MOTIONS OF THE PLANETS

LAB ASTR 1
From *Westminster College Astronomy Labs*

INTRODUCTION

Of particular interest to amateur astronomers, "small" telescope and naked eye observers and casual sky observers; are the sun, the moon, and the five "wandering stars"—the five "naked-eye" planets. Humans from early times have had a fascination for the "heavenly" bodies and came to recognize and to note various changes and rhythms. They too came to realize that their very sustenance was coupled to and dependent on annual seasonal cycles—in time calendars came to be.

Early-on the sense was that the earth, our place and reference was "fixed", so models including/involving the observed moving bodies were contemplated with "we" the earth being the center. With time, to account for the growing body of observational data, the earth-centered models became quite complex and sophisticated and still inadequate to account for and explain all the observed behavior.

Over hundreds to a few thousands years into the more recent scientific era, with more experience and more extensive and precise observations and data, we now confidently understand the earth as being a planet of a sun-centered (heliocentric) planetary solar system.

In this exercise we pursue the fascination of understanding and interpretation of visually observed planetary data with respect to our planetary solar system model.

PURPOSE

To develop perspective and understanding of the motions of the planets as observed from the earth and of some geometric and dynamic aspects involved.

MATERIALS

Mars motion data
Star chart SC-1
Orbit chart SO512
Reference text
Metric ruler
Graph sheet

PROCEDURE AND ANALYSIS

1. Mars Motion Data
   On August 31, 2003 the planet Mars was positioned at a particularly close opposition to the earth. These close oppositions occur only once in fifteen years. The combination of the movements of earth and Mars in their orbits at this time causes Mars to travel to what appears to be a strange path among the stars as viewed from the earth. Mars when at close opposition is a particularly desirable time for telescopic observation—many had their telescopes out at that time.

   Plot the 2003 path of Mars on the graph sheet provided using the following data:

	Date 2003	Right Ascenion	Declination
A	Apr 1	19 h 14.6 m	-22º 58´
B	Apr 11	19 h 41.3 m	-22º 18´
C	Apr 21	20 h 7.3 m	-21º 25´
D	May 1	20 h 32.4 m	-20 º 22´
E	May 11	20 h 56.6 m	-19 º 12´
F	May 22	21 h 21.7 m	-17 º 50´
G	June 1	21 h 43.0 m	-16 º 35´
H	June 11	22 h 2.6 m	-15 º 25´
I	June 21	22 h 20.0 m	-14 º 24´
J	July 1	22 h 34.7 m	-13 º 36´
K	July 11	22 h 46.1 m	-13 º 08´
L	July 22	22 h 53.9 m	-13 º 04´
Stationary	July 31	22 h 56.0 m	-13 º 24´
M	Aug 1	22 h 55.9 m	-13 º 28´
N	Aug 11	22 h 52.9 m	-14 º 13´
O	Aug 22	22 h 44.4 m	-15 º 14´
Closest	Aug 27	22 h 39.3 m	-15 º 41´
Opposition	Aug 31	22 h 35.0 m	-15 º 59´
P	Sept 1	22 h 34.0 m	-16 º 03´
Q	Sept 11	22 h 24.3 m	-16 º 28´
R	Sept 21	22 h 17.7 m	-16 º 20´
Stationary	Sept 30	22 h 15.8 m	-15 º 45´
S	Oct 1	22 h 15.8 m	-15 º 40´
T	Oct 11	22 h 19.1 m	-14 º 32´
U	Oct 22	22 h 27.8 m	-12 º 51´
V	Nov 1	22 h 39.6 m	-11 º 00´
W	Nov 11	22 h 54.2 m	-8 º 55´
X	Nov 21	23 h 11.0 m	-6 º 40´
Y	Dec 1	23 h 29.5 m	-4 º 15´
Z	Dec 11	23 h 49.2 m	-1 º 45´
a	Dec 22	0 h 12.0 m	+1 º 05´

(Identify each point by the letter indicated corresponding to the data and sketch in the path.)

2. Label the celestial equator, draw in and label the ecliptic, draw in a few prominent stars in the background of Mars when in retrograde motion, label these stars and their constellation(s), and label the two stationary points and the ascending node.

3. Describe the apparent path of Mars in your own words (include motions, directions, ….):

4. What compass direction is Mars moving at the time of opposition?

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5. The orbit chart, SO512, is a plane view of the solar system through the orbit of Saturn as seen from the north ecliptic pole.

   Locate the present orbital position of each of the planets listed below from the heliocentric longitude data (current data to be provided).

Mercury	239 º	(Data for June 15, 2007)
Venus	223 º	
Earth	264 º	
Mars	343 º	
Jupiter	256 º	
Saturn	146 º	

6. Refer to the SO512 orbit chart. What are the heliocentric longitudes of Earth and Mars at the time of opposition?

   Earth_____ Mars_____

   The distance between the planets at this time is _____miles.
   Note the centimeter scale at the bottom of SO512 orbit chart and that the radius of the earth's orbit as drawn in one centimeter therefore providing a scale for the chart of centimeters corresponding to astronomical units (AUs). (One AU is about 93 million miles.)

7. Planets are best observed when they are highest in the sky.
   Name the planets presently best observed before midnight.

   _____

   Name the planets presently best observed after midnight.

   _____

8. Name the planets and their present relation to the ecliptic:

Above	Below
_____	_____
_____	_____
_____	_____
_____	_____

9. List the present distances of the planets from earth to the nearest tenth of an astronomical unit:

   Mercury_____ Venus_____

   Jupiter_____ Saturn_____

   Mars_____

10. Find the approximate next opposition dates for (show your work):

    Jupiter _____ Saturn_____