ASTRONOMY

Students can use the table provided in the last page for solving the problems if necessary.

A. Multiple Choice

1. Suppose you see a new planet in the night sky. Based on observations, you find that the planet is close to the Sun, with maximum elongation of 30 degrees. Given that the maximum elongations of Venus and Mercury are 46 and 23 degrees respectively, you can conclude that :

a. the orbit of the planet is closer to the Sun than that of Mercury

b. the orbit of the planet is located between those of Mercury and Venus

c. the orbit of the planet is located between those of Venus and Earth

d. the position of the planet can not be determined from the given data

e. all the answers above are incorrect

[1 point]

2. For an astronaut who is standing on the surface of the Moon facing the Earth, which one of the following statements is correct?

a. The Earth will always appear as a full disk

b. The length of one day and one night is equal to the synodic period of the Moon seen by an observer on the Earth

c. The length of the day is half of the sidereal period of the Moon orbiting the Earth

d. The duration between Earth rise and Earth set is the same as the duration between New Moon and Full Moon on the Earth

e. The surface of the Earth facing the Moon is always the same so that only one side of the Earth is visible from the Moon

[1.5 points]

3. How would the length of the solar day change if the direction of the Earth's rotation is suddenly reversed while maintaining the direction of revolution?

a. It would be 4 minutes longer than before
b. It would be 4 minutes shorter than before
c. It would be 8 minutes longer than before
d. It would be 8 minutes shorter than before
e. It would not change, but remains the same as before
[1.5 points]

4. According to stellar evolution theory, the Sun will evolve into the red giant stage in a few billion years. How would the average temperature on the surface of the Earth change compared to the present temperature, in the time when the Sun becomes a red giant with a radius of 1.12×10^7 km and its temperature drops to 2900 K ? Assume that the current radius of the Sun is 7×10^5 km, its surface temperature is 5800 K and neglect the possible change of the albedo of the Earth.

a. Becomes four times the present temperature

b. Becomes twice the present temperature

c. Becomes half the present temperature

d. Becomes a quarter of the present temperature

e. No change

[2 points]

5. The parallax of a star measured on the Earth is 0.05 arc-seconds. Determine its parallax if we measure it from Jupiter (heliocentric distance of Jupiter is 5.2 AU).

a. 1.00 arc- seconds
b. 0.52 arc- seconds
c. 0.33 arc- seconds
d. 0.26 arc- seconds
e. 0.15 arc- seconds
[1.5 points]

6. If the mass of the Sun increases by two times its present value, and the planets remain in their present orbits, then the Earth's period of revolution will be about:

a. 423 days

b. 365 days

c. 321 days

d. 258 days

e. 147 days

[1.5 points]

7. If the perihelion of comet Halley is 8.9×10^{10} meters and its period is 76 years, then the eccentricity of Halley is:

a. 0.567

b. 0.667

c. 0.767

d. 0.867

e. 0.967

[1.5 points]

8. A particular spectral line of a star is observed at 4999 Å. According to laboratory experiments, this spectral line should appear at 5000 Å. What is the velocity of this star relative to the observer?

a. 60 km/s approaching the observer
b. 60 km/s receding the observer
c. 75 km/s approaching the observer
d. 75 km/s receding the observer
e. The star does not move relative to the observer

[1.5 points]

B. Essay

1. Some time ago, there was a rumour that the planet Mars as seen from the Earth would appear as big as the Moon (about 0.5°). The following data are given. The semi-major axis and eccentricity of the Earth are a_E = 1 AU and e_E = 0.017 respectively and those of Mars are a_M = 1.5 AU, e_M = 0.093, and the radius of Mars is R = 3393.4 km. Determine the maximum angular diamater of Mars and justify the rumour (answer with a RIGHT or WRONG).

To answer these you have to

a. Draw a sketch of the situation.
b. Show the formula(s) that will be used.
c. Show the calculations and the final results.

[5 points]

2. On January 15, 2010, there was an annular eclipse, where at maximum 97% of Solar disk was covered by the Moon. At that time the Earth was very close to its perihelion. The following data are given. The semi major axis of the Earth's orbit is 1.5×10^8 km, the solar radius is 7×10^5 km, eccentricity 0.017 and the radius of the Moon is 1.738×10^3 km. What is the distance of the Moon from the Earth ?

(Show the formula(e), calculations and the final results)

[3 points]

Table of constants and units

Constants	Symbols	Values
Solar luminosity	$L_\odot$	3.86×10^{26} Js^{-1} = 3.86×10^{26} watt
Solar constant	$F_\odot$	1.368×10^{3} Jm^{-2}
Universal gravitational constant	G	6.67×10^{-11} Nm^2kg^{-2}
Earth's gravitational acceleration	g	9.8 ms^{-2}
Earth mass	$M_\oplus$	5.98×10^{24}kg
Lunar mass	$M_\leftmoon$	7.34×10^{22}kg
Solar mass	$M_\odot$	1.99×10^{30}kg
Stefan-Boltzmann constant	σ	5.68×10^{-8} $Js^{-1}m^{-2}K^{-4}$
Astronomical Unit	AU	1.496×10^{11} m
Moon-Earth average distance	D	3.84×10^{8} m
Earth radius	$R_\oplus$	6.37×10^{6} m
Solar radius	$R_\odot$	6.96×10^{8} m
Sidereal year	τ	365.256 days = 3.16×10^{7} s
Solar effective temperature	$T_\odot$	5880° K
Light year	Ly	9.5×10^{15} m
Parsec	pc	3.26 Ly
Speed of light	c	3×10^{8} m/s