Exam #1 Review

Astronomy 101
Review

• Remember: don’t memorize facts, understand concepts
Earth and Moon

• Cause of seasons
• Understand the relative orientation of the Earth, Moon, Sun
• Understand what causes solar and lunar eclipses
• Know what causes tides
History

• Define: retrograde, epicycle
• Geocentric vs. Heliocentric
• Understand the layout of the Solar System and be able to make predictions based on observations
Kepler and Galileo

• Define: ellipse, semimajor axis, period, eccentricity, aphelion, perihelion
• Know the implications of Kepler’s Laws
• Know the implications of Galileo’s observations
Newton

• Define: velocity, acceleration, force, orbital speed, escape velocity, angular momentum
• Know what Newton’s laws tell us
• Be able to use the Newton’s equations to solve problems
Light, Spectra, and Matter

• Define: spectrum, wavelength, frequency, color
• Energy of a photon
• Know the relative wavelengths of light in the spectrum
• Know how the frequency, wavelength, and energy of a photon relate
• What causes an emission or absorption line in a spectrum?
• What do spectral lines tell us?
Light, Spectra, and Matter

- Know what defines an element and isotope
- Know the four fundamental forces and generally where they are most important
- Understand the equation for Gravity and Electromagnetic Force and how to use them to solve simple problems
Light, Spectra, and Matter

• Define: blackbody, temperature
• Understand Kirchoff’s laws
• How does temperature of a star relate to color?
• Be able to use
  – Wien’s law
  – Stefan-Boltzmann law
• Use Doppler effect to calculate speeds
Equations:

Kepler’s third law  \[ P^3 = a^3 \]

Newton’s second law  \[ F = m \times a \]

Newton’s law of gravity  \[ F = G \left( \frac{Mm}{r^2} \right) \]

Newton’s form of Kepler’s third law  \[ M + m = \frac{4\pi^2a^3}{GP^2} \]

Angular momentum  \[ L = m \times v \times r \]

Speed of light  \[ c = \lambda \times v \]
\[ c = 3.0 \times 10^5 \text{ km/s} \]

Energy of a photon  \[ E = h \times f \]

Stefan-Boltzmann Law  \[ E = c\sigma T^4 \]

Wien’s law  \[ \lambda_{\text{max}} = \frac{2,900,000 \text{ nm}}{T} \]

Doppler shift  \[ \frac{\Delta \lambda}{\lambda_0} = \frac{v}{c} \]
Practice question #1 (challenging)

Two identical robotic spacecraft are launched by NASA. The first is inserted into a circular orbit 20,000 km from the center of the Earth, while the second flies to the planet Mongo and is inserted into a circular orbit that is 20,000 km from the center of Mongo. However, the spacecraft orbiting Mongo has an orbital period exactly ¼ the period of the spacecraft orbiting Earth.

What is the mass of Mongo in units of the mass of the Earth?

(Hint: you do not need to know G or the mass of the Earth to do this problem and you can assume the masses of both spacecraft are negligibly small compared to the masses of both Earth and Mongo)
Practice question #2

How far do you have to be from the Sun in AU in order for the gravitational force from the Sun on you to be 100 times smaller than the Sun’s gravitational force on you right now?
Practice question #3

Some stars are known to have a blackbody temperature of 29,000K.

• What is the peak wavelength of their radiation?
• Can this wavelength be observed from the Earth’s surface?
Practice question #4

• Which has a higher frequency?
  – Xray or blue light
  – Radio broadcast or infrared light
  – Ultraviolet light or infrared emissions
Practice question #5

• If two objects are moved closer together by a factor of 10, how much does the gravitational force between them change if the masses remain the same?

• If the mass of one changes by a factor of 10, how much does the gravitational force between them change?
Practice question #6

• If the Sun was to suddenly collapse to a black hole (without changing its mass), how would that affect the orbit of the Earth?
Practice question #7

• You observe an absorption line spectrum from a star. The wavelength of the absorption lines change wavelength by \(\sim 0.01\%\) regularly (in a pattern that repeats every 10 days).
  – How fast is the radial velocity of the star changing over the 10 day period?
  – Could that variation be due to the gravitational pull from a planet?