PHYS-345 HOMEWORK: UNCERTAINTY PROBLEMS

/ /

PROBLEM 01:

a) • $V = \frac{4}{3}\pi r^3$

$= \frac{4}{3}\pi (0.31)^3 = 0.1248\ m^3$

• $\delta V = \left|\frac{\partial V}{\partial r}\delta r\right|$

$= \left|4\pi r^2 \delta r\right|$

$= 4\pi (0.31)^2 (0.001)$

$= 1.2576 \times 10^{-3}\ m^3$

$= 1.2 \times 10^{-3}\ m^3$

significant figures in the measurement:

$V = 124.8 \times 10^{-3}\ m^3$

→ $\boxed{V = (124.8 \pm 1.2) \times 10^{-3}\ m^3}$

b) $r = 0.31 \pm 0.001\ m$

$\delta r = 1 \times 10^{-3}\ m$

$0.31\ m = 310 \times 10^{-3}\ m$

$r = (310 \pm 1) \times 10^{-3}\ m$

$\boxed{r = 310 \pm 1\ mm}$

$\boxed{V = (124.8 \pm 1.2) \times 10^{-3}\ m^3}$

PROBLEM 02:

$\delta L = \sqrt{\left(\frac{\partial L}{\partial M}\delta M\right)^2 + \left(\frac{\partial L}{\partial R}\delta R\right)^2 + \left(\frac{\partial L}{\partial \omega}\delta \omega\right)^2}$

• $\frac{\partial L}{\partial M}\delta M = \frac{1}{2}R^2\omega\,\delta M$

$= \frac{1}{2}(0.250)^2(21.5)(0.01)$

$= 6.7 \times 10^{-3}$

• $\frac{\partial L}{\partial R}\delta R = MR\omega\,\delta R$

$= (1.10)(0.250)(21.5)(0.005)$

$= 29.6 \times 10^{-3}$

• $\frac{\partial L}{\partial \omega}\delta \omega = \frac{1}{2}MR^2\delta\omega$

$= \frac{1}{2}(1.10)(0.25)^2(0.4)$

$= 13.8 \times 10^{-3}$

→ $\delta L = 10^{-3} \times \sqrt{(6.7)^2 + (29.6)^2 + (13.8)^2}$

$= 33.3 \times 10^{-3}\ kg \cdot m^2/s$

$= 0.03\ kg \cdot m^2/s$

→ $L = \frac{1}{2}MR^2\omega$

$= \frac{1}{2}(1.10)(0.25)^2(21.5)$

$= 739.1 \times 10^{-3} = 0.74\ kg \cdot m^2/s$

→ $\boxed{L = 0.74 \pm 0.03\ kg \cdot \frac{m^2}{s}}$

PROBLEM 03:

- $\delta d = \left|\frac{\partial d}{\partial t}\delta t\right| = gt\,\delta t$

$= (9.80)(3.0)(0.5)$

$= 14.7\ m$

- $d = \frac{1}{2}gt^2 = \frac{1}{2}(9.80)(3.0)^2$

$= 44.1\ m$

→ $\boxed{d = (44.1 \pm 14.7)\ m}$

PROBLEM 04:

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

- $\frac{\partial q}{\partial x}\delta x = \left(y + \frac{2x}{y}\right)\delta x$

$= \left[3.0 + \frac{2(6.0)}{3.0}\right](0.1)$

$= 0.7$

- $\frac{\partial q}{\partial y}\delta y = \left(x - \frac{x^2}{y^2}\right)\delta y$

$= \left[6.0 - \left(\frac{6.0}{3.0}\right)^2\right](0.1)$

$= 0.2$

$\delta q = \sqrt{0.7^2 + 0.2^2} = 0.728 = 0.7$

→ $q = xy + \frac{x^2}{y} = (6.0)(3.0) + \frac{(6.0)^2}{3.0}$

$= 18.0 + 12.0 = 30.0$

→ $\boxed{q = 30.0 \pm 0.7}$