PTYS/ASTR 206 – Section 3 – Homework1 – Assigned 1/22/09

NAME: KJ Key

(PRINT CLEARLY)

- Homework is due in class on Thursday January 29th.
- Late homeworks can be turned in class on Tuesday February 3rd for 50% credit.
- Homeworks turned in later than the end of class on Tuesday February 3rd receive 0%.
- Students are encouraged to discuss approaches to solving homework problems with each other; however, all work submitted must be the student's own. Do not turn in identical homeworks! See the syllabus for more information.

Hint: Each of these questions should be quick to answer. If you find yourself engaged in a long chain of complicated reasoning or more than a few lines of math then something is probably wrong! Make sure to start this early and talk to the TA or myself with any questions.

(20)

Question 1: A dangerous asteroid?

5 A near-Earth asteroid is discovered and tracked. The period of the asteroid was found to be 500 days. Using Kepler's third law, find the semi-major axis of this asteroid's orbit in astronomical units (AU).

$P^2 = a^3$ (in yr) (in AU)

$P = \frac{500\ d}{365\ d/yr} = 1.37\ yr$

$1.37^2 = a^3$

$1.88 = a^3$

$\sqrt[3]{1.88} = a$

$1.23\ AU = a$

10 The eccentricity of the asteroid was found to be 0.3. Using formulas in the lecture notes find the perihelion and aphelion distances in AU. Based on these values, could this asteroid impact the Earth? Could it impact Mars?

$r_p = a(1-e) = 1.23(0.7)\ AU = 0.86\ AU$

$r_a = a(1+e) = 1.23(1.3)\ AU = 1.60\ AU$

Mars: $r_p = 1.38\ AU$, $r_a = 1.67\ AU$

Earth: $r_p = 0.98\ AU$, $r_a = 1.02\ AU$

yes, could impact Earth or Mars.

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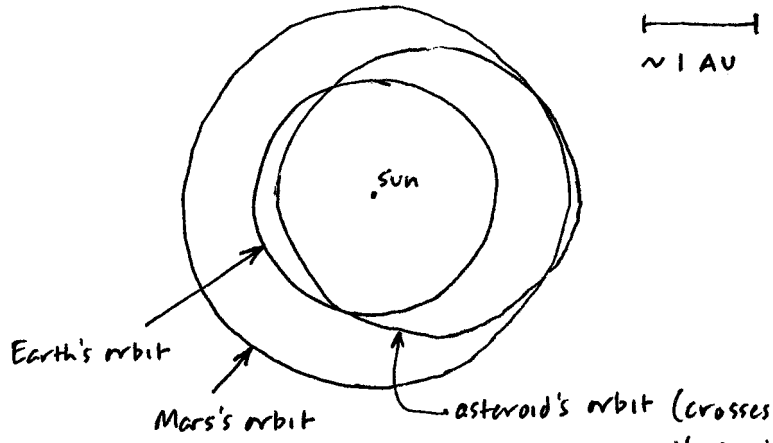
Sketch the orbits of Earth, Mars and this asteroid to scale.

5



(20) **Question 2: Gravity on different planets**

The Earth's acceleration due to gravity is 9.8 m/s^2.

5 What would be this acceleration on a similarly sized planet that had double the mass?

$F = \frac{Gm_1m_2}{r^2}$ $a = \frac{Gm_2}{r^2}$ $a \propto \frac{m}{r^2}$ $F = m_1 a$

m doubles, a doubles.

$a = 19.6\ m/s^2$

5 What would it be on a planet double the size of the Earth and double its mass?

$a \propto \frac{m}{r^2} \propto \frac{2}{2^2} = \frac{1}{2}$

$a = 4.9\ m/s^2$

5 Is your mass on the Moon more or less than on the Earth?

Same (but weight would be less)

5 What's your weight on Earth (you can lie if you like ☺)? How much would you weigh on the Moon? Look up the mass and radius of the Moon and use them to rescale the acceleration of gravity in the same way as the first two parts of the question.

200 lbs.

weight is a force

$F \propto a$

$F \propto \frac{m}{r^2} \propto \frac{0.0123\,m_\oplus}{(0.27)^2 r_\oplus^2} \propto \frac{0.0123}{0.0729} \propto 0.17$

wt. = 200 lbs · 0.17 = 34 lbs.

$a = 9.8\ m/s^2 \cdot 0.17 = 1.7\ m/s^2$

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Question 3: Movement of the Sun

6 A solar day is 24 hours long. How many degrees across the sky does the Sun move every hour?

$$\frac{360^\circ}{24\,h} = \boxed{15^\circ/hr}$$

7 What is the angular size of the Sun in degrees? (Hint: use the small angle approximation to find it in radians and then convert to degrees, 1 radian = 57.3°)

$$\theta = \frac{size}{dist.} = \frac{1.392\times10^{9}\,m}{1.496\times10^{11}\,m} = 9.3\times10^{-3}\,rad \times \frac{57.3^\circ}{1\,rad} = \boxed{0.5^\circ}$$

7 Once a sunset starts (when the limb of the solar disk touches the horizon), how long is it before the whole sun is below the horizon.

$$0.5^\circ \cdot \frac{1\,hr}{15^\circ} = 0.033\,h = \boxed{2\ minutes}$$

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Question 5: Days and Seasons

4 Observing from Tucson, what direction do the stars appear to rotate around the celestial pole?

CCW (counter-clockwise aka anti-clockwise)

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4 Does this answer change for observers in the southern hemisphere? Explain why/why-not.

yes — CW (CCW is only for northern view)
In the Southern hemisphere, you're looking the opposite direction, toward the south celestial pole.

4 The position of the Sun on the celestial sphere is given by its right-ascension and declination. The declination varies throughout the year from -23½° to +23½° and back again. If the solar declination has just <u>increased to</u> +10° then what season is it in Tucson? Explain why?

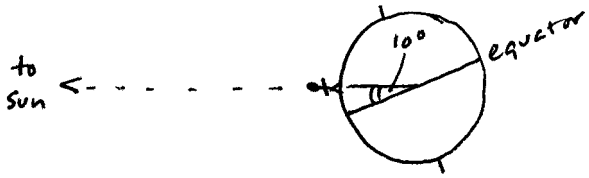
0° dec = spring & fall equinoxes. $-23\frac{1}{2}^\circ$ dec = winter solstice, $+23\frac{1}{2}^\circ$ = summer solstice.
at 10°N: Sun is heading N (+) in spring, S (-) in fall.

Spring

4 At that time of year which latitude on Earth is the Sun directly overhead at noon?

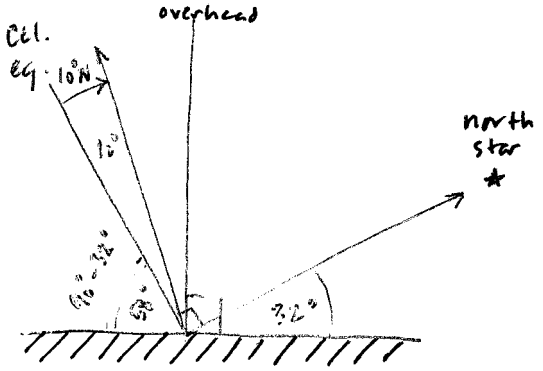
Sketch the situation.

10° N



4 At that time of year, what is the solar incidence angle at Tucson (latitude 32° North)?

Use the formula in the lecture notes to calculate the solar power at that time.



Solar elev. = 68°

$i = 90^\circ - SE = 90 - 68 = \boxed{22^\circ}$

$P = P_0 \cos i = (1370\ W/m^2) \cos 22^\circ = \boxed{1270\ W/m^2}$
0.93

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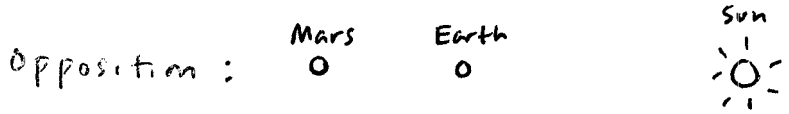
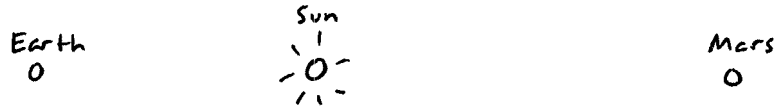
Question 5: Phases

6 There are two situations when Mars is fully illuminated as 'seen' from the Earth. Sketch those two geometries and explain why we can't actually see Mars during one of them.



Superior conjunction (lost in glare of sun):



6 Venus also undergoes phases. When it is more fully illuminated, is it nearer or closer to us? Explain why.

farther — near superior conjunction.
When it is closest to us, it is at "new" phase — the illuminated side faces away from Earth.

6 *Question 26 in chapter 3 of the textbook:* What is the phase of the Moon if it rises at (a) Midnight; (b) sunrise; (c) halfway between sunset and midnight; (d) halfway between noon and sunset? Explain your answers.

A. last quarter
B. new
C. waning gibbous
D. waxing gibbous

(See chapter 3 for complete explanation.)