AS101 - The Solar System
Summer Session 1, 2006

Class Hours: Monday, Tuesday, Wednesday, Thursday, and Friday; 9:30 am - 11:00 am, Room CAS B18A. Wednesday 17 May - Wednesday 28 June.

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Last day to register/add classes: Tuesday 23 May
Last day to drop without W grade: Tuesday 23 May
Holiday, Classes suspended: Monday 29 May (Memorial Day)
Last day to drop with a W grade: Tuesday 6 June

Textbook: The Solar System: The Cosmic Perspective, by Bennett, Donahue, Schneider, and Voit (includes CD). The BU bookstore stocks this book for $64.80 (new) and $48.60 (used). If you plan to purchase a copy from another store, please ensure that you get the correct edition.

Other material: A scientific calculator and a ruler will be essential for the homeworks, labs, and exams.

Website: Electronic copies of the syllabus and other handouts are online at:
http://sirius.bu.edu/withers/teaching/as101_summer1_2006/

Course Overview:
In some areas of science, the content of a typical 100-level introductory class was discovered one hundred years, has been verified by thousands of experiments, and rarely seems exciting. This is not the case for studies of the solar system. Much of what you will learn about the solar system in this class was discovered during your lifetime by spacecraft voyaging far from Earth. The material in this class is as accurate as possible, but future discoveries will undoubtedly disprove some of it (hopefully not much) in the next decade.

I hope that you will concentrate on three themes during this class. First, learning about the objects in our solar system. Second, using some general physical principles about matter, energy, light, forces, and motion to understand why our solar system is the way it is. Third, gaining an appreciation for the process of science: observations, predictions, and testing with new observations.

Homework: Unlike spring or fall semester classes, this class will be completed in six weeks with five classes per week. That means that you must keep up with the material as we cover it in class, rather than catching up every few weeks. To encourage you to do so, there will be one homework per class. Homeworks will contain a small number of short questions. Homeworks assigned on a given day will be due at the start of class the next day.

Laboratory Exercises: There will be five laboratory exercises as part of this class. Four of them will take place during the regular class time, but in room CAS 521. One night lab will take place after sunset in the observatory on the roof of the CAS building. To get to the observatory, go up the stairs opposite CAS 517. The date and time of the night lab will be scheduled later. Lab reports will be due one week after the lab.

Mid-term Exam: Monday 12 June, 9:30 am - 11:00 am, CAS B18A.

Final Exam: Wednesday 28 June, 9:30 am - 11:00 am, CAS B18A.

Grades:

Homeworks	25% (lowest 2 will be dropped)
Labs	25%
Mid-term exam	25%
Final exam	25%

Late Work, Missed Exams: Late homeworks or laboratory reports will not be accepted. If you miss the mid-term or final exam for a very, very good reason, such as a medical emergency, you may petition the Astronomy Department Chairman for permission to have a make-up exam. I recommend not missing the exams.

Astronomy Department Chairman: Professor Jim Jackson, CAS 605, 617-353-6499
Dean of Students: Kenneth Elmore, Third Floor, GSU, 775 Commonwealth Avenue, 617-353-4126

Online Resources:
www.masteringastronomy.com Integrated with the textbook
www.solarviews.com
www.nineplanets.org

Academic Integrity: Students are expected to follow the Student Academic Conduct Code of BU's College of Arts and Sciences: www.bu.edu/cas/undergraduate/conductcode.html. Students who violate this code will fail this class.

Schedule

Date	Number	Description	Book Chapter
Wednesday 17 May	1	Introduction	
Thursday 18 May	2	Our Place in the Universe	Chapter 1
Friday 19 May	3	Discovering the Universe for Yourself	Chapter 2
Monday 22 May	4	LAB: Time	
Tuesday 23 May	5	The Science of Astronomy	Chapter 3
Wednesday 24 May	6	Chapter 3 continued	
Thursday 25 May	7	Making Sense of the Universe	Chapter 4
Friday 26 May	8	Chapter 4 continued	
Monday 29 May	-	HOLIDAY	
Tuesday 30 May	9	LAB: Gravity	
Wednesday 31 May	10	Light and Matter	Chapter 5
Thursday 1 June	11	Chapter 5 continued	
Friday 2 June	12	Telescopes: Portals of Discovery	Chapter 6
Monday 5 June	13	LAB: Optics	
Tuesday 6 June	14	Our Planetary System	Chapter 7
Wednesday 7 June	15	Formation of the Solar System	Chapter 8
Thursday 8 June	16	Chapter 8 continued	
Friday 9 June	17	Planetary Geology	Chapter 9
Monday 12 June	18	MID-TERM EXAM	
Tuesday 13 June	19	Chapter 9 continued	
Wednesday 14 June	20	Planetary Atmospheres	Chapter 10
Thursday 15 June	21	Chapter 10 continued	
Friday 16 June	22	Jovian Planet Systems	Chapter 11
Monday 19 June	23	Chapter 11 continued	
Tuesday 20 June	24	LAB: Craters	
Wednesday 21 June	25	Remnants of Rock and Ice	Chapter 12
Thursday 22 June	26	Other Planetary Systems	Chapter 13
Friday 23 June	27	Chapter 13 continued	
Monday 26 June	28	Our Star	Chapter 14
Tuesday 27 June	29	Chapter 14 continued	
Wednesday 28 June	30	FINAL EXAM	

Useful Equations

Powers of ten

$10^1 = 10$
$10^A \times 10^B = 10^{(A+B)}$

Scientific notation

Write number as 4.01×10^2, 3.6×10^6, or 5.7×10^{-3}, not 401, 3600000, or 0.0057
The decimal point appears after the first non-zero digit, so write 4.01×10^2, not 40.1×10^1 or 0.401×10^3

Angles and Circles

Circumference of circle = $2 \pi r$, where r is radius
Surface area of sphere = $4 \pi r^2$, where r is radius
Volume of sphere = $4 \pi r^3 / 3$, where r is radius
Angular size / 360^o = Physical size / ($2 \pi \times$ distance)
Best angular resolution of a telecope in arcseconds = $2.5 \times 10^5 \times \lambda / D$ where λ is the wavelength and D is the telescope diameter

Orbits

Perihelion distance = a(1-e)
Aphelion distance = a(1+e)
where a = semi-major axis and e = eccentricity

$(\text{Orbital period / years})^2 = (\text{Average distance from Sun / AU})^3$

Motion

v = d / t where v = speed, d = distance travelled, and t = time
a = (change in v) / t where a = acceleration and t = time
Momentum = m v where m = mass and v = speed
Angular momentum = m v r where m = mass, v = speed, and r = radius
F = m a where F = force, m = mass, and a = acceleration
$F = G M_1 M_2 / r^2$ where F = gravitational force, G = gravitational constant, M_1 and M_2 are masses, and r is distance between the two masses
$g = G M_{Earth} / (R_{Earth})^2$ where g is the acceleration due to gravity, G is the gravitational constant, M_{Earth} is the mass of the Earth, and R_{Earth} is the radius of the Earth
$g = 10 \text{ m/s}^2$
$p^2 = a^3 \times 4\pi^2 / (G M_{Sun})$ where p is orbital period, a is average distance from Sun, G is the gravitational constant, and M_{Sun} is the mass of the Sun
p = F / A where p is pressure, F is force, and A is area

Light

$c = \lambda f$ where c is the speed of light, λ is the wavelength, and f is the frequency
E = h f where E is energy, h is Planck's constant, and f is frequency
$(\lambda_{shifted} - \lambda_0) / \lambda_0 = v / c$ where $\lambda_{shifted}$ is the Doppler-shifted wavelength, λ_0 is the rest wavelength, v is the speed, and c is the speed of light.

$P / A = \sigma T^4$ where P is emitted power, A is area, σ is the Stefan-Boltzmann constant, and T is temperature in Kelvin
$\lambda_{max} = 3$ mm / (T in Kelvin) where λ_{max} is the wavelength of maximum intensity
Diffraction limit in arcseconds = 2.5×10^5 x (wavelength of light) / (diameter of telescope)

Matter
$N / N_0 = (1/2)^{(t/X)}$ where N is the current amount of a radioactive substance in a rock, N_0 is the original amount, t is the time since the rock formed, and X is the half-life of the radioactive substance.
$E = mc^2$ where E is energy, m is mass, and c is the speed of light

$c = 3 \times 10^8$ m / s
$G = 6.67 \times 10^{-11}$ m^3 / (kg s^2)
$h = 6.626 \times 10^{-34}$ J s
$M_{Sun} = 2 \times 10^{30}$ kg
$M_{Earth} = 5.97 \times 10^{24}$ kg
$R_{Earth} = 6378$ km (equatorial)
mass of a proton = mass of a neutron = 1.67×10^{-27} kg
mass of an electron = 9.1×10^{-31} kg

Working with Units

1 thousand = 10^3
1 million = 10^6
1 billion = 10^9

Mass
Often measured in kilograms (kg)
1 kg = 10^3 grams (g)
1 pound mass = 454 grams

Time
Often measured in seconds (s)
1 year = 365.25 days
1 day = 24 hours
1 hour = 60 minutes
1 minute = 60 seconds

Distance
Often measured in metres (m)
1 light-year = 9.46×10^{12} kilometres (km)
1 AU (astronomical unit) = 1.5×10^8 km
1 mile = 1.6 km
1 km = 10^3 metres (m)

1 m = 100 centimetres (cm)
1 cm = 10 millimetres (mm)
1 mm = 10^3 micrometres (um)
1 um = 10^3 nanometres (nm)

1 nm = 10^{-9} m
1 um = 10^{-6} m
1 mm = 10^{-3} m
1 cm = 10^{-2} m

1 foot = 30 cm
1 inch = 2.5 cm

Angle
Often measured in degrees
360 degrees in a circle
1 degree = 60 arcminutes
1 arcminute = 60 arcseconds

Speed or Velocity
Often measured in m/s

Acceleration
Often measured in m/s^2

Force
Often measured in Newtons (N)
1 kg m/s^2 = 1 N
1 pound force = 4.45 N

Momentum
Often measured in kg m/s

Angular Momentum
Often measured in kg m^2 / s

Energy
Often measured in Joules (J)
1 kg m^2 /s^2 = 1 J
1 food Calorie = 4184 J
1 electron-volt = 1eV = 1.6×10^{-19} J

Frequency
Often measured in Hertz (Hz)
1 Hz = 1 cycle per second

Power
Often measured in Watts (W)
1 W = 1 J / s

Density
Often measured in kg / m^3

Pressure
Often measured in Pascals (Pa)
1 Pa = 1 N / m^2
1 bar = 10^5 Pa
1 atmosphere of pressure = 10^5 Pa
1 pound per square inch = 1 psi = 6900 Pa

Temperature
Often measured in Kelvin (K)
Degrees Celsius (^{o}C) and degrees Fahrenheit (^{o}F) are also common
A change in temperature of 1 K is the same as a change in temperature of 1 ^{o}C.
A change in temperature of 1 K is the same as a change in temperature of 1.8 ^{o}F.
Tc = Tk - 273.15
Tk = Tc + 273.15
Tc = (5/9) x (Tf-32)
Tf = 32 + (9/5) x Tc
where Tc is the temperature in degrees Celsius, Tk is the temperature in degrees Kelvin, and Tf is the temperature in degrees Fahrenheit.

Some Chemical Elements and Molecules

H: Hydrogen, 1 proton, 0 neutrons, 1 electron
He: Helium, 2p, 2n, 2e
C: Carbon, 6p, 6n, 6e
N: Nitrogen, 7p, 7n, 7e
O: Oxygen, 8p, 8n, 8e

H_2 - molecular hydrogen
N_2 - molecular nitrogen
O_2 - molecular oxygen
O_3 - ozone
CO_2 - carbon dioxide
CH_4 - methane
NH_3 - ammonia
H_2O - water

The textbook use “ice” to mean frozen water and “hydrogen compounds” to mean a mixture of methane, ammonia, and water that is common in the outer solar system. My lectures often use the word “ice” instead of “hydrogen compounds”.