Introductory Astronomy NAME:

Homework 1: Scientific Notation, Units, Math, Angles, Plots, Motion, Orbits: 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 exams.

1. Did you complete reading-homework-self-testing for the Introductory Astronomy Lecture (IAL) by the weekly due date?

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

2. "Let's play *Jeopardy*! For $100, the answer is: It is a math intensive field of science."

   What is _____, Alex?

   a) painting b) sculpture c) literature d) music e) astronomy

3. In _____, a number is written in the form

   $$a \times 10^b \ ,$$

   where a is the coefficient (or in more elaborate jargon the significand or mantissa) and b is the exponent. In normalized _____, $a \in [1, 10)$ (i.e., $1 \leq a < 10$).

   a) logarithmic notation b) ordinary decimal notation c) scientific notation
   d) natural logarithmic notation e) power-10 notation

4. Write a hundred million billion miles in scientific notation.

   a) 10^2 mi. b) 10^6 mi. c) 10^9 mi. d) 10^{17} mi. e) 10^{-9} mi.

5. Express 4011 and 0.052 in the most conventional scientific notation form.

   a) 4.011×10^3 and 5.2×10^{-2}. b) 40.11×10^3 and $52. \times 10^{-2}$.
   c) 40.11×10^2 and $52. \times 10^{-3}$. d) 4.011×10^{-2} and 5.2×10^3. e) 4011 and 0.052.

6. The quantity 2.9979×10^{10} cm/s is the same as:

   a) 29979000 cm/s. b) 29979000000 cm/s. c) 2.9979×10^{10} km/s. d) the speed of sound.
   e) 2.9979 cm/s.

7. Add and multiply 3.01×10^2 and 1.1×10^{-1} rounding off to significant figures. The answers to the two questions are, respectively:

   a) 3.0111×10^2 and 3.311×10^1. b) 3.01×10^2 and 3.311×10^1.
   c) 3.0111×10^2 and 3.3×10^1. d) 3.01×10^2 and 3.3×10^1. e) 3.0×10^2 and $3. \times 10^1$.

8. "Let's play *Jeopardy*! For $100, the answer is: In any measurements of quantities, they are conventionally agreed upon standard things."

   What are _____, Alex?

   a) unities b) dualities c) duplicities d) quantons e) units

9. "Let's play *Jeopardy*! For $100, the answer is: The international standard units for science and probably the most common subset of these units."

   What are the _____ units and _____ units, Alex?

   a) US customary; Btu b) SI or metric; HMS c) SI or metric; MKS
   d) US customary; MKS e) ancient Babylonian; HMS

10. The only major country (if you don't count Liberia and Myanmar as major) that does **NOT** use metric units for standard units is:

    a) Ireland. b) Belize. c) the United Kingdom. d) the United States. e) France.

11. MKS stands for:

    a) meters, kilometers, centimeters. b) meters, kilometers, seconds.
    c) meters, kilograms, seconds. d) millimeters, kilometers, seconds.
    e) millimeters, kilograms, seconds.

12. In the metric system, the prefixes kilo and centi indicate, respectively, multiplication by:

    a) 1000 and 0.01. b) 0.01 and 1000. c) 1000 and 100. d) 60 and 0.01. e) π and e.

13. Standard units like the metric units—and metric units are the only recognized standard ones—are essential for elaborate calculations and the comparison of amounts of vastly different size. But for special systems, it is often convenient to use units adapted for those systems at least in thinking about the systems and sometimes in simple calculations. Following the supreme authority, Wikipedia, these units can be called:

    a) unnatural units. b) natural units. c) base units. d) low, despised units.
    e) good units.

14. The mean distance from the Earth to the Sun in astronomical units (AU) is:

    a) 1 AU. b) 40 AU. c) 1.496×10^{13} cm. d) 1.5 AU. e) 8 arcminutes.

15. Ex-planet Pluto's mean distance from the Sun is about:

    a) 0.387 AU. b) 1.0 AU. c) 39.54 AU. d) 67.781 AU. e) 700 AU.

16. The Earth equatorial radius $R_{\mathrm{eq},\odot} = 6378.1370\,\mathrm{km}$ is a good natural unit for distances to Solar System objects significantly less 1 AU from the Earth. It is used most commonly for:

    a) Earth-Mars mean dist. 60.2687 $R_{\mathrm{eq},\odot}$. b) Earth-Moon mean dist. 30.2687 $R_{\mathrm{eq},\odot}$.
    c) Earth-Moon mean dist. 60.2687 $R_{\mathrm{eq},\odot}$. d) Earth-Venus mean dist. 30.2687 $R_{\mathrm{eq},\odot}$.
    e) Earth-Cruithne mean dist. 30.2687 $R_{\mathrm{eq},\odot}$

17. A light-year is:

    a) the opposite of a leap year. b) less filling. c) the cause of eclipses. d) the distance light travels in one year. e) the time it takes the Earth to return to the same point relative to the observable universe (i.e., the fixed stars in the traditional expression).

18. The lookback time to an object 10 light-years away is:

    a) 3 years. b) 10 years. c) 30 years. d) 100 years. e) 300 years.

19. Astronomers use _____ as the primary natural unit for interstellar distances. The secondary one is _____. They probably should use the secondary one since it has a good modern rationale. But history has stuck us with the primary one.

    a) parsec; kilometer b) light-year; kilometer c) light-year; parsec d) parsec; light-year
    e) megaparsec; kilometer

20. A parsec (pc) is:

    a) about 3 light-years. b) the same as a light-year. c) about the same as a light-year.
    d) the distance light travels in a year. e) about 2 light-years.

21. A kiloparsec (Kpc) is a unit typically used for:

    a) terrestrial distances. b) interstellar distances. c) **INTRAGALACTIC** distances.
    d) **INTERGALACTIC** distances. e) horse races.

22. Name three astronomically relevant physical scales.

    a) The Earth-Moon distance, the Earth-Sun distance, and the radius of the Galactic disk.
    b) The Earth-Moon distance, the Earth-Sun distance, and the length of a snail's trail.
    c) The Earth-Moon distance, the Earth-Paris distance, and the length of a snail's trail.
    d) The Earth-Moon distance, the Earth-Sun distance, and the Las Vegas-Reno distance.
    e) The Earth-Moon distance and the Earth-Sun distance.

23. "Let's play *Jeopardy*! For $100, the answer is: Nearly the time period of a standard 50-minute lecture period as noted by Italian-American physicist Enrico Fermi (1901–1954)."

    What is _____, Alex?

    a) an eternity b) a deci-century (i.e., a tenth of a century) c) 360 seconds d) a centi-century (i.e., a hundredth of a century) e) a micro-century (i.e., a millionth of a century)

24. The only three temperature scales in common use are the Fahrenheit scale, the Celsius scale, and the:

    a) Rankine scale. b) centigrade scale. c) Kelvin scale. d) Calvin scale.
    e) Calvin-Hobbes scale.

25. Nowadays the Fahrenheit scale is adequate for:

    a) nothing. b) physics calculations. c) engineering calculations outside of the U.S.
    d) understanding biota. e) conventional uses in the U.S.

26. The Kelvin scale degree (symbolized K, but with symbol ° omitted by convention) is the same size as the Celsius scale degree (symbolized C). The Kelvin scale is a good natural scale for physics and astronomy since absolute zero is defined to be:

    a) 100 K. b) 300 K. c) −40 K. d) 273.15 K. e) 0 K.

27. Absolute zero is when all microscopic kinetic energy has been removed that can be removed. This is the coldest that matter can be. However, quantum mechanics (the best verified of all physics theories) dictates that there is an irremovable minimum microscopic kinetic energy which is called the:

    a) negative-point energy. b) zero-point energy. c) positive-point energy
    d) triple-point energy. e) infinite energy.

28. Remarkably there are negative temperature states even for the Kelvin scale. They are **NOT** colder than absolute zero since the microscopic particles have more than the zero-point energy. The situation is that temperature among other things is a parameter controlling how particles are distributed among microscopic energy levels in statistical mechanics. Some _____ distributions require negative temperatures. Negative temperature states can be constructed in the laboratory, but probably exist only fleetingly in nature.

    a) unusual b) normal c) everyday d) freezing e) boiling

29. The conversion formulae worth knowing for the common temperature scales are:

$$T_{\rm K} = T_{\rm C} + 273.15\ , \quad T_{\rm C} = T_{\rm K} - 273.15\ , \quad T_{\rm F} = 1.8T_{\rm C} + 32\ , \quad T_{\rm C} = (5/9)(T_{\rm F} - 32)\ ,$$

    where K, C, and F stand for, respectively:

    a) Fahrenheit, Celsius, and Kelvin. b) Celsius, Kelvin, and Fahrenheit.
    c) Kelvin, Celsius, and Fahrenheit. d) Celsius, Fahrenheit, and Kelvin.
    e) Kilroy, Calvin, and Fassbinder

30. Two simple math formulae that everyone should know are for the amount A accumulated at constant rate R in time t and the inverse formula for the time t to accumulate amount A at constant rate R. The formulae are, respectively:

    a) $t = A/R$ and $A = Rt$. b) $t = AR$ and $A = R/t$. c) $A = R/t$ and $t = AR$.
    d) $A = Rt^2$ and $t = A/R^2$. e) $A = Rt$ and $t = A/R$.

31. About how many kilometers are there in a light-minute? Recall the speed of light $c = 2.99792458 \times 10^{10}$ cm/s.

    a) 2.9979×10^{10} km. b) 3×10^{10} km. c) 1.8×10^{12} km. d) 1.8×10^{7} km.
    e) 3×10^{7} km.

32. "Let's play *Jeopardy*! For $100, the answer is: 86400."

    What is the length of _____ in seconds, Alex?

    a) a minute b) an hour c) a day d) a year e) four score and seven years

33. The length of a Julian year of 365.25 days in seconds is:

    a) 60 s. b) 86400 s. c) about $\pi \times 10^7$ s. d) about 10^5 s. e) about 2.2×10^6 s.

34. The Earth rotates once per day and its equatorial radius is 6378.1370 km. What is the speed of a point on the equator relative to the observable universe (i.e., the fixed stars as one says traditionally)? The rotational period of the Earth relative to the observable universe is the sidereal day, not the day which is relative to the Sun. The mean sidereal day is 86164.0905 s.

a) 1 km/s. b) 0.465 km/s. c) 3×10^5 km/s. d) 1 km. e) 0.465 km.

35. The Earth rotates once a day and its equatorial radius is 6378.1370 km. What is the speed of a point at the **POLES** relative to a reference frame orbiting with the Earth, but **NOT** rotating with respect to the observable universe?

    a) 1 km/s. b) 0.46 km/s. c) 3×10^5 km/s. d) 1 km. e) Zero velocity.

36. The acceleration due to gravity of a free-falling object near the surface of the Earth is $g = 9.8\,\mathrm{m/s^2}$. If an object falls from rest and one can neglect air resistance, what is its speed after 3 seconds?

    a) $9.8\,\mathrm{m/s^2}$. b) 9.8 m/s. c) 0.1 m/s. d) about 30 m/s. e) 98 m/s.

37. The mean distance from the Moon to the Earth is 3.844×10^{10} cm and the speed of light is 2.998×10^{10} cm/s. How long does it take light to travel from the Moon to the Earth?

    a) 8 minutes. b) 1.28 seconds. c) No time at all. d) 30 seconds. e) 30 arcminutes.

38. The star Proxima Centauri is 4.2 light-years from the Earth. How many years does it take for light to travel from Proxima to Earth?

    a) 4.2 light-years. b) 4.2 years. c) 4.2 seconds. d) 8 minutes. e) Millions of years.

39. "Let's play *Jeopardy*! For $100, the answer is: It is the transitive verb used in geometry to mean an angle delimits a line or curve or, vice versa, to mean a line or curve delimits an angle."

    What is to _____, Alex?

    a) sublend b) submend c) subrend d) subspend e) subtend

40. How many degrees in a circle, arcminutes in a degree, and arcseconds in an arcminute?

    a) 100, 10, 10. b) 360, 10, 10. c) 360, 100, 100. d) 360, 60, 60. e) 360, 24, 60.

41. A fist at arm's length for the average person spans about how many degrees?

    a) About 1°. b) About 10°. c) About 18°. d) 180°. e) 360°.

42. A Earth-orbiting artificial satellite is passing by Polaris. At closest approach it is about a fist at arm's length away in angular separation. What is the closest approach in angle and in spatial separation?

    a) About 10° in angle and about 10 light years in space.
    b) About 100° in angle and about 100 light years in space.
    c) About 360° in angle and you **CANNOT** tell the spatial separation with the information given.
    d) About 10° in angle and the spatial separation is virtually the same as the Earth-Polaris spatial separation since the Earth-satellite spatial separation is negligible for most purposes compared to the Earth-Polaris spatial separation.
    e) About 10° in angle and also about 10° in spatial separation.

43. Two stars are about 1 fist width apart on the sky. (The fist is at arm's length.) What is the angular separation of the two stars? How far apart are they in space?

    a) The angular separation is about 100° and the stars are separated by about 100 light-years.
    b) The angular separation is about 360° and the stars are separated by about 360 light-years.
    c) The angular separation is about 10° and the stars are separated by about 10 light-years.
    d) The angular separation is about 10°. The spatial separation **CANNOT** be determined from the given information.
    e) The angular separation is about 1 arcsecond. The spatial separation **CANNOT** be determined from the given information.

44. The Moon's orbital period (i.e, the sidereal month) is 27.321661547 days (J2000). What is the Moon's orbital angular velocity relative to the observable universe (i.e., the fixed stars in the traditional expression)?

    a) 12.19°/day. b) 12.50°/day. c) 13.18°/day. d) 15.19°/day. e) 27.32°/day.

45. A straight line on a linear plot represents a/an _____ function.

    a) linear b) inverse-square c) quadratic d) logarithmic e) perpendicular

46. A curve on a linear plot that decreases as 1 over the square of the horizontal axis coordinate represents a/an _____ function.

    a) linear b) inverse-square c) quadratic d) logarithmic e) perpendicular

47. If a function goes to infinity at $x = 0$ (i.e., the origin of the horizontal axis), it

    a) is a linear function. b) may be a linear function. c) must be an inverse-square function.
    d) may be an inverse-square function. e) cannot be an inverse-square function.

48. On a base-10 log plot (i.e., logarithmic plot), an axis unit is:

    a) one. b) a power of ten. c) one or two. d) one, two, or three. e) a power of one.

49. An inertial frame is a reference frame with respect to which all laws of physics are referenced (at least in any ordinary sense), except general relativity which tells us what an exact inertial frame is. What the simplest exact inertial frame is is a/an _____ that is **NOT** rotating with respect to the observable universe (i.e., the bulk mass-energy of the observable universe).

    a) accelerating frame b) rotating frame c) free-fall frame d) non-rotating
    e) oscillating frame

50. "Let's play *Jeopardy*! For $100, the answer is: Most generally, it is the trajectory of a body acted on only by gravity aside from perturbations by other forces."

    What is a/an _____, Alex?

    a) escape trajectory b) closed orbit c) circular orbit d) hyperbolic orbit e) orbit

51. "Let's play *Jeopardy*! For $100, the answer is: Zero."

    What is _____, Alex?

    a) less than b) the eccentricity of the Earth's orbit c) the eccentricity of Pluto's orbit
    d) the eccentricity of a circular orbit e) a legendary outlaw hero of old California

52. Most comets that are gravitationally bound to the Sun have very elliptical orbits. This means that most bound comet orbits have eccentricities that are:

    a) exactly zero. b) almost zero. c) exactly 1. d) $>> 0$ in some sense, but less than 1.
    e) bigger than 1.

53. The eccentricity of a body in orbit about the Sun is 0.20. How does its distance from the Sun vary?

    a) At **APHELION** the body is **20 %** farther from the Sun than the standard mean distance. At **PERIHELION** it is **20 %** closer to the Sun than the standard mean distance.
    b) At **APHELION** the body is **10 %** farther from the Sun than the standard mean distance. At **PERIHELION** it is **20 %** closer to the Sun than the standard mean distance.
    c) At **APHELION** the body is **20 %** farther from the Sun than the standard mean distance. At **PERIHELION** it is **10 %** closer to the Sun than the standard mean distance.
    d) The distance does not vary. The orbit is circular.
    e) The orbit is extremely elliptical. At **APHELION** the planet is well beyond the orbit of **PLUTO**. At **PERIHELION** the planet is well within the orbit of **VULCAN**. Vulcan is an asteroid (sometimes called a planet in the past) that is within the orbit of Mercury. The body is clearly a comet.

54. There are two gravitationally-bound bodies isolated in space. Describe their motion.

    a) The **LARGER** mass body orbits the **SMALLER** mass body in a circle.
    b) The **SMALLER** mass body orbits the **LARGER** mass body in a circle.
    c) The two bodies orbit their joint center of mass in ovals.
    d) The two bodies orbit their joint center of mass in circles always.
    e) The two bodies orbit their joint center of mass in ellipses.

55. To very good approximation, the planets move in:

    a) elliptical orbits with the Sun at one focus of the ellipse.
    b) circular orbits with the Sun at circle center.

c) elliptical orbits with the Sun at the geometric center of ellipse. (The geometric center of an ellipse is where the major and minor axes cross: i.e., where the symmetry axes of the ellipse cross.)
d) planar orbits with the Sun at plane center.
e) spherical orbits with the Sun at sphere center.

56. A planet is orbiting the Sun in an **ELLIPTICAL** orbit.

a) It moves fastest at **APHELION** and slowest at **PERIHELION**.
b) It moves fastest at **PERIHELION** and slowest at **APHELION**.
c) It moves fastest at **HELLION** and slowest at **ANTIHELLION**.
d) It moves at a constant speed.
e) It doesn't move at all.