Objectives for Final, 2008

The final exam will be multiple choice and cover everything in the third and fourth terms. The test will roughly be equally divided among all the topics – and will be around 60-65 questions. It will focus on the ideas and some simple math. There will be no complicated problem solving or essays.

Make sure you understand and can use or explain the following formulas (which will be provided to you on the final.)

Formulas

$a_c = \frac{v^2}{r}$ $K = \frac{1}{2}mv^2$

$x = x_m \cos(\omega t + \varphi)$ $\ddot{x} = -\omega^2 x$ $T = \frac{2\pi}{\omega}$ $f = \frac{1}{T}$

$T = 2\pi\sqrt{\frac{m}{k}}$ $T = 2\pi\sqrt{\frac{L}{g}}$ $T = 2\pi\sqrt{\frac{I}{rmg}}$

$e = \frac{c}{R}$ $\frac{T^2}{R^3} = k$ $T = \frac{S}{S \pm 1}$

$F = G\frac{m_1 m_2}{r^2}$ $T^2 = \left(\frac{4\pi^2}{GM}\right)R^3$ $v_e = \sqrt{\frac{2GM}{r}}$ $U = -\frac{GMm}{r}$

$\gamma = \frac{1}{\sqrt{1 - v^2/c^2}}$ $t = \gamma t_0$ $L = \frac{1}{\gamma}L_0$ $K = \gamma mc^2 - mc^2$ $f = \frac{1}{\gamma\left(1 \pm v/c\right)}f_0$ $c = \lambda f$

$F = k\frac{q_1 q_2}{r^2}$ $E = \frac{F}{q}$ $E = k\frac{Q}{r^2}$ $V = \frac{U}{q}$

$V = IR$ $P = IV$ $R_e = \sum_i R_i$ $\frac{1}{R_e} = \sum_i \frac{1}{R_i}$

Some Moments of Inertia you may want (M = mass, R = radius, L = length)

Disk : $\frac{1}{2}MR^2$ Hoop: MR^2 Hollow Spherical Shell: $\frac{2}{3}MR^2$ Solid Sphere: $\frac{2}{5}MR^2$

Thin Rod, about center of mass: $\frac{1}{12}ML^2$ Thin Rod, about one end: $\frac{1}{3}ML^2$

Constants

g = 10 m/s^2 G = 6.67 x 10^{-11} Nm^2/kg^2 c = 3 x 10^8 m/s k = 9 x 10^9 Nm^2/C^2

e = 1.6 x 10^{-19} C $m_{electron}$ = 9.1 x 10^{-31} kg m_{proton} = 1.67 x 10^{-27} kg

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Vocabulary

Oscillations
simple harmonic motion, hertz, amplitude, phase, angular frequency, period, simple pendulum, physical pendulum, forced harmonic motion, resonance, natural frequency, equations of motion

Astronomy
Celestial Sphere, celestial equator, ecliptic, zodiac, retrograde motion, epicycle, "Music of the Spheres," precession, equinox (vernal & autumnal), solstice (winter & summer), ellipse, eccentricity, perihelion, aphelion, semi-major axis, astronomical unit, sidereal, synodic, parallax, equant, Kepler's Laws

Gravity
G, escape speed, tides, Universal Law of Gravitation, black hole, ellipse, focus, Kepler's Laws

Relativity
simultaneity, time dilation, length contraction, proper time, proper length, speed parameter, Lorentz factor, spacetime, ether, inertial reference frame, twin paradox, Doppler shift, rest energy

Electrostatics
charge, positive, negative, neutral, induction, conduction, polarization, insulator, conductor, Coulomb, Volt, electric field, lines of force, van de graaff generator, electron, proton, neutron, elementary charge

Circuits
Ohm's Law, resistance, resistivity, superconductor, series, parallel, voltmeter, ammeter, current, amps, volts, ohms, equivalent resistance, circuit, short circuit, open circuit

Concepts

Oscillations
- derive the equation of motion for simple harmonic motion.
- apply Newton's Second Law to a variety of situations, solve for the equations of motion, and determine the period of motion, if it is simple harmonic motion.
- derive the formulas listed above.
- correctly use the equations above in a variety of word problems.
- identify, define and give examples for the vocabulary listed above.
- understand and explain the assumptions and approximations made in the above formulas.
- understand and explain what happens to the energy of an oscillating system.
- set up, but not solve, the equations of motion for a damped harmonic oscillator.
- explain qualitatively what happens to a damped harmonic oscillator, e.g. energies, amplitudes, periods, velocities, etc.

Astronomy
- do calculations involving the following orbital quantities: aphelion, perihelion, eccentricity, semi-major axis and period of orbit.
- explain Kepler's 3 Laws.
- compare and contrast the three main models of the solar system prior to Kepler discussed in class (Ptolomeic, Tychonic and Copernican.)
- explain what observations can "prove" or disprove the various models of the solar system.
- explain why Aristotle (and other astronomers through the 17th century) rejected a heliocentric theory of the solar system.
- in general, be able to use and explain the vocabulary listed above.
- in general, be able to do calculations similar to the worksheets/homework done in class
- given appropriate data, calculate the size of a planet.
- be able to calculate synodic periods from sidereal and vice-versa.
- given a series of observational data (of the "sun" and other planets) from a fictional planet, be able to calculate periods and graph orbits.

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- explain the historical significance/major contributions of the following people discussed in class: Aristotle, Eratosthenes, Ptolemy, Hipparchus, Aristarchus, Copernicus, Brahe, Kepler, Galileo.
- describe the motions in the sky that models of the solar system try and explain.
- discuss the significance of the assigned readings, including the details of what the authors were saying, the social context and reactions to the works.

Gravity

- explain what is meant by the term "escape speed" and be able to derive/use the equation given above.
- do calculations involving Newton's Universal Theory of Gravitation.
- in general, be able to use and explain the vocabulary listed above.
- in general, be able to do calculations similar to the worksheet/homework done in class
- be able to derive/explain what happens to the force of gravity as you dig a hole to the center of a planet.
- be able to explain what you would feel gravitationally if you were inside and outside a hollow sphere.
- explain the source of tides.

Relativity

- state and explain the two postulates of special relativity.
- explain and derive the equations for time dilation and length contractions.
- correctly apply the equations listed above to a variety of word problems.
- compare the order of events in different reference frames.
- make qualitative statements about different reference frames observations of events and objects (e.g. lengths, times, frequencies, velocities.)
- explain the significance of special relativity in terms of our understanding of time and space.
- explain the significance of special relativity in terms of our understanding of mass and energy.
- explain the "twin paradox"" and the barn and pole paradox."

Electrostatics

- be able to explain the 3 main ways of charging an object: by friction, induction, and conduction. make sure you understand which methods can be used on insulators and which on conductors, and understand what happens on the molecular level.
- be able to compare and contrast the molecular structure of an insulator verses a conductor
- be able to interpret a picture of electric field lines
- be able to solve word problems involving Coulomb's Law, electric fields, and potential differences (this is a lot of stuff!)
- be able to define/explain/give examples of charge, electric field.

Circuits

- be able to correctly use and apply the formulas listed above in a variety of word problems.
- be able to explain what happens to current and voltage in series and parallel circuits.
- be able to correctly interpret a circuit diagram.
- be able to correctly use ammeters and voltmeters in a circuit.
- be able to compare and contrast an ammeter and a voltmeter.
- given a random circuit, be able to solve for any missing variables (V, I, R).
- be able to calculate the equivalent resistance for a random circuit of resistors.
- be able to explain what is meant by "Ohm's Law" and to describe why some things obey and others do not.
- be able to explain what happens to electrons and energy in a circuit.
- be able to compare and contrast an insulator, conductor and superconductor.
- be able to apply the laws of conservation of energy and charge to a circuit.