Physics 90 Exam for Unit 4 — Parallax, A.U., Parsec, Light-Year, Absolute Magnitude, Classification of Stars, Birth of Stars, Death of Stars

MAY 4, 2020

Do-at-home exam directions. You may use the OpenStax textbook and your class notes, including all materials that Prof. Lee and I used in lecture. If you don't have them all handy, you can view all of the Unit 4 materials here:

https://observatree.github.io/physics90/detailed_schedule_unit_4.html

You can use a calculator. You can't use Google or your friends.

During the official 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, or if a question is badly worded, 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 (I'm just making an example up), or you have to take care of something unusual due to shelter-in-place, you may use more than the standard 8:00-9:05am time period, but please complete the exam expeditiously.

Parallax, A.U., Parsec, Light-Year

1. Parallax

The pie-crust formula in degrees is:

$$\frac{s}{R} = \frac{\theta}{57.3^\circ}$$

If you put one arc-second in for θ, and 1 A.U. in for s, and solve for R, by definition, you get:

(A) 1 A.U.
(B) 1 light-year
(C) 1 parsec

2. Parallax

The orbital distance from the Earth to the Sun is 150,000,000 km. The pie-crust formula with that and all the conversions to arcseconds put in is:

$$\frac{150{,}000{,}000\text{ km}}{R} = \frac{\theta}{57.3 \text{ x } 60 \text{ x } 60 \text{ arcseconds}}$$

Suppose astronomers put a telescope on Mars, which has an orbital radius of 225,000,000 km. If we measured a parallax angle of 0.3 arcseconds here on Earth for some star, then the telescope on Mars would get a parallax angle of:

(A) 0.1 arcseconds
(B) 0.2 arcseconds
(C) 0.3 arcseconds
(D) 0.45 arcseconds

HINTS: (1) I rounded 150,000,000 km and 225,000,000 km so that the orbital radius of Mars and the orbital radius of Mars would be 1.5 times the orbital radius of the Earth. (2) Study Figure 19.4 in the textbook and think about how the angle would change if the baseline between the survey instruments were increased.

3. Parallax

If you solve the parallax formula for *R* (the distance to the object), then you get

$$R = \frac{150{,}000{,}000\text{ km x } 57.3 \text{ x } 60 \text{ x } 60 \text{ arcseconds}}{\theta}$$

To simplify their calculations, astronomers took the whole mess:

150,000,000 km x 57.3 x 60 x 60

and made a new unit out of it that is called the parsec. This unit is about:

(A) 1/3 of an A.U.
(B) 3 A.U.
(C) 1/3 of a light-year
(D) 1 light-year
(E) 3 light-years

4. Parallax

In round numbers, the nearest star, Alpha Centauri has a parallax angle of 3/4 of an arcsecond. This star is therefore about:

(A) 3/4 of a parsec away
(B) 4/3 of a parsec away
(C) 3/4 of a light-year away
(D) 4/3 of a light-year away

5. Parallax

Betelgeuse has a parallax angle of 0.005. What is the distance to Betelgeuse?

(A) 200 parsecs (B) 500 parsecs (C) 600 parsecs (D) 995 parsecs

---

Absolute Magnitude, Classification of Stars

6. Inverse Square Law for Light

The formula for intensity (called the inverse square law for light) is:

$$I = \frac{L}{4\pi R^2}$$

Suppose two stars have the same luminosity, *L*. Suppose Star 1 is three times as far away from Earth as Star 2. Then the intensity of Star 1 we would measure is:

(A) 9 times the intensity of Star 2
(B) 3 times the intensity of Star 2
(C) 1/3 the intensity of Star 2
(D) 1/9 the intensity of Star 2

7. Inverse Square Law for Light

Imagine moving a star from 100 parsecs away from us to 10 parsecs away. After the movement, the star would appear:

(A) 100 times brighter
(B) 10 times brighter
(C) 10 times dimmer
(D) 100 times dimmer

8. Absolute Magnitude

If the star in the previous problem appeared to have magnitude 8, after moving it to a distance of 10 parsecs, it would now appear to have magnitude:

(A) 13 (B) 8 (C) 5 (D) 3

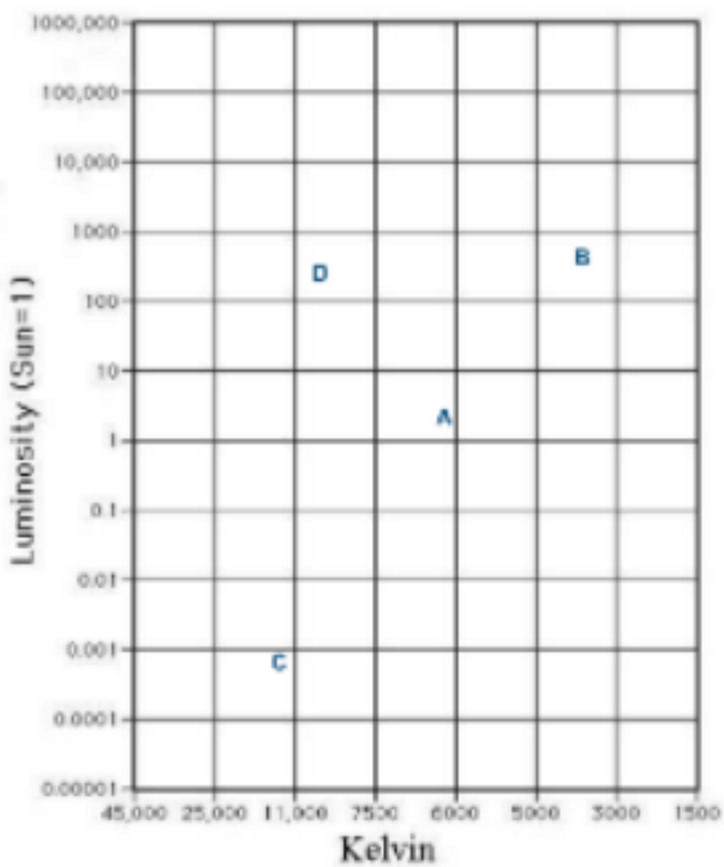
9. Absolute Magnitude

The absolute magnitude of a star is:

(A) The opposite of its apparent magnitude if its apparent magnitude is negative.
(B) The same as its apparent magnitude.
(C) Its apparent magnitude if you imagine moving it to 10 parsecs.
(D) None of the above.

Hertzsprung-Russell (HR) Diagrams

The four problems on the next page refer to the letters on this figure (sorry for fuzzy scan):



10. HR Diagrams

In the textbook and my slides, we have looked at HR diagrams showing thousands of stars. The above HR diagram shows just four stars (A, B, C, and D). Referring to the letters on the diagram, which letter best matches a white dwarf?

(A) A.
(B) B.
(C) C.
(D) D.

11. HR Diagrams

Which letter best matches a main sequence star that is just a little hotter and a little more luminous than our Sun?

(A) A.
(B) B.
(C) C.
(D) D.

12. HR Diagrams

Which letter best matches a main sequence star that is a lot hotter and a lot more luminous than our Sun?

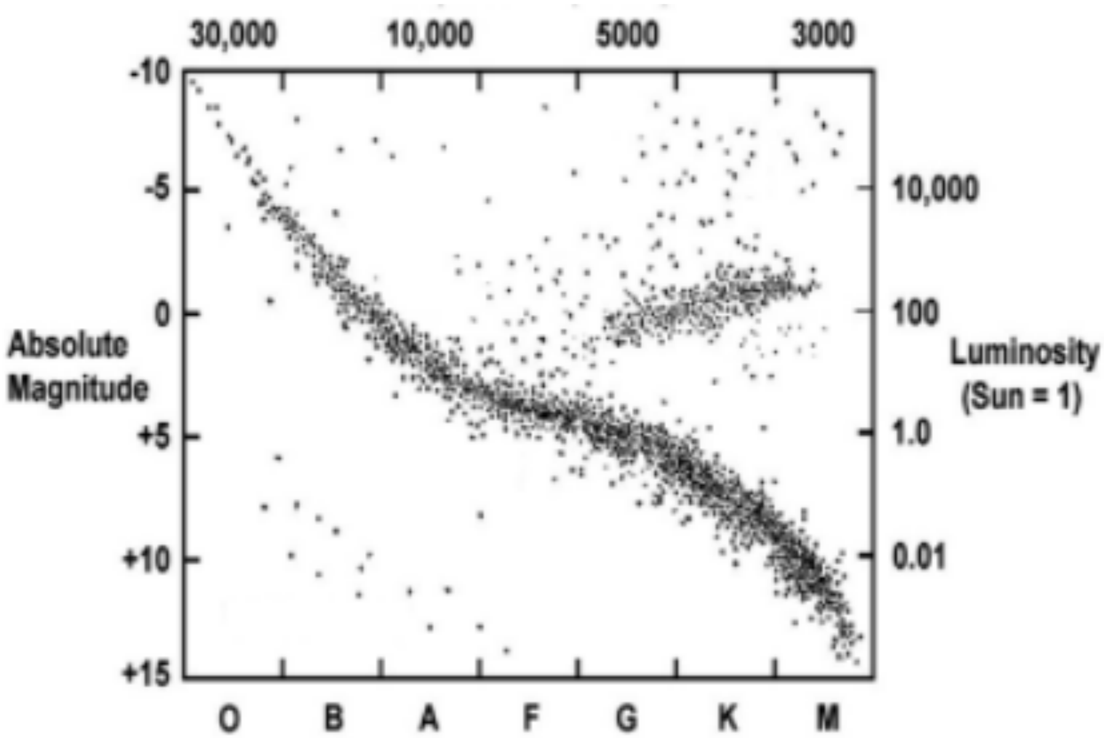
(A) A.
(B) B.
(C) C.
(D) D.

13. HR Diagrams

Which letter best matches a red giant?

(A) A.
(B) B.
(C) C.
(D) D.

14. HR Diagrams



From the Hertzsprung-Russell diagram above which shows many more stars, if you see a B-Type star that is 20,000K, then most likely it has absolute magnitude:

(A) -7
(B) -1.5
(C) +4
(D) +9.5

15. HR Diagrams

90% of all stars on the HR diagram fall into a region called:

(A) the main sequence
(B) the visual region
(C) the red giant region
(D) the white dwarf region

Birth of Stars, Death of Stars

16. Birth of Stars

In Prof. Lee’s numerical simulations, protostars are

(A) prototypes for stars that star designers usually discard
(B) stars made out of protons with no electrons or neutrons
(C) regions of interstellar gas that have achieved sufficient density to collapse into stars

17. Birth of Stars

When a star is born, it begins:

(A) as a white dwarf and enlarges
(B) as a red giant and shrinks
(C) as a main sequence star

18. Death of Stars

A star with the same mass as our Sun finishes its life:

(A) by shrinking to a white dwarf and then enlarging to a red giant
(B) by enlarging to a red giant and then becoming a nova, leaving a white dwarf
(C) by enlarging to a red giant and then becoming a supernova, leaving a neutron star

19. Death of Stars

A star with 10 times the mass of our Sun finishes its life:

(A) by shrinking to a white dwarf and then enlarging to a red giant
(B) by enlarging to a red giant and then becoming a nova, leaving a white dwarf
(C) by enlarging to a red giant and then becoming a supernova, leaving a neutron star

Fun fact: Stars 40 times the mass of our Sun enlarge to a red supergiant and also become a supernova, but they leave a black hole.

20. Death of Stars

(A) When a star turns nova, it spreads some of the elements it has made into a “planetary nebula”

(B) A star turns supernova due to an exotic kind of fusion where protons and electrons fuse to become neutrons.

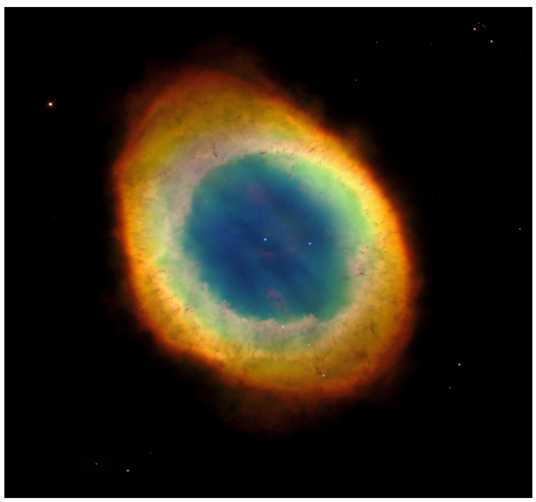
(C) When a star turns supernova, elements heavier than iron (like lead, gold and uranium) are made and pushed out as a nebula

(D) An example of a planetary nebula is the Ring Nebula

(E) An example of a supernova remnant is the Crab Nebula

(F) All of the above, and our galaxy contains crazy and beautiful things.

Ring Nebula:



Crab Nebula: