Astronomy 210 **Spring 2011**

HOUR EXAM 2

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1. DO NOT OPEN THIS EXAM UNTIL INSTRUCTED TO DO SO.
2. Write you name and all answers in your test booklet. Turn in everything: your booklet, and the questions.
3. Show all of your work in the test booklet, and indicate clearly your final answer! A correct final answer may not receive credit if no work is shown.
4. Budget your time! Don't get stalled on any one question.
5. For your reference there are formulas below. Many of these constants and formulas you will not need for this exam!

Possibly Useful Formulae

Astronomical Unit: $1\,\mathrm{AU} = 1.5 \times 10^{11}$ m.
gravitational constant : $G = 6.7 \times 10^{-11}\ \mathrm{m^3\,kg^{-1}\,s^{-2}}$
speed of light: $c = 3.0 \times 10^{8}\ \mathrm{m\,s^{-1}}$
Stefan-Boltzmann constant: $\sigma = 5.7 \times 10^{-8}\ \mathrm{W\,m^{-2}\,K^{-4}}$
Planck's constant: $h = 6.6 \times 10^{-34}$ J s $= 4.1 \times 10^{-15}$ eV s
electron Volt: 1 eV $= 1.6 \times 10^{-19}$ J
Boltzmann constant: $k = 1.4 \times 10^{-23}$ J K^{-1}
mass of the proton: $m_p = 1.7 \times 10^{-27}\,\mathrm{kg}$

$M_\odot = 2.0 \times 10^{30}$ kg	$M_{\rm Earth} = 6.0 \times 10^{24}$ kg	$M_{\rm Jupiter} = 1.9 \times 10^{27}$ kg
$R_\odot = 7.0 \times 10^{8}$ m	$R_{\rm Earth} = 6.4 \times 10^{6}$ m	$R_{\rm Jupiter} = 7.0 \times 10^{7}$ m
$L_\odot = 3.8 \times 10^{26}$ Watt	$T_\odot = 5800$ K	
age of Sun $\simeq 4.6 \times 10^{9}$ yr		

$\vec{F} = m\vec{a}$	$\vec{L} = m\vec{r} \times \vec{p}$	
$v_{\rm circ} = 2\pi r/P = \omega r$	$a_{\rm c} = v^2/r$	
$\vec{F} = Gm_1m_2/r^2\,\hat{r}$	$PE = -Gm_1m_2/r$	$v^2_{\rm circ} = GM/r$
$a^3_{\rm AU} = P^2_{\rm yr}$	$a^3 = GMP^2/4\pi^2$	
$\lambda f = c$	$E_\gamma = hf = hc/\lambda$	$\theta_{\rm diff} = 1.22\lambda/D$
$\lambda_{\rm max}T = 2.9 \times 10^{-3}$ m K		
$F = \dfrac{dE/dt}{A}$	$F = \sigma T^4$	$L = 4\pi R^2 F$
$T = [(1-A)/(2 \text{ or } 4)]^{1/4}\ (R_\odot/d)^{1/2}\ T_\odot$	$= (332 \text{ or } 279 \text{ K})[(1-A)/d^2]^{1/4}$	
$v^2_{\rm esc} = 2GM/R$	$v^2_{\rm rms} = 3kT/\mu$	$v_{\rm esc} \geq 6v_{\rm rms}$ to retain gas
$F_{\rm tide} = 2GMmR/d^3$	$R_{\rm Roche} = 2.4(M/m)^{1/3}r_m = 2.4(\rho_M/\rho_m)^{1/3}\ R_M$	
$n = n_0\ e^{-\lambda t}$	$t_{1/2} = \ln 2/\lambda$	

NOTE: the above symbols may have different meanings in different equations!