Physics 141 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.

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.

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*.

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*.

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.

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.

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

Momentum, Impulse and Collisions

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.

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) which collide elastically or inelastically (using velcro). Location: *South side of demo room, on table*.

Rigid Body Rotation

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

Wilberforce Pendulum - Consists of a mass suspended by a long helical spring and free to turn on its vertical axis, twisting the spring. It is an example of a coupled mechanical oscillator. It can both bob up and down on the spring, and rotate back and forth about its vertical axis with torsional vibrations. When correctly adjusted and set in motion, it exhibits a curious motion in which periods of purely rotational oscillation gradually alternate with periods of purely up and down oscillation. The energy stored in the device shifts slowly back and forth between the translational 'up and down' oscillation mode and the torsional 'clockwise and counterclockwise' oscillation mode, until the motion gradually dies out. The variation in amplitude of the up-down motion and its anti-correlation with rotational amplitude is very noticeable. *Location*: F1-3.

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.

Rotational Dynamics

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. *Location*: F4-5.

The come-a-long - This is a big wheel with string wrapped around it. Pull the string

parallel to the table and the wheel rolls in direction of force (most students expects it to roll the other way and unravel). Pull it perpendicular to the table and it unravels. Pull at a 45 degree angle and it drags, not rolls. *Location*: G6-3

Equilibrium and Elasticity

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

Flexible I-beam - This Flexible I-beam is made of plastic so it can be visibly bent by hand. It shows the basic reasons for using this cross-section in construction. It is four times as stiff in the upright orientation as it is sideways. The beam does not sag under its own weight and returns to its original straightness after bending. *Location*: G1-3

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

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.

Physical Pendulum - Hula hoop oscillating about a fixed point on the rim. Calculate period based on the radius of the hoop. Oscillate a simple pendulum at the same time with a length equal to the radius of the hoop to show that the periods are not the same, as students may have originally guessed. *Location*: Side.