Physics 90 Exam for Unit 2

March 18th, 2020

Do-at-home exam directions:

You may use the OpenStax textbook and your class notes, including all materials that I used in lecture. You will need a calculator for two of the problems (the first and last ones). You need to be able to do cubes (even if that means keying in the same thing three times), and square roots. You can't use Google or your friends.

If you don't have them all, you can view all Unit 2 materials here, including the Wylie Overstreet video:

http://physics.stmarys-ca.edu/courses/Phys090/20S/detailed_schedule_unit_2.html

During the exam time 8:00-9:05am I will be waiting on Zoom (usual meeting code: https://stmarys-ca.zoom.us/j/866254786). If you think you found a typo, you can join the Zoom session and ask me about it.

***When done**, submit a one-page (or more if necessary) Word, PDF, or plain text document **with just your answers** using Moodle TurnItIn, like you would a Seminar essay.*

If you have SDS permission for extended time or any other unusual consideration, like your calculator batteries were dead (just making an example up), or you have to take care of something unusual due to shelter-in-place, you may use more or other than the standard 8:00-9:05am time period, but please complete the exam expeditiously.

Prefixes

k = kilo = 10^3
M = mega = 10^6
G = giga = 10^9
T = tera = 10^{12}
c = centi = 10^{-2}
m = milli = 10^{-3}

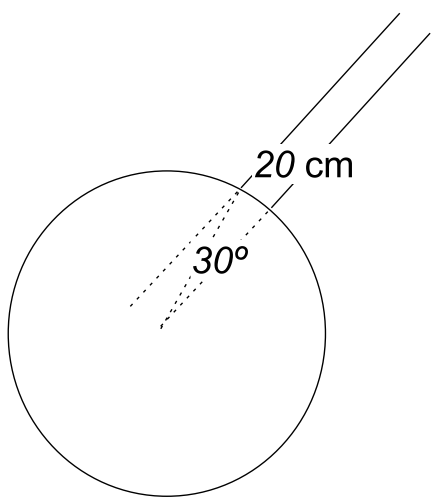
Correct Ideas from the Ancients

1. Eratosthenes and the Beach Ball

Eratosthenes is looking at a beach ball in the sand. He can see that the sunlight is falling straight down on one part of the beach ball. 20cm away on another part of the beach ball, the sunlight is coming down with an angle of 30°. The circumference of the beach ball is:

(A) 1.5 m
(B) $\frac{2}{3}$m
(C) 200 cm
(D) 2.4 m

HINTS: (1) I am asking for circumference — not radius or diameter. If you're crafty, you won't even need the pie crust formula or that $\pi = 3.14$. (2) The description above is enough, but perhaps the following diagram helps.



2. Aristarchus Measures the Moon

Which was **not** part of Aristarchus's calculation for the size of the Moon (but we added it to make his calculation better):

(A) the period *P* of the Moon's orbit
(B) the size of the Earth
(C) the apparent (angular) size of the Moon in the sky
(D) the tapering of the Earth's umbra
(E) the duration of a lunar eclipse

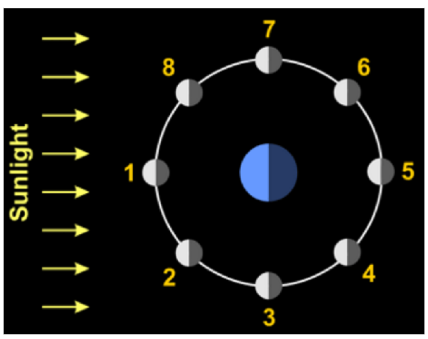
An Incorrect Idea from the Ancients

3. Ptolemaic Model

In Ptolemy's model:

(A) Perfect circles are used to explain all the celestial motions.
(B) Everything orbits the Earth.
(C) Extra circles called epicycles are needed to explain the retrograde motion of Mars.
(D) The model was believed by most but definitely not all people until Copernicus and Galileo.
(E) All of the above.

Moon Phases and Eclipses



In the diagram, you are looking down on the Earth's North pole *and the Moon is going around the Earth counterclockwise*.

4. Moon's Phases

The phase numbered 6 is:

(A) Waxing crescent
(B) Waning crescent
(C) Waxing gibbous
(D) Waning gibbous
(E) Full Moon

5. Moon’s Phases

The phase numbered 4 is:

(A) Waxing crescent
(B) Waning crescent
(C) Waxing gibbous
(D) Waning gibbous
(E) Full Moon

6. Moon’s Phases

Standing looking south, and looking at a 1st Quarter Moon soon after sunset:

(A) The bright side is on the **right**, and the bright side is facing **West** where the Sun went down.
(B) The bright side was on the **left**, and the bright side is facing **West** where the Sun went down.
(C) The bright side was on the **right**, and the bright side is facing **East** where the Sun went down.
(D) The bright side was on the **left**, and the bright side is facing **East** where the Sun went down.

7. Eclipses

We can only have a solar eclipse when the moon phase is:

(A) New
(B) 1st or 3rd Quarter
(C) Full

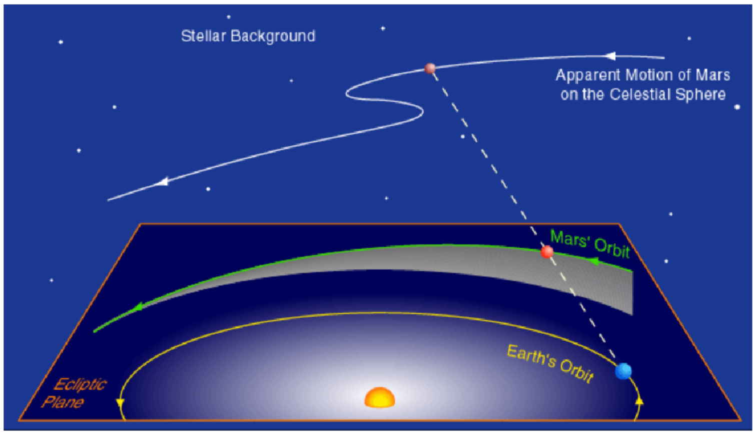
8. Eclipses

When one celestial body (like the Moon) casts a shadow on another (like the Earth), the part of the shadow where the Sun is partially but not completely blocked out is called the:

(A) Epicycle
(B) Umbra
(C) Penumbra
(D) Apogee

Prograde and Retrograde Motion

Mars has an apparent path through the stars. Below is the modern (Copernican) explanation of this:



Consult this diagram for the next two problems.

9. Prograde and Retrograde Motion

In the position of Mars as shown, it appears to be traveling:

(A) **Eastward** through the stars and this is called **prograde** motion.
(B) **Westward** through the stars and this is called **prograde** motion.
(C) **Eastward** through the stars and this is called **retrograde** motion.
(D) **Westward** through the stars and this is called **retrograde** motion.

10. Prograde and Retrograde Motion

A little later than shown in the picture, Mars will appear to be going the other way through the stars.

(A) This is called **prograde** motion, and Mars will be going **westward** through the stars.
(B) This is called **retrograde** motion, and Mars will be going **westward** through the stars.
(C) This is called **prograde** motion, and in modern astronomy we know this is due to epicycles.
(D) This is called **retrograde** motion, and it is actually due to epicycles.

Scale Models of the Solar System

11. Lawn Model

When we made a model on the lawn at 1:10,000,000,000 scale, the Sun's diameter was about the same as the diameter of a

(A) small nail head
(B) large grape
(C) saucer for a cup
(D) tractor tire

12. Lawn Model

When we made a model on the lawn at 1:10,000,000,000 scale, the Earth's diameter was about the same as the diameter of a

(A) small nail head
(B) large grape
(C) dessert plate
(D) tractor tire

13. Lawn Model

When we made a model on the lawn at 1:10,000,000,000 scale, Mercury's distance from the Sun was

(A) at most a few feet
(B) six or so strides
(C) about half the length of the De La Salle lawn
(D) past the guardhouse
(E) beyond St. Mary's Road

14. Black Rock Desert Model

In Wylie Overstreet's Model in Black Rock Desert at 1:850,000,000 scale, the Earth was the size of a marble. In his model, the Sun's diameter was about the same as the diameter of a

(A) small nail head
(B) large grape
(C) dessert plate
(D) tractor tire

Ellipses and Kepler’s Laws

15. Kepler’s 1st Law

Kepler’s 1st Law says the planets travel around the Sun following ellipses with the Sun at one focus. At the other focus is:

(A) Empty space.
(B) The maximum position of the planet from the Sun (aphelion).
(C) Another planet.
(D) The black monolith from *2001: A Space Odyssey*. (Yes, professors put in silly answers to multiple choice questions when they run out of reasonable ones.)

16. Properties of Ellipses

Ellipses are conic sections. One of these choices is **not** a kind of conic section:

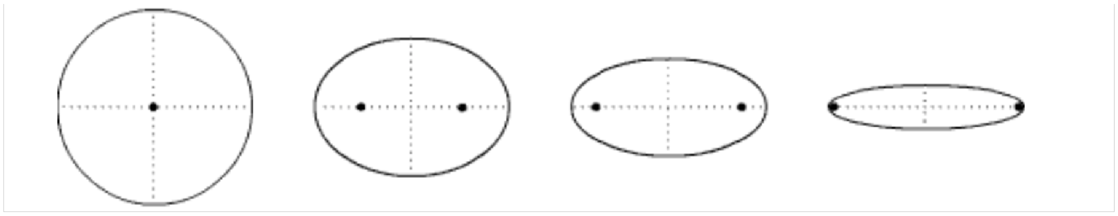
(A) parabola
(B) hyperbola
(C) semi-circle
(D) circle

17. Properties of Ellipses

When we made ellipses in class, you found that a circle is a special case of an ellipse where for a given length of string you:

(A) spaced the two foci as far apart as you could
(B) made the foci spacing equal to the major axis
(C) made the foci spacing equal to half the major axis
(D) made the foci spacing zero

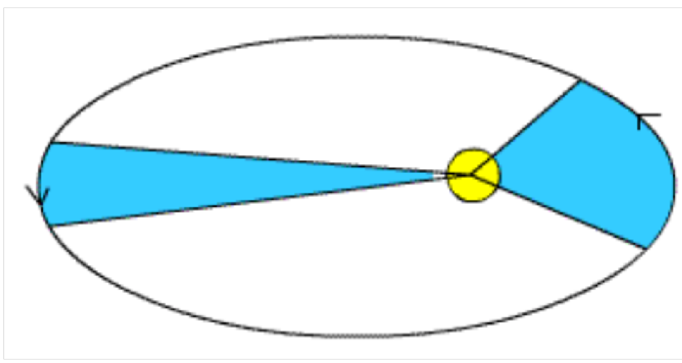
18. Properties of Ellipses



The four ellipses above have very different:

(A) Semi-major axis, *a*, and the one on the left has the **largest** *a*.
(B) Semi-major axis, *a*, and the one on the left has the **smallest** *a*.
(C) Eccentricity, *e*, and the one on the left has the **smallest eccentricity**
(D) Eccentricity, *e*, and the one on the left has the **largest eccentricity**

19. Kepler's 2nd Law



In the drawing above the shaded wedges are drawn so that they have the same area. Thanks to the equal areas in equal times law, you can say:

(A) That the amount of **time elapsed** as the **right** wedge was traced out was longer.
(B) That the amount of **time elapsed** as the **left** wedge was traced out was longer.
(C) That the object is **moving faster** in the **left** wedge.
(D) That the object is **moving faster** in the **right** wedge.

20. Kepler's 3rd Law

Kepler's Third Law says P^2 is proportional to a^3 where P is the period and a is the semi-major axis. If you use units of years for P, and A.U. for a, then in those units, $P^2 = a^3$. The asteroid Vesta has $a = 2.36$ A.U. What is its period?

Write in your answer.