Introductory Astronomy

Homework 19: Some Star Basics Not to be handed in. Homework solutions are posted already.

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038 qmult 00100 1 4 3 easy deducto-memory: stellar parallax
Extra keywords: CK-277-stellar parallax, CK-278-2

1. "Let's play *Jeopardy*! For $100, the answer is: The angular motion of stars on the sky as seen against the background of more distant stars due to the Earth's motion around the Sun."

   What is _____, Alex?

   a) the Doppler shift b) planetary parallax c) stellar parallax d) stellar paradox e) stellar motion

   SUGGESTED ANSWER: (c)

   Wrong answers:
   a) This is frequency or wavelength shift due to relative motion of the source and receiver of some wave phenomenon.

   Redaction: Jeffery, 2001jan01

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038 qmult 00200 1 1 1 easy memory: stellar parallax for distance
Extra keywords: CK-272,277

2. The straightforward surveyor's way of measuring the distance to a star is to use:

   a) stellar parallax with the Earth-Sun distance as a baseline.
   b) stellar parallax with the Earth-Moon distance as a baseline.
   c) solar parallax with the Earth radius as a baseline.
   d) solar parallax with the Earth-Sun distance as a baseline.
   e) a tape measure.

   SUGGESTED ANSWER: (a)

   Wrong answers:
   c) In principle, the distance to the Sun can be measured this way.
   e) As Lurch would say: "Aaaarh."

   Redaction: Jeffery, 2001jan01

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038 qmult 00302 2 3 3 moderate math: parallax star distance

3. If a star exhibits 0.5 arcseconds of stellar parallax using the Earth-Sun distance as a baseline (which is conventional), how far is the star in parsecs?

   a) 0.5 pc. b) 1 pc. c) 2 pc. d) 4 pc. e) 10 pc.

   SUGGESTED ANSWER: (c) The solution is

   $$d = \frac{1}{p} = \frac{1}{0.5} = 2\,\text{pc}$$

   where d is distance in parsec and p is the stellar parallax (CK-273).

   Wrong answers:
   e) As Lurch would say: "Aaaarh."

Redaction: Jeffery, 2001jan01

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038 qmult 00310 2 1 5 moderate memory: closest star to Earth

Extra keywords: CK-277-2

4. The closest star to Earth (not counting the Sun) is _____ at 1.30 pc (4.22 ly).

   a) Barnard's Star. b) Jeffery's Star. c) Sirius A. d) Alpha Centauri A. e) Proxima Centauri.

SUGGESTED ANSWER: (e) See (FK-A-6) for the data.

Wrong answers:

d) This 2nd closest at 1.34 pc.

Redaction: Jeffery, 2001jan01

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038 qmult 00320 2 5 5 mod. thinking: increasing stellar parallaxes

Extra keywords: CK-279-18

5. If all the stellar parallaxes (i.e., parallax angles measured during a half revolution of the Sun) were **INCREASING** with time, this would mean that the stars were all:

   a) getting smaller. b) moving away. c) getting dimmer. d) getting redder. e) moving closer.

SUGGESTED ANSWER: (e)

Wrong answers:

b) Exactly wrong. It fooled me to for a bit.

Redaction: Jeffery, 2001jan01

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038 qmult 00400 1 1 5 easy math: AU to parsec conversion

Extra keywords: CK-278-14

6. A dim star is located at about 2 million astronomical units from Earth. Recall $1\,\mathrm{AU} = 1.496 \times 10^{11}\,\mathrm{m}$ and $1\,\mathrm{pc} = 3.09 \times 10^{16}\,\mathrm{m}$. Approximately, what is the distance to the star in parsecs?

   a) $1.5 \times 10^{11}\,\mathrm{pc}$. b) $2 \times 10^{6}\,\mathrm{pc}$. c) $3 \times 10^{17}\,\mathrm{pc}$. d) $3\,\mathrm{pc}$. e) $10\,\mathrm{pc}$.

SUGGESTED ANSWER: (e) Behold

$$2 \times 10^{6}\,\mathrm{AU} \times \frac{1.496 \times 10^{11}\,\mathrm{m}}{1\,\mathrm{AU}} \times \frac{1\,\mathrm{pc}}{3.09 \times 10^{16}\,\mathrm{m}} \approx 10\,\mathrm{pc}\ .$$

Wrong answers:

b) This is the distance in AU.

c) This is the distance in meters.

Redaction: Jeffery, 2001jan01

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038 qmult 00500 1 1 1 easy memory: star-star collisions

7. In galaxy collisions, direct star-star collisions in which star matter impacts star matter occur:

   a) very rarely because interstellar distances are very large compared to star sizes. b) with high frequency. c) never. d) never: such collisions are physically impossible. e) for all stars in the colliding galaxies.

SUGGESTED ANSWER: (a) See FK-596 and CK-398.

Wrong answers:
d) Oh, c'mon.
e) As Lurch would say: "Aaaarh."

Redaction: Jeffery, 2001jan01

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038 qmult 01000 1 1 4 easy memory: luminosity
Extra keywords: CK-276,277

8. The total power of a star (i.e., energy output per unit time) is called:

a) brightness. b) rightness. c) lightness. d) luminosity. e) incandescence.

SUGGESTED ANSWER: (d)

Wrong answers:
e) This is usually the state of being white hot.

Redaction: Jeffery, 2001jan01

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038 qmult 01004 1 1 4 easy memory: photometry defined
Extra keywords: CK-283,295

9. The light from astronomical bodies is often studied by observering their light flux in broad wavelength bands using colored filters. (The emission is usually reported in astronomical magnitudes, but one doesn't need to know that.) The study of emission in this way is called:

a) spectroscopy. b) optometry. c) trigonometry. d) photometry. e) geometry.

SUGGESTED ANSWER: (d)

Wrong answers:
e) As Lurch would say: "Aaaarh."

Redaction: Jeffery, 2001jan01

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038 qmult 01010 1 4 4 easy deducto-memory: star brightness
Extra keywords: CK-277-3

10. The brightest stars are of order _____ times more luminous than the Sun and the dimmest are of order _____ times the Sun's luminosity.

a) 10^{-5}; 10^{6} b) 1/2; 2 c) infinite; zero d) 10^{6}; 10^{-5} e) 2; 1/2

SUGGESTED ANSWER: (d)

Wrong answers:
c) This is impossible, except speaking metaphorically.

Redaction: Jeffery, 2001jan01

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038 qmult 01200 2 1 5 mod memory: flux inverse-square
Extra keywords: CK-276,277

11. The flux (energy per unit time per unit area) of light from a star as a function of distance from the star obeys a/an:

a) inverse-cube law. b) reverse-cube law. c) gravity law. d) force law. e) inverse-square law.

SUGGESTED ANSWER: (e)

Wrong answers:
b) A nonsense answer.

Redaction: Jeffery, 2001jan01

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038 qmult 01210 2 4 5 mod. deducto-memory: inverse-square law proof

12. "Let's play *Jeopardy*! For $100, the answer is: This law describing how the light flux from a star decreases with distance is proven from this general physical principle as applied to the steady state nature of a star and the surrounding space."

What is _____, Alex?

a) the principle of equivalence b) the cosmological principle c) the perfect cosmological principle d) the relativity postulate e) conservation of energy

SUGGESTED ANSWER: (e)

Wrong answers:
a) This is a principle Einstein invoke to guide him to general relativity.
b) This is a principle guiding cosmological modeling. It seems to be true.
c) This is a principle that was invoked to justify the steady-state universe model. It has been proven false pretty decisively in its original meaning, but it may have a reformulation in the eternal inflation theory.
a) This is a principle Einstein invoke to guide him to special relativity.

Redaction: Jeffery, 2001jan01

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038 qmult 01300 2 1 3 easy memory: inverse-square distance

13. If you knew the luminosity of a star, then it distance could be determined directly:

a) from its luminosity alone.
b) a measurement of its flux using the inverse-cube law.
c) a measurement of its flux using the inverse-square law.
d) a measurement of its flux using any inverse power formula.
e) in no known way.

SUGGESTED ANSWER: (c)

Wrong answers:
e) As Lurch would say: "Aaaarh."

Redaction: Jeffery, 2001jan01

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038 qmult 01320 1 3 1 easy math: Earth-Sun luminosity distance

Extra keywords: this question can easily be solved by deduction

14. According to one standard reference, the solar luminosity $L_\odot = 3.86 \times 10^{26}\,\mathrm{W}$ and the solar constant (i.e., the solar flux at the mean distance of the Earth) $f = 1373\,\mathrm{W/m^2}$. Stellar luminosity L and flux f are related by the inverse-square law

$$f = \frac{L}{4\pi d^2} \ ,$$

where d is the distance from the center of the star to the location where f is measured. Solve for d analytically and then find mean Earth-Sun distance.

a) $d = \sqrt{L/(4\pi f)}$ and $d = 1.496{\times}10^{11}$ m. b) $d = \sqrt{L/f}$ and $d = 1.496{\times}10^{11}$ m. c) $d = \sqrt{L}$ and $d = 1.496 \times 10^{2}$ m. d) $d = \sqrt{L/(4\pi f)}$ and $d = 1.496 \times 10^{2}$ m. e) $d = \sqrt{1/f}$ and $d = 1.496 \times 10^{11}$ m.

SUGGESTED ANSWER: (a) The given formula is obviously the correct inverse formula. One could do the math to get the value, but since all the other answer formulae are wrong, except one that puts the Sun at 150 m, one doesn't really have to. The value one computes is accurate to only 4 digits. According AB-14-6, the mean Earth-Sun distance is $1.49597870 \times 10^{11}$ m. The solar luminosity and solar constant are from AB-14-2.

Fortran Code

```
      print*
      pi=acos(-1.)
      xlum=3.86e26
      solconst=1373.
      dd=sqrt(xlum/(4.*pi*solconst))
      print*,'The calculated Earth-Sun distance is ',dd,
     & ' m'  !  1.49573E+11
```

Wrong answers:
c) The Sun is only about 150 m away.

Redaction: Jeffery, 2001jan01

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038 qmult 01400 1 4 5 easy deducto-memory: distance ladder defined

15. "Let's play *Jeopardy*! For $100, the answer is: This metaphorical expression is the name for the collection of distance measurement techniques used to establish cosmic distances on all scales."

What is _____, Alex?

a) Gandalf distaff b) distance distaff c) distance adder d) distance viper e) distance ladder

SUGGESTED ANSWER: (e)

Wrong answers:
a) Oh, c'mon.

Redaction: Jeffery, 2001jan01