: 5 minutes.

Roller coaster loop - Calculate the minimum height required for a ball to make it around a vertical loop, and demonstrate to verify. *Location*: Side. Class time: 20 minutes.

Momentum, Impulse and Collisions and center-of-mass

Happy/Sad Balls - Two balls of equal dimensions react differently when thrown to the ground. Happy ball, made of neopreme rubber, will bound back up. Unhappy ball, made of norbornene, hits the ground and stays there. *Location*: G1-3. Class time: < 5 minutes

M and 2M collision (Elastic and Inelastic) - Using datastudio files on the demonstration laptop and Pasco photogate sensors, measure the before and after velocities of two masses (M and 2M) on the frictionless air track which collide elastically or inelastically. Location: *South side of demo room, on table*. Class time: 15-20 minutes.

Hanging Body - This is an asymmetric figure that has hooks to be hung by at various points. The object is to find the center of mass--the point on which gravity acts. By drawing a straight line from the hook in the direction of gravity for each hook, the center of mass can be found at the inter-section of all the lines. *Location*: G6-3 Class time: < 5 minutes

Rigid Body Rotation / Rotational Dynamics

Rotating stool/Weights - Classic demo. 2 weights and a low friction rotating stool. *Location*: F5-6. Class time: 5-10 minutes.

Masses on a Rod (Moment of Inertia comparison) - Two weights are mounted on a rod, which spins about the handle in its center. A hanging weight causes the system to rotate, and the position of the weights determines the angular acceleration. *Location*: F6-1. Class time: 5-10 minutes.

Assorted masses rolling on inclined plane - Disks and cylinders of different material, sizes, and shapes are rolled down an inclined plane. The initial energy is the same for all materials if started from the same height, and the final energy should also be the same. However, the moment of inertia differs from object to object. Students can predict outcomes of a race between different mass distributions. Class time: 15-20 minutes.

Gravitation

Periodic Motion

Parallel Spring bracket - Various experiments can be done with the bracket. Hang masses in ratio 2:1 from springs with a spring constant in ratio 2:1 and demonstrate that

the period is the same. Hang springs of different spring constants in series and parallel. *Location*: F2-2 Class time: 10-15 minutes.

Pendula - These pendula attached to a stand have a length ratio of 2:1. The two pendulums begin swinging together. They will fall out of synchronization but will meet every four times since frequency depends upon the square root of length. One can also use this demo to demonstrate that a pendulum's period is independent of its mass (there are two equal length strings and one half length). *Location*: Side. Class time: 5-10 minutes.

Waves and interference

Alarm on a String (Doppler effect) - Simple, quick, and convincing display of the Doppler effect of sound waves. Simply twirl a buzzer parallel and perpendicular to the students' lines of sight to demonstrate a noticeable variation in pitch. *Location*: E5-2. Class time: < 5 minutes.

String Vibrator - Using a sine wave generator to drive a string vibrator, the driving frequency and tension of the string can be varied to explore standing waves in strings and to determine the speed of the wave. Can be used with strobe light (*Shelf A5-1*) for a dramatic display of aliasing. *Location*: South side. Class time: 10-15 minutes.

Open ended resonance tube - Students will have no difficulty hearing resonant frequencies from this tube. Two nested cardboard tubes with a removable inner stopper allow students to hear resonance in both open and closed tubes. The inner plunger tube can be used to vary the length of the column. A measuring tape is mounted to the plunger tube to indicate the effective length. Vary sound source frequency to investigate an open-tube resonant frequency pattern. Use with open speaker and sine wave generator (*both on Shelf A5-1*). *Location*: North side next to ripple tank table. Class Time: 5-15 minutes.

Optics Interference demo - 2 possibilities here. One easy option is to set up a bright light bulb and pass out slit plates (contain single/double slits and various gratings) for students to look through individually. The interference patterns are strongly visible. A second option, (a bit more time consuming) is to set up a slit plate on the front desk, and shine red and green laser light through assorted slits (single and double) and diffraction gratings to see the effect of slit size/spacing as well as frequency on the patterns. *Location*: Both experiments in kits on shelf A6-3. Class time: 5-10 minutes.

Big spring - Useful for making an analogy with thin films. Have a student hold one end of the spring, and you send a pulse down to the student. The pulse will bounce back inverted (180 degree phase shift), since the student acts like a fixed end. A similar effect occurs when light reflects off of a material with higher index of refraction - behaves more like a fixed end than a free end, so the wave is inverted. *Location*: Shelf F1-2. Class time: 5-10 minutes.