CHAPTER ONE

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1.2 Ex. 1.1

$1.93\times10^{13}\ kg = 1.93\times10^{13}\times10^{3}\ g = 1.93\times10^{16}\ g$

$= 1.93\times10^{1}\times10^{15}\ g = \boxed{19.3\ Pg}$ ✓

CYU 1.1

$4.79\times10^{5}\ kg = 4.79\times10^{5}\times10^{3}\ g = 4.79\times10^{2}\times10^{6}\ g = \boxed{479\ Mg}$ ✓

1.3 Ex 1.2

$d = 10\ mi \times \frac{1609\ m}{1\ mi} = 16090\ m \qquad \bar{v} = \frac{d}{t} = \frac{16090\ m}{1200\ s} = \boxed{13.4\ m/s}$ ✓

$t = 20\ min \times \frac{60\ s}{1\ min} = 1200\ s$

CYU 1.2

$\bar{v} = \frac{\Delta x}{t} = \frac{9\ Pm}{1\ yr} \times \frac{9\times10^{15}\ m}{1\ yr} \times \frac{1\ yr}{3\times10^{7}\ s} = \boxed{3\times10^{8}\ m/s}$ ✓

Ex. 1.3

$\rho = \frac{7.86\ g}{1\ cm^3} \times \frac{1\ kg}{1000\ g} \times \left(\frac{100\ cm}{1\ m}\right)^3 = \boxed{7.86\times10^{3}\ kg/m^3}$ ✓

CYU 1.3

$10^{14}\ m^2 \times \left(\frac{1\ km}{1000\ m}\right)^2 = \boxed{1\times10^{8}\ km^2}$ ✓

CYU 1.4 too ~~small~~ big b/c lbs are ~~bigger~~ than N

SM - Forces - recorded in lbs → lbs are smaller than N; output was too small.

1.4 Ex. 1.4

$[A] = L^2 \quad [2\pi r] = L \quad [\pi r^2] = L^2 \quad \therefore \boxed{A = \pi r^2}$ ✓

CYU 1.5

$[V] = L^3 \quad [4\pi r^2] = L^2 \quad [\frac{4}{3}\pi r^3] = L^3 \rightarrow \boxed{V = \frac{4}{3}\pi r^3}$ ✓

Ex. 1.5

$s = vt + \frac{1}{2}at^2 = [L^1 \cdot \cancel{T^{-1}}]\cancel{T} + [L^1 \cdot \cancel{T^{-2}}]\cancel{T^2} = [L]$ consistent

$s = vt^2 + \frac{1}{2}at = L^1T^{-1}\cdot T^2 + L^1T^{-2}\cdot T^1$ not consistent

$v = \sin(at^2/s) \rightarrow \sin(L\cdot T^{-2}\cdot T^2\cdot L^{-1})$ not consistent

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CYU 1.6

$v = at \Rightarrow L^1 \cdot T^{-2} \cdot T^1 = LT^{-1}$ consistent

1.5

Ex. 1.6

density of water $= 1 \frac{g}{cm^3} = 10^3 \frac{kg}{m^3}$

Surface area of earth $= 4\pi r^2 \approx 10 \cdot (10^7 m)^2 \approx 10^{15} m^2$

↳ Oceans are $\frac{3}{4}$ of the surface area → just assume that the whole thing is ocean.

depth of the ocean is probably 10^3 m

Volume = depth × A = $10^{18} m^3$

$m = \rho V = 10^{18} m^3 \cdot 10^3 \frac{kg}{m^3} = \boxed{10^{21} kg}$ ✓

CYU 1.7

Mass of atmosphere $= 10^{19} kg$; density $= 1 \frac{kg}{m^3}$

~~Assume~~ $V = \frac{m}{\rho} = 10^{19} m^3$

Volume of atmosphere + volume of earth $= 10^{19} m^3 + 10^{21} m^3$

~~radius of earth + atmosphere~~ = $= 10^{21} m^3$

$V = \frac{4}{3}\pi r^3 \approx 4r^3$ radius of earth + atmosphere $= \sqrt[3]{\frac{V}{4}}$ $\approx 10^7$ m

~~height~~ height of atmosphere $= 10^7 m - 6\times10^6 m$

(underestimate b/c density decreases as height increases) $= \boxed{4 \times 10^6 m}$ ✗

$\rho = \frac{m}{V}$ $V = \frac{m}{\rho} = \frac{10^{19} kg}{1 \frac{kg}{m^3}} = 10^{19} m^3$

spherical shell - $V = \frac{4}{3}\pi (r^3 - (r-t)^3)$ $r = t + r_e$

$= 4((t+r_e)^3 - r_e^3) = 10^{19} m^3$

$(t+r_e)^3 = 3\times10^{18} + (6\times10^7)^3$

$= 2\times10^{23} m^3$

$t + r_e = 6\times10^7$ m

$t = 6\times10^7 m - 6\times10^6 m = \boxed{5.4\times10^7 m}$ ✗

$\boxed{3\times10^4 m}$

1.6 Ex. 1.7

4.8, 5.3, 5.9, 5.4. Avg. = 5.1 ± 0.2 lb

% uncertainty = $\frac{0.2}{5.1} \times 100 = \boxed{3.9\%}$ ✓

CYU 1.8

Uncertainty = ± 0.05 s; the sprinters were 0.03 apart so the stopwatch isn't good enough.

Ch. 1 Problems EOO

1) The field of study dedicated to understanding the universe at all scales.

5) People will be more willing and quick to accept expected values than unexpected values and will therefore be more skeptical of unexpected measurements.

9) a) base unit vs. derived units - derived units are formed from base units

b) base quantity vs. derived quantity - base quantities are universal constants; derived quantities are based on those

c) Quantity - has a numerical value; Unit - is a unit of measurement & can store any value.

13) check the units and check to see if it makes sense

17) 1 lifetime - 10^9 seconds ≈ 100 yrs

generation = 33 yrs since 0 AD - 2020 yrs

2020/33 yrs = $\boxed{61 \text{ generations}}$

21) nerve impulse - 10^{-3} s

$\frac{1 \text{ s}}{10^{-3} \text{ s/impulse}} \approx \boxed{1000 \text{ impulses/second}}$

25) a) 9.57×10^5 s = $\boxed{957 \text{ ks}}$ b) 0.045 s = $\boxed{45 \text{ ms}}$

c) 5.5×10^{-7} s = $\boxed{550 \text{ ns}}$ d) 3.16×10^7 s = $\boxed{31.6 \text{ Ms}}$

29) a) 3.8×10^{-5} kg = $\boxed{3.8 \text{ cg}}$ b) 2.3×10^{17} kg = $\boxed{230 \text{ Eg}}$

c) 2.4×10^{-11} kg = $\boxed{24 \text{ ng}}$ d) 8×10^{15} kg = $\boxed{18 \text{ Eg}}$

e) 4.2×10^{-3} kg = $\boxed{4.2 \text{ g}}$

33) a) $\frac{1.0\,m}{s} \times \frac{1\,km}{1000\,m} \times \frac{3600\,s}{1\,h} = \boxed{3.6\,km/h}$

b) $\frac{1.0\,m}{s} \times \frac{1\,km}{1000\,m} \times \frac{3.1\,mi}{5\,km} \times \frac{3600\,s}{1\,h} = \boxed{2.2\,mi/h}$

37) $29028\,ft \times \frac{1\,m}{3.281\,ft} \times \frac{1\,km}{1000\,m} = \boxed{8.85\,km}$

X 41) $\frac{10^{18}\,kg}{1\,m^3} \times \frac{1000\,Mg}{1\,kg} \times \cancel{\frac{[illegible]}{10^{6}}} \times \left(\frac{1\,m}{100\,cm}\right)^3 \times \frac{1\,mL}{1000\,\mu L} = \boxed{10^{12}\,\frac{Mg}{\mu L}}$

45) $1^\circ \times \frac{2\pi}{360^\circ} = \cancel{[illegible]}\ \boxed{\frac{\pi}{180}\,rad = 0.017\,rad}$

49) $12\,fl\text{-}oz \times \frac{30\,cm^3}{1\,fl\text{-}oz} \times \left(\frac{1\,m}{100\,cm}\right)^3 = \boxed{3.6 \times 10^{-4}\,m^3}$

53) a) $[v] = LT^{-1}$ b) $[a] = LT^{-2}$ c) $\int v\,dt = s$ $[s] = L$

d) $\int a\,dt = v$ $[v] = LT^{-1}$ e) $\left[\frac{da}{dt}\right]$ LT^{-3}

10^{28} but close enough 57) weight of a human - 70 kg

$70\,kg \times \frac{1000\,g}{kg} \times \frac{1\,mol}{18\,g} \times \frac{10^{24}\,molecules}{mol} = \boxed{4 \times 10^{27}\,molecules}$

61) milky way dia. $10^{21}\,m \rightarrow A = \pi(5\times10^{20}\,m)^2 = 8\times10^{41}\,m^2$

Solar system dia. $10^{13}\,m = A = \pi(5\times10^{12}\,m)^2 = 8\times10^{25}\,m^2$

$A_{mw}/A_{ss} = \boxed{10^{16}\text{ Solar systems}}$

65) time for a human to do a floating-point operation - around 10 s

supercomputer - 10^{-17} s

a) human lifetime - 10^9 s $10^9\,s / 10\,s = \boxed{10^8\text{ operations}}$

X b) ~~[illegible]~~ $10^{-17}\,s / 10^8$ operations $= \boxed{10^{-25}\,s}$

69) 130 ± 5 bpm $\%u = \frac{\delta A}{A} = \frac{5}{130} \times 100\% = \boxed{4\%\text{ uncertainty}}$

73) a) 99 - 2 sig figs, 100. - 3 sig figs

b) ↳ $\%u = \frac{1}{99} = \boxed{1.0\%}$ ↳ $\%u = \frac{1}{100.} = \boxed{1.00\%}$

c) Sig figs are more meaningful b/c the % u is the same for both

77) $A = \pi r^2 = \pi\left(\frac{D}{2}\right)^2 = \pi(3.102\,cm/2)^2 = \boxed{7.557\,cm^2}$

81) $s = s_0 + v_0 t + \frac{1}{2} a_0 t^2 + \frac{1}{6} j_0 t^3 + \frac{1}{24} s_0 t^4 + \frac{1}{120} c t^5$

a) $[s_0] = L$; m b) $[v_0] = LT^{-1}$; m/s c) $[a_0] = LT^{-2}$; m/s²

d) $[j_0] = LT^{-3}$; m/s³ e) $[s_0] = LT^{-4}$; m/s⁴ f) $[c] = LT^{-5}$; m/s⁵

85) 1 lbm = 0.4539 kg ± 0.0001 kg

a) $\% u = \frac{\delta A}{A} \times 100\% = \frac{0.0001\,kg}{0.4539\,kg} = 0.02\%$

b) ~~[illegible]~~

$10000\,lbm \times \frac{0.4539\,kg \pm 0.0001\,kg}{1\,lbm} = \boxed{4539\,kg \pm 1\,kg}$ (10,000 lbm)

89) $\sum_{n=0}^{\infty} a_n x^n = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + \dots$

It wouldn't be mathematically possible to add the terms together if the units didn't cancel out b/c the arguments of math functions are dimensionless. It also wouldn't make sense to add different physical quantities if the dimensions were different, so in all equations w/ addition, the dimensions must match.

1) "the science concerned with describing the interactions of energy, matter, space & time to uncover the fundamental mechanisms that underlie every phenomenon"

9) b) base quantities are chosen conventionally/practically

c) quantities don't have numerical values ~~[illegible]~~ per se

41) $\frac{10^{18}\,kg}{1\,m^3} \times \frac{1000\,g}{1\,kg} \times \frac{1\,Mg}{10^6\,g} \times \left(\frac{1\,m}{100\,cm}\right)^3 \times \frac{1\,cm^3}{1\,mL} \times \frac{1000\,mL}{1\,L} \times \frac{1\,L}{10^6\,\mu L}$

$= \boxed{10^6 \frac{Mg}{\mu L}}$ ✓

65) b) $\frac{10^{-17}\,s}{1\text{ operation}} \times 10^8\text{ operations} = \boxed{10^{-9}\,s}$ ✓

73) b) best to use uncertainties