Introductory Astronomy **NAME:**

Homework 19: Some Star Basics: Homeworks and solutions are posted on the course web site. Homeworks are **NOT** handed in and **NOT** marked. But many homework problems ($\sim$ 50–70 %) will turn up on tests.

Answer Table

Name:

	a	b	c	d	e		a	b	c	d	e
1.	O	O	O	O	O	37.	O	O	O	O	O
2.	O	O	O	O	O	38.	O	O	O	O	O
3.	O	O	O	O	O	39.	O	O	O	O	O
4.	O	O	O	O	O	40.	O	O	O	O	O
5.	O	O	O	O	O	41.	O	O	O	O	O
6.	O	O	O	O	O	42.	O	O	O	O	O
7.	O	O	O	O	O	43.	O	O	O	O	O
8.	O	O	O	O	O	44.	O	O	O	O	O
9.	O	O	O	O	O	45.	O	O	O	O	O
10.	O	O	O	O	O	46.	O	O	O	O	O
11.	O	O	O	O	O	47.	O	O	O	O	O
12.	O	O	O	O	O	48.	O	O	O	O	O
13.	O	O	O	O	O	49.	O	O	O	O	O
14.	O	O	O	O	O	50.	O	O	O	O	O
15.	O	O	O	O	O	51.	O	O	O	O	O
16.	O	O	O	O	O	52.	O	O	O	O	O
17.	O	O	O	O	O	53.	O	O	O	O	O
18.	O	O	O	O	O	54.	O	O	O	O	O
19.	O	O	O	O	O	55.	O	O	O	O	O
20.	O	O	O	O	O	56.	O	O	O	O	O
21.	O	O	O	O	O	57.	O	O	O	O	O
22.	O	O	O	O	O	58.	O	O	O	O	O
23.	O	O	O	O	O	59.	O	O	O	O	O
24.	O	O	O	O	O	60.	O	O	O	O	O
25.	O	O	O	O	O	61.	O	O	O	O	O
26.	O	O	O	O	O	62.	O	O	O	O	O
27.	O	O	O	O	O	63.	O	O	O	O	O
28.	O	O	O	O	O	64.	O	O	O	O	O
29.	O	O	O	O	O	65.	O	O	O	O	O
30.	O	O	O	O	O	66.	O	O	O	O	O
31.	O	O	O	O	O	67.	O	O	O	O	O
32.	O	O	O	O	O	68.	O	O	O	O	O
33.	O	O	O	O	O	69.	O	O	O	O	O
34.	O	O	O	O	O	70.	O	O	O	O	O
35.	O	O	O	O	O	71.	O	O	O	O	O
36.	O	O	O	O	O	72.	O	O	O	O	O

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001 qmult 00007 1 4 1 easy deducto-memory: reading done 2

1. Did you complete reading the intro astro web lecture before the **SECOND DAY** on which the lecture was lectured on in class?

   a) YYYessss! b) Jawohl! c) Da! d) Sí, sí. e) OMG no!

   SUGGESTED ANSWER: (a),(b),(c),(d)

   Wrong answers:
   e) As Lurch would say AAAARGH.

   Redaction: Jeffery, 2008jan01

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038 qmult 00100 1 4 1 easy deducto-memory: stars are hot gas spheres

Extra keywords: Sun-question

2. Stars are spheres:

   a) of hot gas. b) with a core of solid iron and a hydrogen outer layer. c) with a core of liquid iron and a hydrogen outer layer. d) with a core of pure helium gas and a hydrogen outer layer. e) of hot rock.

   SUGGESTED ANSWER: (a)

   Wrong answers:
   d) Way down the road in the post-main sequence phase, the Sun's core will be mainly helium for awhile.
   e) C'mon.

   Redaction: Jeffery, 2001jan01

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038 qmult 00200 1 4 5 easy deducto-memory: solar composition

Extra keywords: Sun-question

3. The Sun's surface composition by mass (which approximates the average cosmic composition and is typical of non-ancient stars) is about:

   a) 100 % helium.
   b) 71 % hydrogen, 27 % nitrogen, and 20 % everything else.
   c) 71 % carbon, 27 % nitrogen, and 2 % everything else.
   d) 71 % hydrogen, 27 % nitrogen, and 2 % everything else.
   e) 71 % hydrogen, 27 % helium, and 2 % everything else.

   SUGGESTED ANSWER: (e)

   The solar composition is pretty close to the average cosmic composition. The values come from Cox-28, but are rounded-off to whole numbers.

   Wrong answers:
   a) Well word helium is derived from the Greek word for the Sun and the Sun god: Helios
   b) This composition doesn't add up to 100 %.

   Redaction: Jeffery, 2001jan01

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038 qmult 00300 1 4 3 easy deducto-memory: stellar parallax defined 2

Extra keywords: CK-277-stellar parallax, CK-278-2, the definition is in ch-04

4. "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 00320 1 3 3 easy math: stellar parallax calculation 1, Van M.'s star
Extra keywords: CK-278-12, Van Maanen's star

5. Van Maanen's star has a stellar parallax of 0.232 arcseconds. About how far away is this star?
Recall the distance formula for stellar parallax is

$$d_{\text{parsec}} = \frac{1}{\theta_{\text{arcsecond}}} \ ,$$

where $\theta_{\text{arcsecond}}$ is the parallax angle in arcseconds and d_{parsec} is the distance in parsecs.

a) 0.232 pc. b) 1 pc. c) 4.3 pc. d) 2.32 pc. e) 10 pc.

SUGGESTED ANSWER: (c)

The solution is

$$d_{\text{parsec}} = \frac{1}{\theta_{\text{arcsecond}}} = \frac{1}{0.232} = 4.31 \text{ pc} \ ,$$

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

Fortran Code

```
print*
theta=.232
dd=1./theta
print*,'distance d=',dd   ! 4.310345
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Wrong answers:
e) As Lurch would say: "Aaaarh."

Redaction: Jeffery, 2001jan01

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038 qmult 00340 2 1 5 moderate memory: closest star to Earth , not Sun
Extra keywords: CK-277-2

6. 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
http://en.wikipedia.org/wiki/List_of_nearest_stars
for the data.

Wrong answers:
d) This 2nd closest at 1.34 pc.

Redaction: Jeffery, 2001jan01

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038 qmult 00350 2 5 5 mod. thinking: increasing stellar parallaxes
Extra keywords: CK-279-18

7. 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 2 1 5 moderate math: AU to parsec conversion

Extra keywords: CK-278-14

8. 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: matter star-star collisions

9. 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 00510 1 1 2 easy memory: star gravitational interactions

10. Because gravity is a long-range, inverse-square-law force, significant gravitational interactions between two stars:

    a) almost never occur. b) are relatively common. c) never occur. d) occur only when the star matter impacts on star matter. e) occur only when star matter does not impact on star matter.

    SUGGESTED ANSWER: (b)

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

    Redaction: Jeffery, 2001jan01

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038 qmult 00600 1 1 4 easy memory: luminosity defined 1

Extra keywords: CK-276,277, Sun-question

11. 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 00620 1 4 4 easy deducto-memory: range of star luminosities

Extra keywords: CK-277-3, FK-414

12. 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^{-4}; 10^{6} b) 1/2; 2 c) infinite; zero d) 10^{6}; 10^{-4} e) 2; 1/2

SUGGESTED ANSWER: (d) The values differ a bit between CK-277-3 and FK-414. But (d) is more or less right either way.

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

Redaction: Jeffery, 2001jan01

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038 qmult 00700 1 4 5 easy deducto-memory: flux defined
Extra keywords: Sun-question

13. "Let's play *Jeopardy*! For $100, the answer is: This is the energy per unit time per unit area **OR** the energy per unit time per unit area in some wavelength band **OR** the energy per unit time per unit area per unit wavelength (or frequency) from some light source (e.g., a star or the Sun)."

What is _____, Alex?

a) fugue b) flow c) luminosity d) light e) flux

SUGGESTED ANSWER: (e)

Wrong answers:
a) Strictly for classical music aficionados.

Redaction: Jeffery, 2001jan01

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038 qmult 00710 1 1 4 easy memory: photometry defined
Extra keywords: CK-283,295

14. 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 00800 2 1 5 mod memory: flux inverse-square behavior
Extra keywords: CK-276,277

15. The flux (energy per unit time per unit area perhaps in a wavelength band or per wavelength) of light from a star as a function of distance from the star in the absence of extinction by the interstellar medium 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 00810 2 4 5 mod. deducto-memory: flux inverse-square law proof

16. "Let's play *Jeopardy*! For $100, the answer is: The inverse-square law describing how the light flux from a star decreases with distance is proven from **THIS** general physical principle when applied to a star and its surrounding vacuum space in a steady state condition."

What is the _____, Alex?

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

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 00820 2 1 3 easy memory: inverse-square law luminosity distances
17. 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 00830 1 3 1 easy math: Earth-Sun luminosity distance
Extra keywords: this question can easily be solved by deduction
18. According to one standard reference, the solar luminosity $L_\odot = 3.846 \times 10^{26}\,\mathrm{W}$ http://nssdc.gsfc.nasa.gov/planetary/factsheet/sunfact.html 2013 and the solar constant (i.e., the solar flux at the mean distance of the Earth) $f = 1367.6\,\mathrm{W/m^2}$. 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 $d = 1.496 \times 10^{11}\,\mathrm{m}$. b) $d = \sqrt{L/f}$ and $d = 1.496 \times 10^{11}\,\mathrm{m}$. c) $d = \sqrt{L}$ and $d = 1.496 \times 10^{2}\,\mathrm{m}$. d) $d = \sqrt{L/(4\pi f)}$ and $d = 1.496 \times 10^{2}\,\mathrm{m}$. e) $d = \sqrt{1/f}$ and $d = 1.496 \times 10^{11}\,\mathrm{m}$.

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 149.6 m, one doesn't really have to. The value one computes is accurate to only 4 digits. According Cox-12, the mean Earth-Sun distance is $1.4959787066 \times 10^{11}\,\mathrm{m}$. The solar luminosity and solar constant are from Cox-340, but similar values come from AB-14-2.

Fortran Code

```
          print*
          pi=acos(-1.d0)
          xlum=3.846e26    ! http://en.wikipedia.org/wiki/Sun
         !                 !
http://nssdc.gsfc.nasa.gov/planetary/factsheet/sunfact.html agrees as of 2013
          solconst=1367.6d0 ! 1361 http://en.wikipedia.org/wiki/Solar_constant
         !                 ! 1361
http://atmospheres.gsfc.nasa.gov/climate/?section=136 same value, new one
         !                 !   but just for the solar minimum, what of average
value?
```

```
         !                 ! 1361, but average is about 1362 over solar period
         !                 !
http://science1.nasa.gov/science-news/science-at-nasa/2010/05feb_sdo/
         !                 ! 1367.6
http://nssdc.gsfc.nasa.gov/planetary/factsheet/earthfact.html 2013
          au=1.49597870700d11  ! http://en.wikipedia.org/wiki/Astronomical_unit
modern defined value
          dd=sqrt(xlum/(4.d0*pi*solconst))
          print*,'The calculated Earth-Sun distance, the AU, ',
&
         &                     'and the relative difference'
          print*,dd,au,(dd-au)/au
    !  149596063028.94812        149597870700.00000      -1.2083536346937205E-005
```

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

Redaction: Jeffery, 2001jan01

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038 qmult 00900 1 4 5 easy deducto-memory: distance ladder defined

19. "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 the _____, 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

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038 qmult 00910 1 1 1 easy memory: 1st rung of distance ladder

20. The first rung of the distance ladder is uses the distance measurement technique of:

    a) stellar parallax. b) spectrosoopic parallax. c) Cepheids. d) the Tully-Fisher relation.
    e) Type Ia supernovae.

SUGGESTED ANSWER: (a)

The rungs of the distance ladder can be counted in different ways, but stellar parallax can only be reasonably counted as the 1st rung.

Wrong answers:
b) This is the second rung.

Redaction: Jeffery, 2001jan01