

Physics 207: Introductory Mechanics - Applications

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Measuring and describing motion

- Applications of echolocation: autofocus cameras
- Echolocation in bats
- Imaging using echolocation
- Medical ultrasound imaging

Motion in 1 dimension, dimensional analysis

- Kitchen faucets and splashing
- Toilets vs. urinals
- M-mode echocardiography and mitral valve abnormalities
- Jumping insects
- August 2006 Comair crash
- Acceleration of jets and cars

Dimensions and dimensional analysis

- Why units matter: The crash of Air Canada flight 703

Vectors; Motion in Two Dimensions; Projectile Motion; Circular Motion

- Hang time in basketball
- Eruption of Mount St. Helens
- Trajectories of bullets
- Relative motion: snow and rain on your windshield, airplanes flying sideways
- G forces in salad spinners, washing machines and turbofan engines
- Particle accelerators
- How do trains with rigid axles turn corners?

Forces and their components

- Why do tennis nets sag in the middle?
- Cycling down Buffalo Street
- Coal trains and breaking couplers on hills
- Physics of driving
- Braking distances of small and large vehicles

Forces exerted by springs, series and parallel connections

- Otolith organs - measuring acceleration and orientation using masses and springs
- Force-displacement relation of:
 - a spring
 - of a rubber band
 - of a foot arch
 - of an earlobe
 - of arteries
 - of a single DNA molecule
- Molecular mechanism of muscle action; series and parallel connections

Fluid drag forces

- Aerodynamics and drag coefficients of automobiles
- Air drag in sports: cycling, ski jumping and luge
- Fish schooling and bird formations during migration
- Forces due to wind
- Wind bending of tall buildings
- Damage from hurricanes
- Forces due to flowing water and geologic erosion
- Ballistic missile defences

Forces in Circular Motion

- Ultracentrifuges
- Firestone Wilderness AT tire failures

Work, Energy and Oscillations

- Human energy needs through the ages
- Power and energy in cycling
- Panting of dogs
- Magnetic resonance imaging
- Elastic mechanisms in animal movement: running, hopping, galloping and flying
- Motion of bivalve mollusks
- Detecting DNA with nanomechanical oscillators
- Atomic force microscopy

Gravity and Orbital Motion

- NEAR mission to asteroid Eros
- Laser Interferometer Gravity Wave Observatory (LIGO)
- Gravity mapping
- SpaceshipOne versus the Shuttle

Conservation of momentum

- Guns, rockets and cephalopod propulsion

Collisions

- Shock absorbers: airbags, foot arches, boxers, and woodpeckers
- How the dinosaurs died - meteor impacts and mass extinctions
- The assassination of President John F. Kennedy
- Molecular diffusion
- Slingshot maneuvers and planetary exploration

Torque, static equilibrium, levers

- Levers in kitchen utensils
- Forces in lifting a briefcase
- Back forces when lifting a weight
- Weight lifters
- Prolapsed disk
- How to throw a ball at 50 m/s using molecules that move at 10^{-5} m/s
- Body shape and heart attack risk

Elasticity and the strength of materials

- Achilles tendon
- Proportions of animals and trees - geometric and elastic similarity; allometry
- Building large buildings with mud, stone, and steel

Thermodynamics and Heat

- Thermal expansion of the Eiffel Tower
- Thermal expansion in dentistry: fillings and crazing
- Formation of the Taugannock Amphitheatre
- The 2003 Northeast Blackout
- Convection: home heating, pattern formation, and flames on earth and in space
- Cooling of bees
- Medical Thermography
- Blackbody radiation and the Big Bang
- Radiative cooling: dewars, carports and hoar frost

Static fluids: pressure, Pascal's principle, buoyancy, and surface tension

- Atmospheric pressure at the earth's surface
- Pressure and temperature versus altitude
- Pascal's principle and spiders
- Pressure in human disease and conditions: reflux esophagitis, hiatal hernia, fecal incontinence, glaucoma
- Buoyancy and fish: swim bladders, cuttle bones, and the demise of the USS Thresher
- Surface tension and water striders
- Breathing and lung design

Moving fluids: continuity, Bernoulli's equation, viscosity, turbulent flow

- Bernoulli applications: shower curtains, perfume atomizers, wind damage to buildings, airfoil design, ventilation of prairie dog burrows, water circulation in aquatic animals, noisemakers, reeds, and brass instruments, detecting arterial constrictions, coughs
- How did nature choose the radii of our blood vessels?
- Blood flow through capillaries
- Sickle cell anemia
- Atherosclerosis and arteriosclerosis
- Pipetting liquids
- Separation of macromolecules: ultracentrifuges
- Why don't clouds fall?
- Turbulent flow & vortices: airplanes, hurricanes, tornados

Traveling and standing waves

- Pulse waves, atherosclerosis, high blood pressure, and congestive heart failure
- Standing waves in kettle drums, vocal chords, and wine glasses
- Tuvan throat singers
- Doppler weather radar
- Doppler ultrasound imaging
- Astronomical red shifts

Putting it all together

- The mechanical design of the ear