Chapter 2, #25, 26, 29, 30 March 26, 2021

↑ repeat with 2.45 GHz microwave radiation

25. $f\lambda = c$ $\lambda = \frac{c}{f}$

$\lambda = \frac{3\times10^8 \frac{m}{s}}{95\times10^6\ Hz}$ $Hz = \frac{1}{s}$ so seconds cancel

$= \frac{3}{95}\times10^2\ m \approx 3m$ (3.16 m if you want more exactness)

Repeat for 2.45 GHz radiation (microwaves)

$\lambda = \frac{3\times10^8 \frac{m}{s}}{2.45\times10^9\ Hz} = \frac{3}{2.45}\times10^{-1}\ Hz$

$= 0.122\ m$ or about 12 cm

26. $E = hf$ h is Planck's constant

(a) 10x the frequency $\Rightarrow$ 10x the photon energy

(b) Put in $f = \frac{c}{\lambda}$

$E = \frac{hc}{\lambda}$

2x the wavelength $\Rightarrow \frac{1}{2}$ the photon energy

29. $$L = 4\pi R^2 \sigma T^4$$

radius

Temperature

luminosity

surface area

σ = Stefan–Boltzmann constant

All of the above is from Figure It Out Box 2.3

(a) If we keep everything the same but triple T_{sun}, we get $(3T_{sun})^4$ in the formula, which is $81\,T_{sun}^4$. So the formula is 81x more than $L_{sun} = 4\pi R_{sun}^2 \sigma T_{sun}^4$

(b) We get $(2R_{sun})^2$ where we had R_{sun} so another factor of 4. $4 \times 81 = 324$x more luminosity than the sun.

30. $L_{other\ star} = 2L_{sun}$

$R_{other\ star} = R_{sun}$

What is $T_{other\ star}$ compared to T_{sun}

$T_{other\ star} = \sqrt[4]{2}\,T_{sun}$

SOLUTION | PROBLEM SET 2 | April 2, 2021

Aristarchus determines size of Moon

1a. 30° of pie crust is $\frac{1}{12}$ of 360°

The whole circumference is $2\pi \cdot 5''$ which is $31.4''$ and $\frac{1}{12}\, 31.4'' = 2.6''$

b. 4" of crust and again $\frac{1}{12}$ of circumference.

Circumference is 48".

$$2\pi r = C \Rightarrow r = \frac{48''}{2\pi} = 7.6''$$

2. The eclipse shadow is

$$\frac{3}{720} \text{ of } 360° = 1.5°$$

3. The Moon's diameter occupies $\frac{1}{3}$ of the shadow width

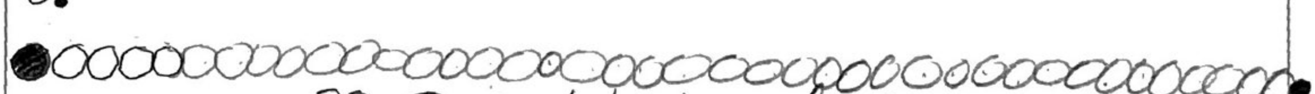
4. $D_{Moon} = \frac{1}{3} D_{Earth}$

5. $r = \frac{57.3°}{0.5°} D_{Moon} = 114.6\, D_{Moon}$

$= 114.6\, \frac{D_{Earth}}{3} = 38\, D_{Earth}$

(actually the umbra tapers, so a correct answer if Aristarchus could figure that would be more like $D_{Moon} = \frac{1}{4} D_{Earth}$)

6.



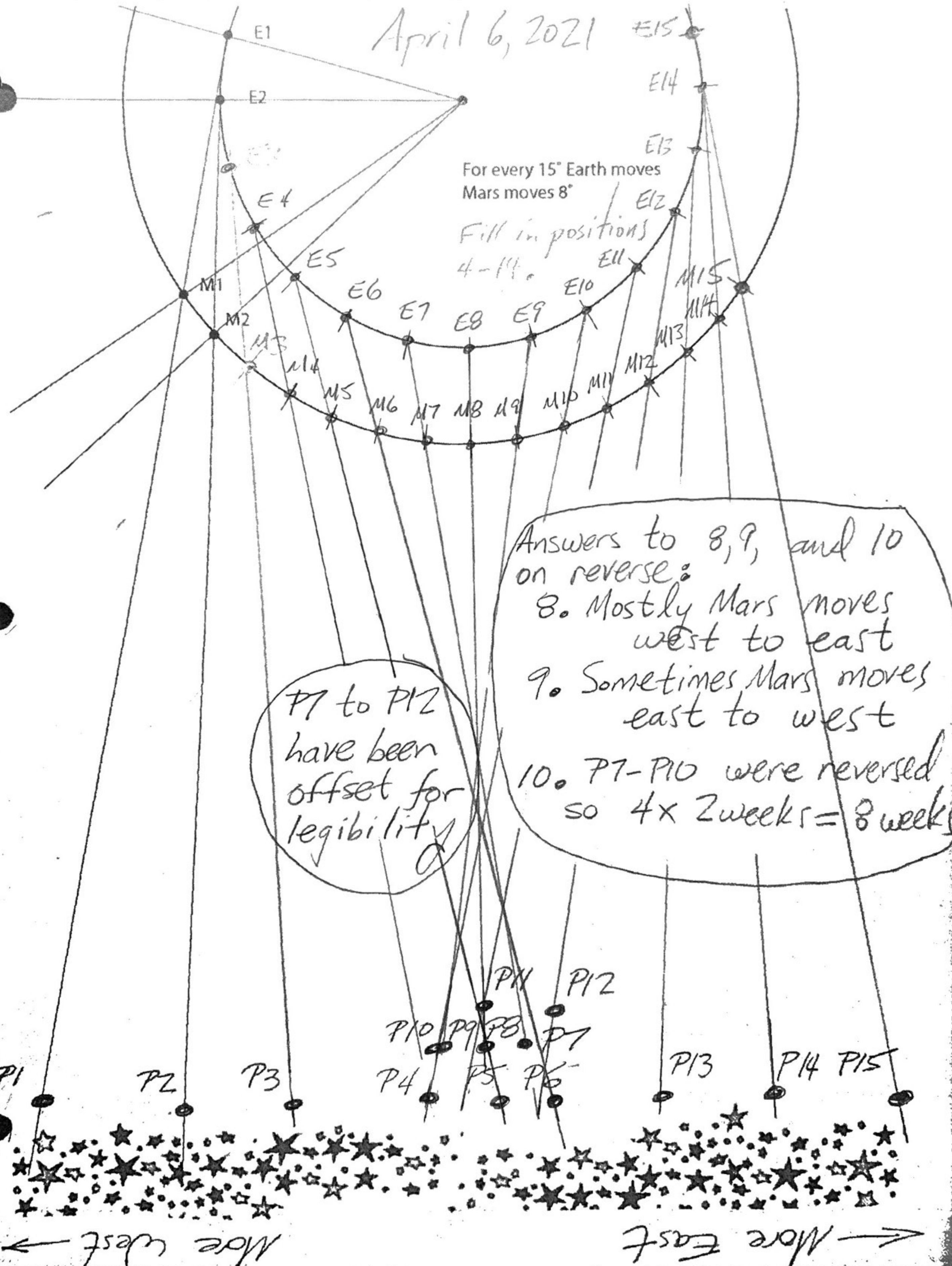
38 D_{Earth} distant and Moon is $\frac{1}{3}$ D_{Earth}

30 D_{Earth} distant and Moon is $\frac{1}{4}$ D_{Earth}

7. 

PROBLEM SET 3 SOLUTION

April 6, 2021



Answers to 8, 9, and 10 on reverse:

8. Mostly Mars moves west to east
9. Sometimes Mars moves east to west
10. P7-P10 were reversed so 4 × 2 weeks = 8 weeks

Chapter 4: Problems 1, 11, 12, 30, 31, 46
Chapter 5: Problems 35, 39

Chapter 4 Problems

1. Measuring an arc on the picture it looks like a star about 5.3 cm from the center travels about 3.3 cm.

The circumference corresponding to 5.3 cm is $2\pi \cdot 5.3\text{cm} \doteq 33\text{ cm}$

$\frac{3.3\text{cm}}{33\text{ cm}} = \frac{1}{10}$ of a circle, so the exposure was $24\text{hrs}/10 = 2.4$ hours.

(If you want to be overly fussy $\frac{23\text{hrs } 56\text{ minutes}}{10}$)

The stars on the right side of the picture are going up.

11. (a) 16th mag is 5 mags dimmer than 11th mag. The 11th mag star is 100x brighter.

APPARENT MAGNITUDE

(b) The 6th magnitude star is 10 mags brighter than the 16th magnitude star. It is

$100 \times 100 = 10{,}000$ times brighter — apparently!

it might just be closer

12. $\frac{1}{24}$ of $360°$ is $15°$.

If you want to be fussy, the stars go around once every 23h 56m. So a more accurate answer is

$$\frac{1\,hr}{23\,hr\ 56\,m}\ 360° = \frac{1}{23\frac{56}{60}}\ 360° = 15.04°$$

30. The stars advance the same amount from one month to the next $\left(\frac{1}{12}360° = 30°\right)$ as they do in two hours. So the answer is True. (2 months corresponds to four hours).

31. False, because at latitude $38°$. we can never see south of declination $-52°$ $(38+52=90)$. So no matter when you look from SF you will never see (for example) Proxima Centauri or The Magellanic Clouds.

46. 7 mags is 5 mags + 2 mags
$= 100 \times 2.5 \times 2.5 \approx 600$

The exact way is to put $100^{-(m_2-m_1)/5}$ into a calculator $m_2=3$ $m_1=10$ $100^{-(3-10)/5} = 631$

Chapter 5 Problems

35. If you use yrs and A.U. as your units, then the proportionality constant in $P^2 \propto a^3$ is $P^2 = \frac{(1\,yr)^2}{(1\,A.U.)^3}\, a^3$

A comet with 10^6 yrs as its period has

$$P^2 = 10^{12}\, yr^2$$

So a^3 must be $10^{12}\, A.U.^3$

$$a = \sqrt[3]{10^{12}}\, A.U. = 10^4\, A.U. \quad \text{(That's choice (c).)}$$

39. P^2 for Xander is $64\, yr^2$

So a^3 must be $64\, A.U.^3$

$$a = \sqrt[3]{64}\, A.U. = 4\, A.U. \quad \text{(That is choice (a).)}$$