

LIST OF LECTURE DEMONSTRATIONS FOR FRESHMAN PHYSICS

Note that there is a demonstration here for approximately every lecture period in a typical physics 121 course.

1. Ubiquity of Vectors – Van de Graaf generator with strips of paper standing up radially.
2. Vector addition – “Vectors to Nashville” (Bus trip from ABQ to Nashville via several possible and variously circuitous routes). Also illustrates that average velocity and average speed are not identical.
3. Position vs. time plots – Student walking along a room-sized number-line to a position vs. time “script”.
4. Constant acceleration – Atwood’s machine. Can demonstrate positive velocity and negative acceleration at same time.
5. Constant acceleration – Marking paper-tape and falling weight. Potato gun – Where available.
6. Centripetal Force and Tangential Velocity – Ball on Rope.
7. Projectile Motion -- Marx Brook spring-loaded catapult. Fires perfectly across classroom and shows the $\sin(2\theta)$ range function.
8. Projectile Motion – Monkey and hunter.
9. Forces – Drag an oscilloscope cart with a spring-scale. Mass – Bring a “slug” to class.
10. Inertia – Class in parking lot. Place cinderblock on glass jar and break with sledge hammer. (Jar survives). [Alternate – Karate style board-breaking]
11. Inertial reference frame – Drag large lab cart with plastic school bus inside. Point out that school bus doesn’t move relative to class, but does move relative to lab cart. Talk about real forces and pseudoforces.
12. Tension and Statics-- Waterjug hung on jumprope cannot be pulled perfectly horizontal.
13. Normal force in accelerated frame -- Student “astronauts” go up in Workman elevator with a bathroom scale and report findings back to class.
14. Friction – Pulling masses w/ springs over various surfaces. Showing static vs. kinetic friction. Stick slip motion – Drag a student’s desk a few feet.
15. Tension – Spring scale between carts in accelerating “train” – Show tension decreasing as move back from “engine”.
16. Work – Have petite student lift a 10 gram weight over her head. Have a burly student hold a large lead weight still at chest level, then walk around the room for a couple of minutes. Point out that only the first student did any work. Work performed by falling mass. [DVD VI-3]
17. Conservative Forces – Drag a student + desk around the room. Note that friction is not a conservative force.
18. Energy Conservation – Commit hara-kiri before class with a bowling ball on a rope pulled right up to my nose.
19. Gravitational Potential -- Car on loop-the-loop. Potential Wells – Balls in a bowl. Stable equilibrium – Tall Tilted Aluminum tubing.
20. Spring Potential -- Can measure spring constant of “rubber band” (pretend it’s linear!) and reasonably well calculate the velocity of a small paper clip or piece of

- chalk you allow a selected student to fire across the class. Bow and Arrow analysis. [DVD VI-4]
21. 1-D Collisions with pool balls on right-angle beam. Pool balls hitting ping-pong ball. "Click-clack" balls.
 22. Momentum Cons -- Rocket car demo and Liquid Nitrogen Cannon [DVD IV-4]
 23. Impulse -- Egg drop with and without water in cup. Impact timing [DVD V-6]
 24. Rotational Motion -- Motorized rotary table to illustrate right-hand rule and rotational analogs of position, velocity, acceleration.
 25. Rotational motion – Spin a bike wheel and ask students to point fingers in direction of $\vec{\omega}$, $\vec{\alpha}$. Parabolic surface of a water tank in uniform rotational motion.
 26. Moment of Inertia – Lead weights on rotary table. Students tug on table with weights at center and at edge to get sense of moment of inertia.
 27. Rotational Kinetic Energy – Hoop and Disk race.
 28. Angular momentum Cons -- Drop a weight onto a rotating table. (Rotational Collision) Student on rotating table pulling in weights (figure skater demo). Inverting a spinning bicycle wheel.
 29. Torques – Show precession of gyroscope – The clearest evidence that cross-products are real!
 30. Elasticity – Beam bending – Young's modulus // Gravitation – Guinea and Feather apparatus.
 31. Gravitation – Bring in Cavendish apparatus – DVD of Cavendish Experiment
 32. Relativity – Calculation of relativistic forces and accelerations.
 33. Relativity – Images of Einstein rings, etc.
 34. Relativity – DVD on relativistic appearance of objects.
 35. Temperature – Statistical interpretation – Applet of bouncing balls in a piston. (Real bouncing ball apparatus driven by membrane.)
 36. Thermal expansion – Hoop and ball using LN2 and a blow torch. Bimetallic strip.
 37. Black body radiation – Spectra of hot objects. IR Camera – Paint face with ice.
 38. Heat Capacity and Thermal Conductivity – Red Hot piece of Aerogel. Handling Aluminum and Wooden rods that both spent two hours in a freezer before class.
 39. Adiabatic compression – Bicycle pump
 40. Entropy – Coin flipping