ASTR1050
Fall 2025

Equations

$$\alpha = \frac{L}{D} \qquad \theta = \frac{\ell}{R}$$

$$\frac{P_1^2}{P_2^2} = \frac{a_1^3}{a_2^3} \qquad P^2 \propto a^3$$

$$F_g = G\frac{M_1 M_2}{r^2} \qquad g = G\frac{M}{R^2}$$

$$v = \sqrt{\frac{GM}{R}} \qquad P^2 = \frac{4\pi^2}{GM}a^3$$

$$e = \frac{c}{2a} \qquad \mathrm{Ap} = a\,(1+e)$$

$$\mathrm{Pe} = a\,(1-e) \qquad F = ma$$

Constants/Conversions

1 pc $= 3.09 \times 10^{16}$ m
π rad $= 180$ °
$60' = 1$ °
$60'' = 1'$
$G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}

SI prefixes

Name	Symbol	Base 10
Tera	T	10^{12}
Giga	G	10^{9}
Mega	M	10^{6}
Kilo	k	10^{3}
Centi	c	10^{-2}
Milli	m	10^{-3}
Micro	μ	10^{-6}
Nano	n	10^{-9}
Pico	p	10^{-12}
Femto	f	10^{-15}

Multiple Choice Section (50 %)

1. Why is the sidereal day different than the solar day?

(a) The precession of Earth's rotational axis.
(b) The Earth moves in its orbit as it rotates on its axis.
(c) The Earth orbits around the Sun in an epicycle about the deferent.
(d) Angular momentum is transferred from Earth's rotation to the orbit of the Moon.

2. What is the significance of the Equinox?

(a) The Sun is at its highest point in the sky.
(b) The Sun is at its lowest point in the sky.
(c) There are equal parts day and night.
(d) The Earth is closest to the Sun.

3. Why was the Julian calendar adopted over the Lunisolar calendar?

(a) The Julian calendar requires less-complex corrections compared to the Lunisolar calendar.
(b) The Julian calendar is a more accurate measure of the tropical year.
(c) The Julian calendar used the lunar phases to keep track of the Earth year.
(d) The Julian calendar is a more accurate calendar than the Gregorian calendar.

4. What is the significance of the Zodiac?

(a) They are the 12 constellations that lie on the celestial equator.
(b) They are the 12 constellations that lie on the galactic equator.
(c) They are the 12 constellations that lie on the celestial poles.
(d) They are the 12 constellations that lie on the ecliptic.

5. The declination of our zenith is:

(a) The longitude of our observing location.
(b) The time zone of our observing location.
(c) The latitude of our observing location.
(d) The right ascension on the meridian.

6. **The Sun is $66.5\,^\circ$ above the northern horizon on the summer solstice (21 June). What is our observation latitude?**

   (a) $0\,^\circ$

   (b) $-23.5\,^\circ$

   (c) $66.5\,^\circ$

   (d) $+23.5\,^\circ$

7. **The Orion Nebula has right ascension 6 hours. When is the best month to observe this target?**

   (a) March

   (b) December

   (c) June

   (d) September

8. **True or False: Newton's Laws of Gravitation can be used to derive Kepler's Third Law.**

   (a) True

   (b) False

9. **When will the First Quarter Moon cross our meridian?**

   (a) 6 am

   (b) 12 pm

   (c) 6 pm

   (d) 12 am

10. **Why did astronomers hypothesize there may have been another planet interior to Mercury?**

    (a) Mercury's rotation is in a 2:3 resonance with its orbital period.

    (b) Mercury has an unusually eccentric orbit.

    (c) The Mercurian atmosphere is stripped.

    (d) Mercury's orbit precesses.

Open ended (50 %)

11. Suppose you are on a manned mission to Mars.

(a) **On the summer solstice at your Martian base, you notice the Sun is at your zenith. At another site on Mars $1,479$ km south, objects cast shadows at $25\ ^\circ$. Calculate the radius of Mars.**

(b) **If the surface gravity on Mars is 3.728 m s^{-2}, calculate the mass of Mars.**

(c) **On the surface of Mars, you notice the Martian moon Phobos in the sky. If Phobos is $12.7'$ in size, calculate the semi-major axis of the orbit of Phobos. Phobos has radius $11,080$ m.**

(d) **Calculate the force of gravity between Mars and Phobos. Phobos has mass 1.06×10^{16} kg.**

(e) **Calculate the surface gravity on the surface of Phobos. Phobos has radius $11,080$ m.**

12. Ganymede is one of the Galilean moons around Jupiter.

(a) **If Ganymede has Apoapsis** 1.0716×10^9 **m and Periapsis** 1.0692×10^9 **m, find the eccentricity of Ganymede.**

(b) **Find the semi-major axis of Ganymede's orbit.**

(c) **Find the orbital speed of Ganymede. Hint: Jupiter's mass is** 1.90×10^{27} **kg.**

(d) **Find the orbital period of Ganymede.**

(e) **Europa is another moon around Jupiter with orbital period** 3.551 **days. Calculate Europa's semi-major axis.**

Answer key

1. **B**
2. **C**
3. **A**
4. **D**
5. **C**
6. **A**
7. **B**
8. **A**
9. **C**
10. **D**
11. **a.** $R = 3,390$ km
    b. $M = 6.42 \times 10^{23}$ kg
    c. $a = 9.36 \times 10^{6}$ m
    d. $F_g = 5180$ TN (5.180×10^{15} N)
    e. $g = 0.576$ cm s^{-2}
12. **a.** $e = 0.00112$
    b. $a = 1.0704$ Gm (1.0704×10^{9} m)
    c. $v = 10,880$ m s^{-1}
    d. $P = 7.155$ days
    e. $a = 6.709 \times 10^{8}$ m