Answers set 1

I

the # of people is 2.93×10^8

\# of square miles is 3.54×10^6

so the density is

$$n = \frac{2.93 \times 10^8}{3.54 \times 10^6} = 82.8 \frac{\text{people}}{\text{square mile}}$$

the web says

dist from Denver to

cheyenne = 98 miles

Oklahoma city = 507 miles

} "r"

and the # of people living in the two circles is $n \times \pi r^2$

- cheyenne 2.5 million
- okl. city 67.4 million

(II)

(a) the definition of a light year is: "the distance light travels in a year." so by this definition, light goes a million light years in a million years, so its velocity is 1 million light YRS / 1 million years = 1

(b) I can think of 2 ways to find "a" + "b".

Method 1 : simultaneous equations. Take two data points, say the 1st + last

First: $\frac{N}{r_{max}^3} = \frac{4.9 \times 10^9}{(1000)^3} = a + 1000b$

Last: $\frac{N}{r_{max}^3} = \frac{480 \times 10^9}{(4000)^3} = a + 4000b$

i.e. $4.9 = a + 1000b$

$7.5 = a + 4000b$

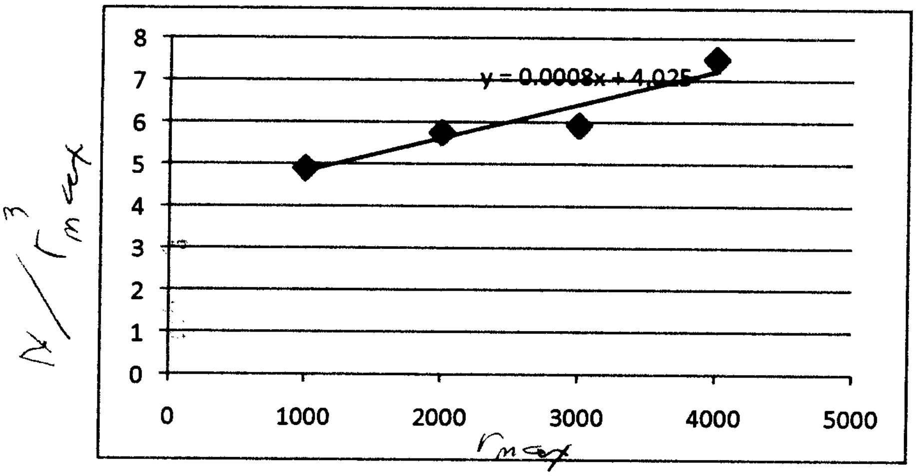
Solving those I get

$a = 4.03$

$b = 8.67 \times 10^{-4}$ ←

method 2   Graph $\frac{N}{r_{max}^3}$ against r_{max}

dist D	N	N / D^3
1000	4.90E+09	4.9
2000	4.60E+10	5.75
3000	1.60E+11	5.92592593
4000	4.80E+11	7.5



excel fits a trend line with

$a = 4.025$ ←

$b = .0008 = 8 \times 10^{-4}$

These agree pretty well with the first method. But notice that they do not agree exactly. If we wanted very accurate answers we would have to think about why, and which method gives the most accurate answer.

(c) we know $\epsilon = \frac{4\pi}{3} n$ so $n = \frac{3}{4\pi} \epsilon$

and $b = \frac{\pi}{c} \dot{n} = \pi \dot{n}$ so $\dot{n} = b/\pi$

[I'll use "ϵ" and "b" from Excel]

I get $n = 0.96$ galaxies/(million light years)^3

$$\dot{n} = 2.55 \times 10^{-4} \frac{\text{galaxies}}{[\text{million light years}]^3 [\text{million years}]}$$

(d) $t = n/\dot{n} = \frac{0.96}{2.55 \times 10^{-4}}$ million years

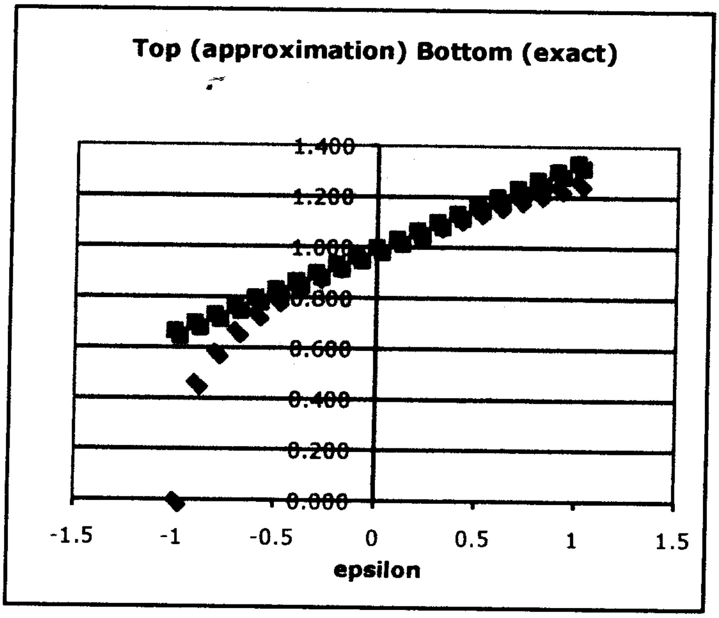
$t = 3,760$ million years $= 3.76$ billion YRS

III

Test the expansion formula for cube roots

ε	x = 1+ε	(x) ^ 0.333 (exact)	1 + ε/3 (approx)
1	2	1.260	1.333
0.9	1.9	1.239	1.300
0.8	1.8	1.216	1.267
0.7	1.7	1.193	1.233
0.6	1.6	1.170	1.200
0.5	1.5	1.145	1.167
0.4	1.4	1.119	1.133
0.3	1.3	1.091	1.100
0.2	1.2	1.063	1.067
0.1	1.1	1.032	1.033
0	1	1.000	1.000
-0.1	0.9	0.965	0.967
-0.2	0.8	0.928	0.933
-0.3	0.7	0.888	0.900
-0.4	0.6	0.843	0.867
-0.5	0.5	0.794	0.833
-0.6	0.4	0.737	0.800
-0.7	0.3	0.669	0.767
-0.8	0.2	0.585	0.733
-0.9	0.1	0.464	0.700
-1	0	0.000	0.667

accurate to 2 figures for $|\epsilon| \leq 0.1$ or so



(4) Cepheids

(a)

we know $F = L/4\pi R^2$ so ~~R = ...~~

$L = 4\pi R^2 F$ and $R = 57$ light years

$R = 5.39 \times 10^{19}$ cm

so

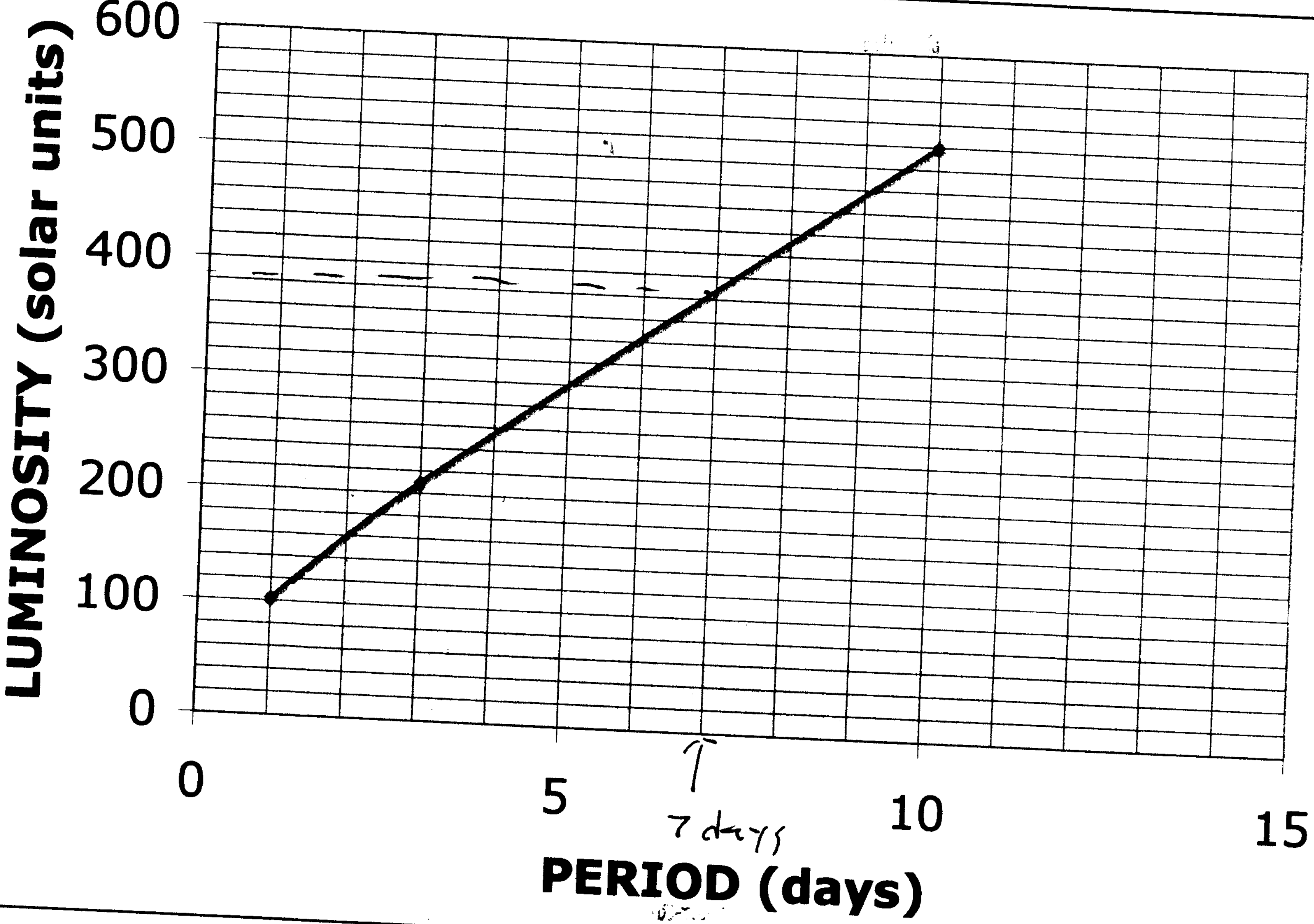
	L	L/Lsun
#1	6.14×10^{35} erg/sec	160
#2	9.87×10^{35} erg/sec	258
#3	1.83×10^{36} erg/sec	477

(c) the 7-day cepheid must have a luminosity of about 385 Lsun, or 1.47×10^{36} erg/sec. It's distance is

$$R = \left[\frac{L}{4\pi F}\right]^{1/2} = 4.25 \times 10^{24} \text{ cm}$$

$$= 4.49 \text{ million light yrs}$$

$F = 6.5 \times 10^{-15}$ erg/cm² - sec



LUMINOSITY (solar units)
600
500
400
300
200
100
0
0
5
10
15
7 days
PERIOD (days)