ASTR 220 Fall 2015
Learning Goals for Midterm 2 & Equation List

Learning Goals

- Overall
  - The student should be able to define the astronomical terms introduced and be able to use them appropriately.
- Lecture 10: The student should be able to...
  - ...explain how astronomers use spectroscopy to determine surface compositions of asteroids.
  - ...discuss the most common surface compositions of asteroids.
- Lecture 11: The student should be able to...
  - ...discuss the two primary methods astronomers use to calculate an asteroid's mass.
  - ...mathematically calculate an asteroid's mass given a word problem with physical information.
  - ...determine the overall compositions of objects based on their average densities.
  - ...explain how astronomers have determined that asteroids are porous.
  - ...discuss the connection between asteroids and meteorites.
  - ...describe a comet's changing appearance as it orbits the Sun and explain why the appearance changes.
  - ...explain why comets are considered less of an impact threat than asteroids.
- Lecture 13: The student should be able to...
  - ...explain what happens to dust when it "impacts" the Earth.
  - ...explain what happens in specific to various size object of less than 50-m diameter when they impact the Earth.
  - ...discuss specific examples of well-studied airbursts or impacts.
- Lecture 14: The student should be able to...
  - ...explain what a shockwave is and how it might be created by an impact.
  - ...explain how the impact of a meteor creates an impact crater in the Earth's surface.
  - ...discuss other effects of an impact, such as the shockwave, ejecta, heat, and climate change.
  - ...use given distances at which various impact effects occur for specific impactor sizes in order to estimate the effect distance for a different impactor size.
  - ...discuss specific examples of historical impacts.
- Lecture 15: The student should be able to...

  - ...list characteristics that scientists look for in order to determine if a geologic structure is an impact crater, and why.
  - ...enumerate the approximate number of impact craters confirmed on the Earth's surface.
  - ...discuss what geologic processes affect impact craters on the Earth's surface and how.
  - ...describe and discuss what a plot of asteroid size versus impact frequency looks like, and why, and what implications that has for asteroids impacting the Earth.
  - ...explain why an impact frequency does not give a prediction of when an impact will occur.

- Lecture 16: The student should be able to...
  - ...discuss and describe the methods astronomers use to search for new asteroids.
  - ...discuss how astronomers use asteroid images to determine the characteristics of a new asteroid's orbit.
  - ...discuss the relevance of the region of uncertainty to asteroid impacts.
  - ...discuss why multiple images are needed in order to determine the orbital path of a newly-discovered asteroid.

- Lecture 17: The student should be able to...
  - ...describe how and why an asteroid's region of uncertainty changes shape and size as more observations of it are taken over time.
  - ...be able to describe and sketch the concepts of the region of uncertainty, B-plane, and capture radius.

- Lecture 18: The student should be able to...
  - ...describe how the path of risk of a potential asteroid impact is determined from the region of uncertainty.
  - ...explain what an "apparition" is in relation to asteroid observations.
  - ...discuss how long astronomers need to observe asteroids of various sizes in order to give a well-determined percent chance of impact.

- Lecture 20: The student should be able to...
  - ...discuss cases of asteroid impacts for which evacuation is a valid defense and why.
  - ...explain why "destroying" an asteroid is not feasible.
  - ...explain the general idea of how to make an asteroid's orbit larger or smaller.
  - ...describe what a "keyhole" is in relation to near-Earth asteroids and impacts.
  - ...discuss Apophis's path in the future and how we know it will not impact the Earth.

- Lecture 21: The student should be able to...
  - ...be able to explain and apply Newton's Second Law of Motion.
  - ...be able to explain and apply Newton's Third Law of Motion.
  - ...discuss the physical method underlying the Kinetic Impactor deflection strategy.
  - ...be able to compare implementations of the Kinetic Impactor deflection strategy using proportional reasoning.

- ...be able to mathematically calculate a deflection distance using the Kinetic Impactor deflection strategy from information given in a word problem.
- ...discuss the physical method underlying the Nuclear deflection strategy.
- ...compare implementations of the Nuclear deflection strategy using proportional reasoning.
- ...mathematically calculate a deflection distance using the Nuclear deflection strategy.
- ...discuss pros and cons of using both the Kinetic Impactor and Nuclear deflection strategies.

- Lecture 22: The student should be able to...
  - ...discuss the physical method underlying the Gravity Tractor deflection strategy.
  - ...compare implementations of the Gravity Tractor deflection strategy using proportional reasoning.
  - ...mathematically calculate a deflection time using the Gravity Tractor deflection strategy from information given in a word problem.
  - ...discuss pros and cons of the Gravity Tractor deflection strategy.
  - ...discuss the physical method underlying the Disruption deflection strategy.
  - ...mathematically calculate a deflection energy required using the Disruption deflection strategy from information given in a word problem.
  - ...discuss pros and cons of the Disruption deflection strategy.

Equations

$$F = \frac{GM_1M_2}{d^2}$$

$$v_{ave} = \sqrt{\frac{GM_r}{r_{ave}}}$$

$$P = \frac{2\pi r_{ave}}{v_{ave}}$$

$$E_k = \frac{1}{2}mv^2$$

$$c = \lambda f$$

$$L = 2.4 \times 10^{-7} d$$

$$I = \frac{L}{4\pi d^2_{Sun-asteroid}}$$

$$\sigma = \frac{4\pi d^2_{Earth-asteroid} b}{IA}$$

$$R = \sqrt{\frac{\sigma}{\pi}}$$

$$M_r = \frac{4\pi^2 r^3_{ave}}{GP^2}$$

$$\rho = \frac{M}{V}$$

$$D = 1.16L \left(\frac{v^2}{gL} \right)^{0.22}$$

$$r_{ave} = \sqrt[3]{\frac{GM_r P^2}{4\pi^2}}$$

$$d_{E-a}^2 = d_{S-a}^2 + d_{S-E}^2 - 2d_{S-a}d_{S-E}cos(A)$$

$$p = \frac{\sigma}{a} \times 100\%$$

$$F = ma$$

$$d = \frac{\beta mU}{M}t$$

$$d = (2.25 \times 10^{-9} m^4/s/J)\frac{W}{D^3}t$$

$$t = \sqrt{\frac{d}{a}}$$

$$E_{disrupt} = (1.7 \times 10^3 J/kg)M \left(\frac{R}{1m} \right)^{-0.36} + (7.8 \times 10^{-2} J/kg)M \left(\frac{R}{1m} \right)^{1.36}$$