Breakdown of the Introduction (**0:00 - 12:32**)

**0:00 - 0:54** Expression that the demonstrations are shown in approximate order of use for a general Astronomy course

**0:55 - 3:52** Explanation of the bibliography of demonstrations, which has a searchable index and is accessible at [www.pira-online.org](http://www.pira-online.org)

**3:53 - 5:17** Explanation of the Demo Classification Scheme, which the bibliography uses

**5:18 - 5:41** Brief list of references

**5:42 - 7:27** Overview of how to contact instructors via TAP-L

**7:28 - 8:51** Brief list of additional online resources that also provide demonstrations

**8:52 - 10:01** Emphasis of the importance of clicker question participation

**11:20 - 11:39** Brief explanation of PIRA 200

Topics and their suggested demonstrations (chronological order)

**12:34 - 18:00** Orreries & celestial spheres

* Introduction (**12:34 - 13:24**)
* Solar system motions, moon & planet phases, etc (via use of orreries) (**13:25 - 16:00**)
* Sky motions (azimuths, rising/setting times, RH declination, etc) shown relative to any horizon & zenith (via use of celestial spheres) (**16:09 - 18:00**)

**18:28 - 20:40** Precession & Mutation (via use of a gyroscope or spinning tops)

**20:46 - 22:36** Phases of the moon (via use of a wireless camera or a projected light source)

**23:11 - 24:30** Ellipses (emphasis of the bi-focal points in drawing ellipses with a simple setup)

**24:36 - 26:50** Retrograde motion (via a simple clock mechanism setup)

**26:52 - 30:29** Scale models of the solar system (various examples)

**30:33 - 33:00** Freefall (emphasis on the indicated relationship of motion with the geometry of space shown via a vacuum tube and two different-mass objects)

**33:01 - 34:29** Inertia (via table cloth removal or string breakage)

**34:30 - 35:44** Persistence of motion (Newton’s 1st Law) (via objects on an air track)

**35:46 - 38:12** Acceleration & constant velocity (Newton’s 2nd and 1st Laws) (via fan powered vehicles on an air track)

**38:12 - 40:15** Circular motion (angular acceleration & tangential velocity) (via swinging a ball on a string)

**40:16 - 43:19** Conservation of momentum (via spring loaded vehicles on an air track)

**43:20 - 45:27** Center of mass (demonstrating binary star systems) (via two connected bodies & a marked center of mass)

**45:28 - 46:45** Conservation of angular momentum (demo A) (via spinning masses at varying radii)

**46:54 - 56:45** Electromagnetic spectrum (large projector grating shown at **1:11:40 - 1:11:50**)

* Use of an infrared camera to show thermal radiation (**46:54 - 51:45**)
* Projection of light through a prism & through a grating (**51:52 - 56:45**)

**56:45 - 1:01:36** Wien’s Law(peak shift of blackbody spectrum shown via the heating of a nail)

**1:01:37 - 1:11:34** Spectrometry (emphasis on various “fingerprints”)

* Free spectroscopes available for order (pay S&H only) (**1:04:54 - 1:06:35**)
* Use of *Ocean Optics* spectrometer to show wavelength intensities (**1:08:13 - 1:10:12**)

**1:11:35 - 1:16:01** Band absorption (via use of various substances such as food coloring or use of a *Reveal* light bulb) (Use of *Glow Doodles* also suggested)

**1:16:05 - 1:17:40** Sunspots (via viewing a light bulb filament through a projector’s overhead light)

**1:18:00 - 1:20:05** Convection cells (via the heating of oil)

**1:20:06 - 1:23:37** Random walk / Diffusion of photons (via the use of *Bumble Balls* or a vibrating peg-board)

**1:23:38 - 1:25:19** Nuclear fusion / Strong nuclear force (via three magnets and an iron disc)

**1:25:39 - 1:28:35** Rayleighscattering (via use of *PineSol* in water, illuminated through a projector)

**1:29:20 - 1:31:40** Conduction & Radiation (conclusion at **1:37:58 - 1:38:32**)(entire process spans **1:29:20 - 1:38:32**)

* Conduction shown via the heating of loosely welded nails
* Radiation “shown” via the lighting of a match across a distance, or the use of a spotlight on a radiometer

**1:31:39 - 1:32:50** Conservation of angular momentum (demo B) & centrifugal flattening (via use of a *Hoberman Sphere*)

**1:33:12 - 1:34:09** Gravity (geometry of space and its influence on orbital motions) (via use of a fabric membrane)

**1:34:27 - 1:36:35** Supernovae / stellar collapse / momentum buildup (via use of *Astro Blaster* or simple vertical setup of disks of varying radii)

**1:36:36 - 1:37:57** and **1:38:46 - 1:39:40** Expanding/contracting/steady-state universe (via use of a glow-in-the-dark *Hoberman Sphere,* or a rubber tube with attached balls, or the stretching of fabric)

**1:37:58 - 1:38:32** Radiation (via use of a spotlight on a radiometer)

**1:38:46 - 1:39:40** Expanding/contracting/steady-state universe (via the stretching of fabric)

**1:39:41 - 1:41:05** Non-Euclidian geometry (via use of part of a tire intertube and a sphere)

**1:41:24 - 1:44:15** Radiation detection (via use of a Geiger counter and various suggested objects)

**1:44:16 - 1:45:48** Conclusion & explanation of a special conceptual significance for the use of a vacuum canon

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