Information about the Midterm

The midterm is on Tuesday, October 17, from 6:30 – 8:00 PM. If you are ill or miss the test for any reason, contact me via email ecarlson@wfu.edu or by cell 336-407-6528.

To the midterm, you should bring:

- Pen or pencil
- Calculator
- Ruler with metric markings
- Paper

I'll supply paper if you prefer.

Outline of the Midterm

This test consists of three parts. For the first two parts, you may write your answers directly on the exam, if you wish. For the last part, use separate sheets of paper. Useful equations can be found at the start of part 3. The total test is worth 140 points [170 points for PHY 610].

Part I: Multiple Choice [30 points]
For each question, choose the best answer (2 points each)

[questions 1-15]

Part II: Short answer [40 points] [50 points for 610]
PHY 310: Choose three of the following four topics, and write 2-4 sentences discussing it.
PHY 610: Answer all three of the following questions

[questions 16-19]

Part III: Calculation [80 points] [100 points for 610]
For each of the following problems, give the answer, explaining your work. (20 points each)
PHY 310: Choose four of the following five problems.
PHY 610: Answer all five of the following problems

[questions 20-24]

Equations for the Midterm

The following should be memorized by you:

Units

$2\pi \text{ rad} = 360°$

$1° = 60'$

$1' = 60''$

$1'' = 1000 \text{ mas}$

$\frac{1 \text{ pc}}{1 \text{ rad}} = \frac{1 \text{ AU}}{1''}$

Metric

$\text{k} = 10^3$

$\text{M} = 10^6$

$\text{G} = 10^9$

$\text{m} = 10^{-3}$

$\mu = 10^{-6}$

$\text{n} = 10^{-9}$

Simple Orbits

$\mathbf{F} = -\frac{GMm\hat{\mathbf{r}}}{r^2}$

$E_P = -\frac{GMm}{r}$

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

$v^2 = \frac{GM}{R}$

$\mathbf{g} = \frac{\mathbf{F}}{m} = -\frac{GM\hat{\mathbf{r}}}{r^2}$

Gauss's Law

$\mathbf{g}(R) = -\frac{GM(R)\hat{\mathbf{r}}}{R^2}$

Distance/Size and Proper Motion

$s = \alpha d \quad v_t = \mu d$

Virial Theorem

$2E_K + E_P = 0$

Luminosity/Brightness

$L = 4\pi R^2 \sigma T^4$

$L = 4\pi d^2 F$

Magnitude/Distance

$m - M = 5\log d - 5$

$d = 10^{1+\frac{m-M}{5}} \text{ pc}$

Galactic Orbits

$\Omega = \frac{V_0}{R_0}$

EM waves

$c = 3\times 10^8 \text{ m/s}$

$\omega = ck$

$k\lambda = 2\pi$

$\nu = 1/T$

$\omega = 2\pi\nu$

$c = \lambda\nu$

Photons

$E = h\nu$

$E = \hbar\omega$

Radar Distance

$2d = ct$

Parallax

$d = \frac{1}{p}$

Doppler Shift

$1 + z = \frac{\lambda_0}{\lambda} \approx 1 + \frac{v_r}{c}$

Hubble's Law

$v = H_0 d$

You should be able to use the following equations, but you are not expected to memorize them:

Units

$1 \text{ AU} = 1.496\times 10^{11} \text{ m}$

$1 \text{ pc} = 3.086\times 10^{16} \text{ m}$

$1 \text{ eV} = 1.602\times 10^{-19} \text{ J}$

$1 \text{ y} = 3.156\times 10^7 \text{ s}$

$R_\odot = 6.955\times 10^8 \text{ m}$

$M_\odot = 1.989\times 10^{30} \text{ kg}$

$L_\odot = 3.826\times 10^{26} \text{ W}$

$T_\odot = 5777 \text{ K}$

Physical Constant

$k_B = 1.381\times 10^{-23} \text{ J/K}$

$k_B = 8.671\times 10^{-5} \text{ eV/K}$

$\sigma = 5.670\times 10^{-8} \text{ W/m}^2/\text{K}^4$

$\hbar = 1.055\times 10^{-34} \text{ J}\cdot\text{s}$

$\hbar = 6.582\times 10^{-16} \text{ eV}\cdot\text{s}$

$G = 6.673\times 10^{-11} \text{m}^3/\text{kg/s}^2$

Gravitational Potential Energy

$E_P = -\frac{1}{2}\int d^3\mathbf{r}\int d^3\mathbf{r}' \frac{G\rho(\mathbf{r})\rho(\mathbf{r}')}{|\mathbf{r}-\mathbf{r}'|}$

$E_P = \frac{1}{2}\int d^3\mathbf{r}\,\rho(\mathbf{r})\Phi(\mathbf{r})$

Black Hole

$R_S = \frac{2GM}{c^2}$

Relative speed, Circular Orbits

$v_r = R_0 \sin l\left(\frac{V}{R} - \frac{V_0}{R_0}\right)$

Brightness/Magnitude

$F = 2.518\times 10^{-8}\text{W/m}^2\left(10^{-\frac{2}{5}m}\right)$

Black Body Radiation

$u = \frac{\pi^2}{15}\frac{(k_B T)^4}{(\hbar c)^3}$

$\lambda_{\text{max}} T = 2.8978\times 10^{-3} \text{ m}\cdot\text{K}$

Doppler Shift

$1 + z = \frac{\lambda_0}{\lambda} = \sqrt{\frac{1 + v_r/c}{1 - v_r/c}}$

Elliptical Galaxy Shape

$e = 10\left(1 - \frac{b}{a}\right)$

Planetary Nebula

$M^* = -4.47$

TRGB

$M_t = -4.10$

Type Ia SN

$M_{\text{max}} = -19.3$

Galactic Orbits

$\kappa^2 = \frac{2V^2}{R^2} + \frac{1}{R}\frac{d}{dR}V^2$

$\nu = \sqrt{4\pi G\rho_0}$

Cepheid Period/Luminosity

$M = -2.43\log(P) - 1.62$

Galactic Collisions $|\Delta\mathbf{v}| = \frac{2GM}{vb}$