Physics 2BL Winter 99

Hw #1 Solution:

3.7) $a = 5 \pm 1$ cm $t = 3.0 \pm 0.5$ s

$b = 18 \pm 2$ cm $m = 18 \pm 1$ gram

$c = 12 \pm 1$ cm

a) $a+b+c = 35 \Longrightarrow$ error $= \pm(\delta a + \delta b + \delta c) = \pm 4$ cm

$$\boxed{35 \pm 4 \text{ cm} = 35 \text{ cm} \pm 11\%}$$

b) $a+b-c \Longrightarrow$ error $= \pm(\delta a + \delta b + \delta c) = \pm 4$ cm

11 ± 4 cm $=$ 11 cm $\pm$ 36%

c) $ct = 12 \text{ cm} \times 3 \text{ s} = 36$ cm·s

$$\frac{\delta(ct)}{ct} = \frac{\delta c}{c} + \frac{\delta t}{t} = \frac{1}{12} + \frac{0.5}{3.0} = 0.25$$

$\delta(ct) = 0.25\, ct = 9$ cms

$$\boxed{ct = 36 \pm 9 \text{ cm·s} = 36 \text{ cm·s} \pm 25\%}$$

d) $mb/t = 108$ gram·cm/s

$$\frac{\delta(mb/t)}{mb/t} = \frac{\delta m}{m} + \frac{\delta b}{b} + \frac{\delta t}{t} = \frac{1}{18} + \frac{2}{18} + \frac{0.5}{3.0} = 0.34$$

$\delta(mb/t) = 0.34\, mb/t = 36.72$ gram·cm/s

$$\boxed{mb/t = 110 \pm 40 \text{ gram·cm/s} = 110 \text{ gram·cm/s} \pm 36\%}$$

3.11) a) $\tau = \frac{(2.4 \pm 0.1\,s)}{5} = \frac{2.4}{5} \pm \frac{0.1}{5}\,s = \boxed{\begin{array}{l} 0.48 \pm 0.02\,s \\ = 0.48\,s \pm 4\% \end{array}}$

b) $\tau = \frac{(9.4 \pm 0.1\,s)}{20} = 0.47 \pm 0.005\,s$

$$\boxed{\begin{array}{l} \tau = 0.470 \pm 0.005\,s \\ = 0.470 \pm 1\% \end{array}}$$

c) Yes. But there would always be some error, and the improvement gained from timing more oscillations would eventually become so negligible as to make the exercise pointless.

3.13) $r = 2.0 \pm 0.1\,m$

$V = \frac{4}{3}\pi r^3 = 33.512\,m^3$

$\delta V = \frac{\partial V}{\partial r}\,\delta r = 4\pi r^2\,\delta r$

or

$\frac{\delta V}{|V|} = \frac{4\pi r^2\,\delta r}{|V|} = \frac{4\pi r^2}{\frac{4}{3}\pi r^3}\,\delta r = 3\,\frac{\delta r}{|r|} = 0.15$

$\delta V = 0.15\,|V| \approx 5\,m^3$

$V = 34 \pm 5\,m^3$

3.48) a) $x = 20 \pm 1$, $y = 2$, $z = 0$

$$q = \frac{(x+y)}{(x+z)} = 22/20 = 1.1$$

$$= (x+y)(x+z)^{-1}$$

General Eq.

$$\delta q = \sqrt{\left(\frac{\partial q}{\partial x}\delta x\right)^2 + \cancel{\left(\frac{\partial q}{\partial y}\delta y\right)^2} + \cancel{\left(\frac{\partial q}{\partial z}\delta z\right)^2}}$$

$$\left[\delta q = \left|\frac{\partial q}{\partial x}\right| \delta x\right]$$

$$\frac{\partial q}{\partial x} = (x+z)^{-1} + (x+y)(-1)(x+z)^{-2}$$

$$= \frac{(x+z)}{(x+z)^2} - \frac{(x+y)}{(x+z)^2}$$

$$= \frac{z-y}{(x+z)^2}$$

$$\longrightarrow \left[\delta q = \left|\frac{(z-y)}{(x+z)^2}\right| \delta x = \left(\frac{2}{20^2}\right)(1) = 0.005\right]$$

By Steps

$$\frac{\delta q}{q} = \sqrt{\left(\frac{\delta(x+y)}{x+y}\right)^2 + \left(\frac{\delta(x+z)}{x+z}\right)^2}$$

$\delta(x+y) = 1$

$\delta(x+z) = 1$

$$\frac{\delta q}{q} = \sqrt{\left(\frac{1}{22}\right)^2 + \left(\frac{1}{20}\right)^2} = 0.07$$

$$\longrightarrow \left[\delta q = 0.08\right]$$

$x = 20 \pm 1$
$y = -40$
$z = 0$

$q = \frac{-20}{20} = -1$

b) by General Eq:

$$\left[\delta q = \left|\frac{(z-y)}{(x+z)^2}\right| \delta x = \left(\frac{40}{20^2}\right)(1) = 0.1\right]$$

by Steps:

$$\frac{\delta q}{|q|} = \sqrt{\left(\frac{1}{-20}\right)^2 + \left(\frac{1}{20}\right)^2} = 0.07$$

$$\left[\delta q = 0.07\right]$$