1. a. 91.44 m
   b. 3.11 mi
   c. 183 cm
   d. 671,000,000 mph
   e. 186,000 mi/s
   f. 89 km/h
   g. 4047 m^2
   h. 62.4 lb/ft^3
2. a. 318 (2 orders of magnitude)
   b. 333000 (5 orders of magnitude)
   c. humpback whale; the Titanic
3. a. 11.2 : 1 (1 order of magnitude)
   b. 1410 : 1 (3 orders of magnitude)

4. a. 1800 m
   b. 33.3 s
5. 53 mph
6. a. 9.47×10^{12} km; 5.88×10^{12} mi
   b. 300,000 km; 186000 mi
   c. 116 days
7. a. 8.31 minutes
   b. 8.31 light-minutes
   c. 158 years!
8. a. 49 Gm
   b. 140 Gm
9. 28 m
10. 1.1°
11. 49 arc seconds
12. 360,000 km; 410,000 km
13. 31.9 arc minutes
14. a. 40,070 km
    b. 1670 km
    c. 1038 mph
15. a. 72,000 km
    b. 22,290 km

16. a. north pole
    b. south pole
    c. equator
17. a. positive (north)
    b. negative (west)
18. a. 0°
    b. 180° (or – 180°)
19. 15°
20 a. 34° N, 118° W
    b. 35° S, 20 ° E
    c. 52° N, 0° W
    d. 0°, 90°W
    e. 34° S, 151°E

21. a. New Orleans
    b. Hawaii
    c. Paris
    d. Tokyo
    e. Tasmania
22. a. on NW horizon
    b. directly above the ship
    c. South, halfway up the sky
    d. directly below the ship
    e. North, just above the horizon

23. a. 0°, 90°

    b. 45°, 90°

    c. zenith

    d. 60°, 270°

    e. –30°, 270°

24. a. SE

    b. 1.1°

    c. 510 ft

1. a. $\frac{100\text{ yd}}{1}\cdot\frac{3\text{ ft}}{1\text{ yd}}\cdot\frac{12\text{ in}}{1\text{ ft}}\cdot\frac{2.54\text{ cm}}{1\text{ in}}\cdot\frac{1\text{ m}}{100\text{ cm}}=\boxed{91.44\text{ m}}$

b. $\frac{5\text{ km}}{1}\cdot\frac{1000\text{ m}}{1\text{ km}}\cdot\frac{100\text{ cm}}{1\text{ m}}\cdot\frac{1\text{ in}}{2.54\text{ cm}}\cdot\frac{1\text{ ft}}{12\text{ in}}\cdot\frac{1\text{ mi}}{5280\text{ ft}}=\boxed{3.11\text{ mi}}$

c. $\frac{6.00\text{ ft}}{1}\cdot\frac{12\text{ in}}{1\text{ ft}}\cdot\frac{2.54\text{ cm}}{1\text{ in}}=\boxed{183\text{ cm}}$

d. $\frac{3\times10^{8}\text{ m}}{1\text{ s}}\cdot\frac{100\text{ cm}}{1\text{ m}}\cdot\frac{1\text{ in}}{2.54\text{ cm}}\cdot\frac{1\text{ ft}}{12\text{ in}}\cdot\frac{1\text{ mi}}{5280\text{ ft}}\cdot\frac{60\text{ s}}{1\text{ min}}\cdot\frac{60\text{ min}}{1\text{ h}}=\boxed{671000000\text{ mph}}$

e. $\frac{3\times10^{8}\text{ m}}{1\text{ s}}\cdot\frac{100\text{ cm}}{1\text{ m}}\cdot\frac{1\text{ in}}{2.54\text{ cm}}\cdot\frac{1\text{ ft}}{12\text{ in}}\cdot\frac{1\text{ mi}}{5280\text{ ft}}=\boxed{186000\frac{\text{mi}}{\text{s}}}$

f. $\frac{55\text{ mi}}{1\text{ h}}\cdot\frac{5280\text{ ft}}{1\text{ mi}}\cdot\frac{12\text{ in}}{1\text{ ft}}\cdot\frac{2.54\text{ cm}}{1\text{ in}}\cdot\frac{1\text{ m}}{100\text{ cm}}\cdot\frac{1\text{ h}}{60\text{ min}}\cdot\frac{1\text{ min}}{60\text{ s}}=\boxed{89\frac{\text{km}}{\text{h}}}$

g. $\frac{43560\text{ ft}^2}{1}\cdot\frac{12\text{ in}}{1\text{ ft}}\cdot\frac{12\text{ in}}{1\text{ ft}}\cdot\frac{2.54\text{ cm}}{1\text{ in}}\cdot\frac{2.54\text{ cm}}{1\text{ in}}\cdot\frac{1\text{ m}}{100\text{ cm}}\cdot\frac{1\text{ m}}{100\text{ cm}}=\boxed{4047\text{ m}^2}$

h. $\frac{1.0\text{ g}}{1\text{ L}}\cdot\frac{1\text{ kg}}{1000\text{ g}}\cdot\frac{2.205\text{ lb}}{1\text{ kg}}\cdot\frac{1\text{ L}}{1000\text{ mL}}\cdot\frac{1\text{ mL}}{1\text{ cm}^3}\cdot\left(\frac{2.54\text{ cm}}{1\text{ in}}\right)^3\cdot\left(\frac{12\text{ in}}{1\text{ ft}}\right)^3=\boxed{62.4\frac{\text{lb}}{\text{ft}^3}}$

2. a. $\frac{1.90 \times 10^{27}\ \text{kg}}{5.97 \times 10^{24}\ \text{kg}} = 318 = 3.18 \times 10^{2} \approx 10^{2}$

b. $\frac{1.99 \times 10^{30}\ \text{kg}}{5.97 \times 10^{24}\ \text{kg}} = 333000 = 3.33 \times 10^{5} \approx 10^{5}$

c. Use the same type of calculation and compare 100 kg to other things.

3. a. $\frac{2 \cdot 71400\ \text{km}}{2 \cdot 6370\ \text{km}} = 11.2 = 1.12 \times 10^{1} \approx 10^{1}$

b. $\frac{\frac{4}{3}\pi(71400\ \text{km})^3}{\frac{4}{3}\pi(6370\ \text{km})^3} = \frac{1.52 \times 10^{15}\ \text{km}^3}{1.08 \times 10^{12}\ \text{km}^3} = 1408 = 1.408 \times 10^{3} \approx 10^{3}$

4. a. $v = \frac{d}{t}\quad 30 = \frac{d}{60}\quad d = \left(30\,\frac{\text{m}}{\text{s}}\right)(60\ \text{s}) = 1800\ \text{m}$

b. $v = \frac{d}{t}\quad 30 = \frac{1000}{t}\quad t = \frac{1000\ \text{m}}{30\,\frac{\text{m}}{\text{s}}} = 33.3\ \text{s}$

5. $v = \frac{d}{t}$ $v = \frac{1800\text{ mi}}{34\text{ h}}$ $t = \boxed{53\text{ mph}}$

$$\frac{3 \times 10^8 \text{m}}{1\text{ s}} \cdot \frac{1\text{ km}}{1000\text{ m}} = 3 \times 10^5 \frac{\text{km}}{\text{s}}$$

6. a. $v = \frac{d}{t}$ $d = vt$ $d = \left(3 \times 10^5 \frac{\text{km}}{\text{s}}\right)(365 \cdot 24 \cdot 60 \cdot 60\text{ s}) = \boxed{9.47 \times 10^{12}\text{ m}}$

$$\frac{9.47 \times 10^{12}\text{m}}{1} \cdot \frac{100\text{ cm}}{1\text{ m}} \cdot \frac{1\text{ in}}{2.54\text{ cm}} \cdot \frac{1\text{ ft}}{12\text{ in}} \cdot \frac{1\text{ mi}}{5280\text{ ft}} = \boxed{5.88 \times 10^{12}\text{mi}}$$

b. $d = \left(3 \times 10^5 \frac{\text{m}}{\text{s}}\right)(1\text{ s}) = \boxed{300{,}000\text{ km}}$ $\frac{3 \times 10^5\text{km}}{1} \cdot \frac{1\text{ mi}}{1.609\text{ km}} = \boxed{186{,}000\text{ mi}}$

c. $d = vt$ $t = \frac{d}{v} = \frac{3 \times 10^8\text{ m}}{30\frac{\text{m}}{\text{s}}} = 1 \times 10^7\text{s}$ $\frac{1 \times 10^7\text{s}}{1} \cdot \frac{1\text{ h}}{3600\text{ s}} \cdot \frac{1\text{ d}}{24\text{ h}} = \boxed{116\text{ d}}$

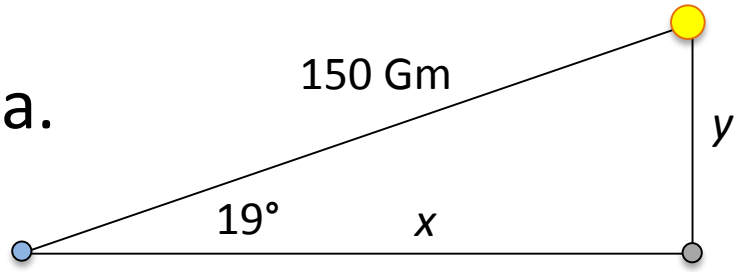
7. a. $d = vt$ $t = \frac{d}{v} = \frac{149.6 \times 10^9\text{ m}}{3 \times 10^8\frac{\text{m}}{\text{s}}} = 498.7\text{ s}$ $\frac{498.7\text{ s}}{1} \cdot \frac{1\text{ min}}{60\text{ s}} = \boxed{8.31\text{ min}}$

b. Works same as light-years, so *d* = 8.31 light-minutes

c. $d = vt$ $t = \frac{d}{v} = \frac{149.6 \times 10^9\text{ m}}{30\frac{\text{m}}{\text{s}}} = 4.987 \times 10^9\text{s}$

$$\frac{4.987 \times 10^9\text{s}}{1} \cdot \frac{1\text{ h}}{3600\text{ s}} \cdot \frac{1\text{ d}}{24\text{ h}} \cdot \frac{1\text{ y}}{365\text{ d}} = \boxed{158\text{ y}}$$

8. a.



$$\frac{19 \text{ deg}}{1} \cdot \frac{1 \text{ rad}}{57.3 \text{ deg}} = 0.3316 \text{ rad}$$

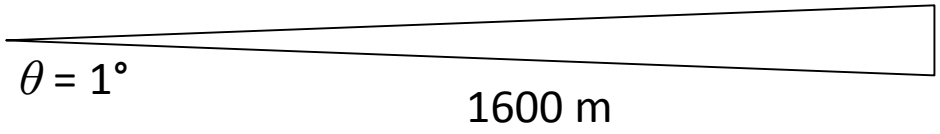
$$\theta = \frac{a}{r} \quad a = \theta r \quad a = 0.3316 \cdot 150$$

$$a = 0.3316 \cdot 150 = 49.7 \qquad y = \boxed{49 \text{ Gm}}$$

$$x^2 + y^2 = 150^2$$

b. $x^2 + 49^2 = 150^2$ $\quad x = \sqrt{150^2 - 49^2} = \boxed{140 \text{ Gm}}$

9.



a = ?

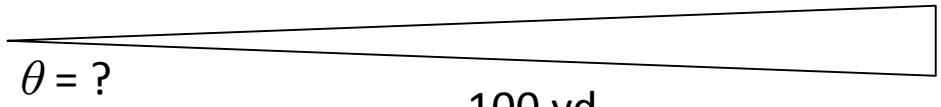
$$\theta = \frac{a}{r} \quad a = \theta r$$

$$a = 0.01745 \cdot 1600$$

$$\frac{1 \text{ deg}}{1} \cdot \frac{1 \text{ rad}}{57.3 \text{ deg}} = 0.01745 \text{ rad}$$

$$a = \boxed{28 \text{ m}}$$

10.



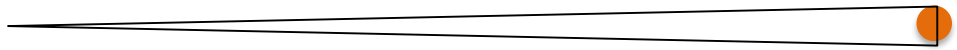
6 ft $\quad \theta = \frac{a}{r} \quad \theta = \frac{6 \text{ ft}}{300 \text{ ft}}$

$$\frac{100 \text{ yd}}{1} \cdot \frac{3 \text{ ft}}{1 \text{ yd}} = 300 \text{ ft}$$

$$\theta = 0.020 \text{ rad}$$

$$\theta = \frac{0.02 \text{ rad}}{1} \cdot \frac{57.3 \text{ deg}}{1 \text{ rad}} = \boxed{1.1°}$$

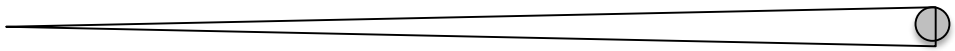
11.



$$\theta = \frac{a}{r} \quad \theta = \frac{1.4 \times 10^{8}\ \text{m}}{5.9 \times 10^{11}\text{m}} = 2.37 \times 10^{-4}\ \text{rad}$$

$$\theta = \frac{2.37 \times 10^{-4}\text{rad}}{1} \cdot \frac{57.3\ \text{deg}}{1\ \text{rad}} \cdot \frac{60'}{1\ \text{deg}} \cdot \frac{60''}{1'} = \boxed{49''}$$

12.



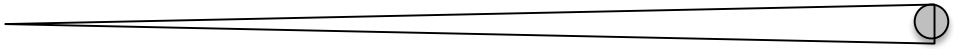
$$\theta = \frac{a}{r} \quad r = \frac{a}{\theta}$$

$$\frac{29'\ or\ 33'}{1} \cdot \frac{1\ \text{deg}}{60'} \cdot \frac{1\ \text{rad}}{57.3\ \text{deg}} = 0.00844\ or\ 0.0096\ \text{rad}$$

$$r = \frac{3480\ \text{km}}{0.00844} = \boxed{410{,}000\ \text{km}}$$

$$r = \frac{3480\ \text{km}}{0.0096} = \boxed{360{,}000\ \text{km}}$$

13.



$$\theta = \frac{a}{r} \quad \theta = \frac{1.39 \times 10^{9}\ \text{m}}{149.6 \times 10^{9}\text{m}} = 0.00929\ \text{rad}$$

$$\theta = \frac{0.00929\ \text{rad}}{1} \cdot \frac{57.3\ \text{deg}}{1\ \text{rad}} \cdot \frac{60'}{1\ \text{deg}} = \boxed{31.9'}$$

14. a. $C = 2\pi r = 2\pi \cdot 6378 \text{ km}$

$$C = \boxed{40{,}070 \text{ km}}$$

b. $\frac{1}{24} = \frac{x}{2\pi r} = \frac{x}{40070 \text{ km}}$ $\quad x = \frac{1}{24} 40070 = \boxed{1670 \text{ km}}$

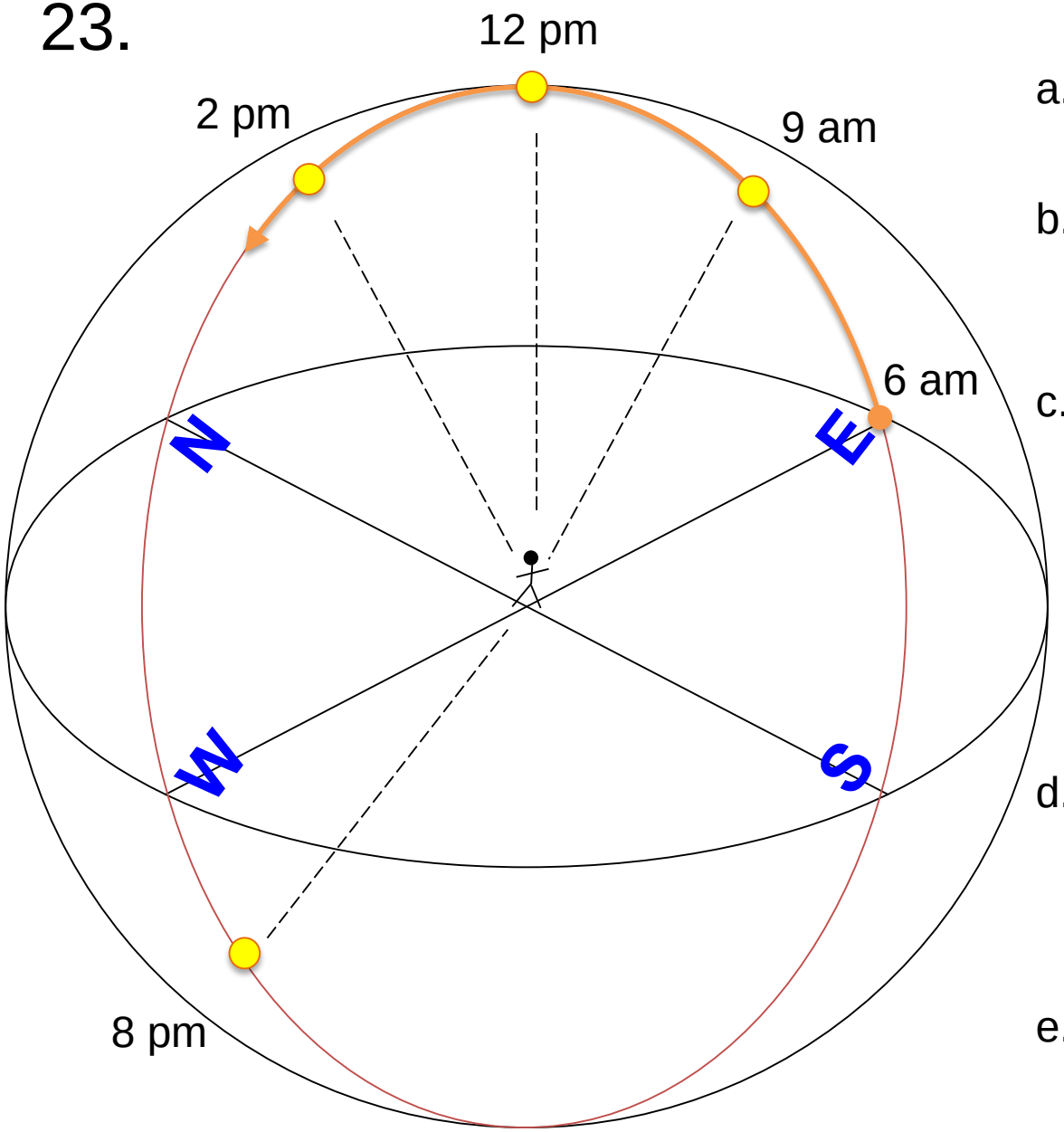
c. $v = \frac{d}{t} = \frac{40070 \text{ km}}{24 \text{ h}} \cdot \frac{1 \text{ mi}}{1.609 \text{ km}} = \boxed{1038 \text{ mph}}$

15. a. $\frac{5°}{360°} = \frac{1000}{C}$ $\quad C = \frac{360}{5} 1000 = \boxed{72{,}000 \text{ km}}$

b. $C = 2\pi r \quad r = \frac{C}{2\pi} = \frac{72000}{2\pi} = 11460 \text{ km}$

$$dia = 2r = 2 \cdot 11460 = \boxed{22{,}920 \text{ km}}$$

23.



a. on horizon altitude is zero,
east is azimuth = 90˚

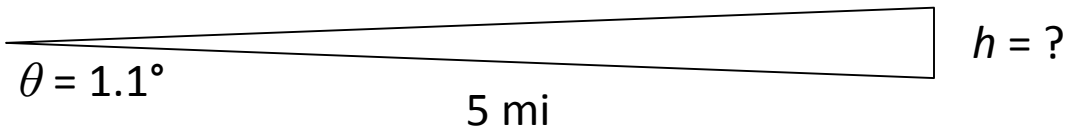
b. at 9 am Sun is halfway to zenith
so altitude is 90/2 = 45˚
still east so azimuth = 90˚

c. at 12 pm Sun is at zenith so
altitude is = 90˚
note: azimuth is undefined!

d. at 2 pm Sun is one third of way
to sunset so altitude is
90 – 90/3 = 90 – 30 = 60˚
now west so azimuth = 270˚

e. at 8 pm Sun is 2 hours past
sunset so altitude = 0 – 30 = –
30˚
still west so azimuth = 270˚

24. b. $\theta = 6.1° - 5° = \boxed{1.1°}$



c. $\dfrac{1.1 \text{ deg}}{1} \cdot \dfrac{1 \text{ rad}}{57.3 \text{ deg}} = 0.0192 \text{ rad}$

$\theta = \dfrac{a}{r} \quad a = \theta r$

$\dfrac{5 \text{ mi}}{1} \cdot \dfrac{5280 \text{ ft}}{1 \text{ mi}} = 26400 \text{ ft}$

$h = 0.0192 \cdot 26400 \text{ ft}$

$h = \boxed{510 \text{ ft}}$