Key Concepts

PHY 111: Fundamental Physics I
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vector properties and manipulation
dot and cross products
use of the right hand rule

speed vs. velocity
velocity from displacement (relation, including graphical)
graphical and algebraic vector addition
relative motion

acceleration as two-part concept (change in magnitude, direction of velocity)
math relation between acceleration, velocity, displacement
vertical motion in presence of gravity (uniform acceleration/free fall)
two-dimensional motion (ballistics) in presence of gravity

Newton's inertia law and how force alters motion
summing forces (vectors) in free-body diagrams, useful tool
special cases: inclined plane (frictionless), masses coupled by rope
friction: static and kinetic, incorporate into free-body problems
translational equilibrium vs. rotation

Centripetal acceleration and force
circular motion with examples of what causes this (tension, gravity, friction, normal)
Law of Gravitation, features and behavior
gravity of a sphere, spinning and oblate Earth
circular orbits and Kepler's third law (T vs. r), orbital speed, ellipses, geosynchronous orbit?

Description and definition of work, relation to force
work and friction
conservative forces and reversibility
kinetic and potential energy, conservation, example of gravity
frictional dissipation?
escape velocity (from energy considerations), relation to fall from infinity

black hole, neutron star
power, definition, examples

momentum, definition
impulse changes momentum (relates to force)
momentum conservation (isolated system)
one-dimensional inelastic collision, energy loss/momentum conservation
one-dimensional elastic collision, energy/momentum conserved
two-dimensional collisions, inelastic, final speed and direction

angular displacement/radians, relation of omega, alpha
relation of these to linear motion/analogs
constant alpha equations, analog to free fall
torque conceptually/visually two ways
sum of torques, rotational equilibrium
center of gravity, not torque from gravity
determining the center of gravity, weighted sum of weight forces
stability and center of gravity
moment of inertia
combination translational and rotational motion (of and around center fo mass)
rotational and translational KE combined
angular momentum, relation to torque, conservation
vector explanation/pictures, definitions

Hooke's law, springs, linear restoring force, spring PE
stress, strain, breaking strength
Young and Bulk Modulus, relation to spring constant
SHM, amplitude and phase
spring oscillator, frequency and period, pendulum
damping, resonance

Mechanical waves (transverse and longitudinal)
wave velocity, wavelength/frequency/period, pitch (sound)
wave speed, strings (transverse), liquid, air, solid (compression)
wave superposition, fundamentals vs. harmonics
sound waves, wavefronts, intensity
sound level/loudness, decibels, log relation
sound beats, beat frequency
standing waves, nodes, allowed frequencies/resonance, modes/configuration
Doppler effect, moving emitter, moving receiver

atomic nature, masses/moles
solid, liquid, gas states

hydrostatic pressure, gauge and atmospheric pressure
hydraulic machines, Pascal's principle (fluid pressure distribution)
buoyant force/fluid displacement, specific gravity
laminar and turbulent flow, streamlines
continuity equation, relates fluid speed
volume and mass flux through cross-section
Bernoulli's equation and concept of energy density
speed vs. height (Torricelli's result)
pressure vs. speed (Venturi effect), blood pressure, airplane wing
viscosity?

Kelvin scale, absolute zero
linear and volumetric expansion of solids and liquids
beta = 3 alpha approximation, cube model, proportional expansion
ideal gas law
phase diagrams, water
kinetic theory of gases, relate pressure and volume to speed, relation of T to KE
Maxwell-Boltzmann distribution, probability spectrum for given T
energy partition in three-dimensions, degrees of freedom
evenly distributed energy for two gases

Thermal energy, random/disordered KE, motion
T as measure of average value of KE
Heat Q, thermal energy in motion
Joule vs. calorie, positive Q = heat in
specific heat capacity, equation relating Q to delta T
zeroth law of thermodynamics
heat of combustion
freezing/melting and latent heat of fusion, no T change
vaporization/evaporation, special case: boiling
thermal energy transfer: radiation, absorption/emission, emissivity, Stefan-Boltzmann law, Planck curves
thermal energy transfer: convection, heated fluid
thermal energy transfer: conduction, atomic collisions, thermal conductivity, T gradient and heat current

Work, heat, and change in internal energy, relation to T
kinds of thermal processes, idea of state, reversibility
volume work, P vs. V diagram
isothermal change, T = const, connection with ideal gas law, isotherms
adiabatic change, Q =0, adiabats
Carnot engine and engines, Carnot cycle, efficiency
refrigerator, coefficient of performance
second law of thermodynamics, disorder
entropy S, general relation to Q and T, max entropy state
statistical description of entropy, probability, micro/macrostates