Physics 100 HW 1 (Due 1/17/07) Name S. Olsen

1. What is your height (or what would you like your height to be) in:
   a) inches? b) feet? c) millimeters? d) centimeters? e) meters? f) kilometers?

   73″   6.1′   1854 mm   185.4 cm   1.85 m 1.85×10^{-3} km

2. How many seconds are there in one calendar year?

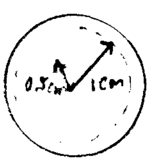
   $1 \text{ yr} = 365 \text{ days} \times 24 \text{ hr/day} \times 60 \text{ min/hr} \times 60 \text{ sec/min} = 3.15 \times 10^7 \text{ s}$

3. Give your age (or what age you would like to be) in:
   a) years b) months c) weeks d) days e) hours f) minutes g) seconds h) microseconds.

   39 yr   468 mo   2028 wk   14,245 day (1.4×10^4 day) 3.4×10^5 hr 2.1×10^7 min 1.26×10^9 s 1.26×10^{15} μs

4. The minute and second hands on my watch are both 1 cm long; the hour hand is 0.5 cm long. At what speeds do the *tips* of each hand move?

   $V = \frac{\text{distance}}{\text{elapsed time}} = \frac{2\pi R}{\text{time}}$



   a) second hand:

   $V_s = \frac{2\pi\, 1\text{ cm}}{60\text{ s}} = 0.105 \text{ cm/s} \; (= 1.05 \text{ mm/s})$

   b) minute hand:

   $V_{min} = \frac{2\pi\, 1\text{ cm}}{1\text{ hr}} = \frac{2 \times 3.14 \times 1\text{ cm}}{3600\text{ s}} = 1.7 \times 10^{-3} \text{ cm/s} \; (= 0.0017 \frac{\text{mm}}{\text{s}})$

   c) hour hand:

   $V_{hr} = \frac{2\pi \times \frac{1}{2}\text{ cm}}{12\text{ hrs}} = \frac{2 \times 3.14 \times \frac{1}{2}\text{ cm}}{12\text{ hr} \times 3600\text{ s/hr}} = 7.3 \times 10^{-5} \text{ cm/s} \; (= 0.000073 \frac{\text{mm}}{\text{s}})$

5. Take a piece of paper roughly the same size as this one and measure the sides (in cm).

   a) What is its area (in cm^2)? $22 \text{ cm} \times 28 \text{ cm} = 616 \text{ cm}^2$

   Cut it in half 12 times and paste/tape the last remaining piece on to this sheet.   0.4 cm   0.3 cm

   b) What is the area of the piece that is left? (about) $0.4 \text{ cm} \times 0.3 \text{ cm} = 0.12 \text{ cm}^2$

   c) Compare the ratio of the measured areas of **b)** to **a)** to what you calculate from multiplying $\frac{1}{2}$ by itself 12 times.

   $616 \text{ cm}^2 \times \left(\frac{1}{2}\right)^{12} = \frac{616 \text{ cm}^2}{4096} = 0.15 \text{ cm}^2$ ← about the same

(You are not done yet, there is more on the other side!)

For the following problems use the x^y key on your calculator plus trial and error to get a *roughly correct* answer.

6. A hydrogen atom has a cross-sectional area of about 10^{-18} cm^2. How many times would you have to cut the paper in half (see previous problem) to get down to this size?

$a = A_o\left(\frac{1}{2}\right)^n \Rightarrow 10^{-18}cm^2 = 616cm^2\left(\frac{1}{2}\right)^n$

$\frac{10^{-18}cm^2}{616\ cm^2} = \left(\frac{1}{2}\right)^n = 1.6\times10^{-21}$

$n \simeq 69$

trial & error

n	$(½)^n$	
50	9.0×10^{-16}	big
60	8.6×10^{-16}	big
70	8.5×10^{-22}	small
69	1.6×10^{-21}	ok

7. The entire surface of the Earth has an area of about 5×10^{18} cm^2. How many times would you have to double the size of this paper to make it have an area that large?

$a = A_o(2)^n \Rightarrow 5\times10^{18}cm^2 = 616cm^2(2)^n$

$\frac{5\times10^{18}cm^2}{616\ cm^2}$ $2^n = 8\times10^{15}$

$n = 53$

trial & error

n	2^n	
40	1×10^{12}	small
50	1×10^{15}	small
53	8×10^{15}	OK

8. In recent years, the amount of oil used by the US has been increasing by about 3% each year. (This means that each year we consume 1.03 times the amount we consumed the previous year.) The US currently consumes about 20 million barrels of oil per day. If we continue increasing our consumption at the same 3%/year rate, how many barrels per day will the US consume 30 years from now (*i.e.*, in 2037)?

Yr	Consumpt
2008	20 MB × 1.03
2009	20 MB × (1.03) × 1.03
⋮	⋮
2037	$20MB\times(1.03)^{30} = 20MB\times2.43 = 48.5\ MB/day$

9. You have 2 parents, 4 grandparents, 8 great grandparents, 16 great-great grandparents, 32 great-great-great grandparents, etc.

a) Go back 40 generations (about 1000 years): how many great-great-great-...etc grandparents do you have?

$2^{40} = 1.1\times10^{12}$ ancestors

b) How does this number compare with the population of the Earth at that time (which was about 300 million people)?

much bigger