

$a \Rightarrow$ measurement

$$\% \Delta a = \frac{\Delta a}{a} * 100$$

$\Delta a \Rightarrow$ absolute uncertainty

$\frac{\Delta a}{a} \Rightarrow$ fractional uncertainty

$\% \Delta a \Rightarrow$ % uncertainty

$$\textcircled{3} \quad R = \frac{V}{I}$$

$$\% \Delta R = \% \Delta V + \% \Delta I$$

$$\% \Delta R = (4\%) + (6\%) = 10\%$$

$$\% \Delta R = \frac{\Delta R}{R} * 100$$

$$\therefore \Delta R = \frac{\% \Delta R}{100} * R = \frac{(10\%)}{100} * 24\Omega = 2.4\Omega$$



$$\textcircled{4} \frac{\Delta l}{l} = 0.02$$

$$\underline{\% \Delta l} = \frac{\Delta l}{l} * 100 = (.02)(100) = \underline{2\%}$$

$$\% \Delta V = 3(\% \Delta l) = 3(2\%) = \textcircled{6\%}$$

$$\textcircled{5} \% \Delta m = \underline{4\%}$$

$$\% \Delta K = \underline{6\%}$$

$$T = 2\pi \sqrt{\frac{m}{K}} = 2\pi \left(\frac{m}{K}\right)^{1/2}$$

$$\% \Delta T = \frac{1}{2} (\% \Delta m + \% \Delta K) = \frac{1}{2} (4\% + 6\%) = \textcircled{5\%}$$

$$\textcircled{6} y = mx + b$$

$$y = _$$

$$x = _$$

$$m = _$$

$$b = _$$

Eqn	Constants	Variables to plot	Gradient	Vertical intercept	
$P = kT$	k	$P \checkmark$	$T \checkmark$	$k \checkmark$	0
$v = u + at$	u, a	$v \checkmark$	t	$a \checkmark$	u
$v^2 = 2as$	a	$v^2 \checkmark$	$s \checkmark$	$2a \checkmark$	$0 \checkmark$
$\lambda = -\omega^2 x$	ω^2	$x \checkmark$	$\lambda \checkmark$	$-\omega^2 \checkmark$	$0 \checkmark$
$V = \frac{kq_1q_2}{r}$	q_1, k	$V \checkmark$	$r^{-1} = \frac{1}{r} \checkmark$	kq_1q_2	$0 \checkmark$
$\frac{4\pi^2}{GM} R^3$	G, M	$T^2 \checkmark$	$R^3 \checkmark$	$\frac{4\pi^2}{GM}$	$0 \checkmark$

$\textcircled{8}$ typo on p.5 on packet in 2nd to last sentence

"can read to the nearest hundred th of a volt,
the uncertainty is $\pm 0.1V$."

typo, should be $\pm 0.01V$

(a) mass scale

$$5.344 \pm 0.001g$$

(b) graduated cylinder

$$67.0 \pm 0.5 \text{ mL}$$

$$\textcircled{9} \quad r^2 = \frac{2m}{qB^2} V$$

(a) A graph of r^2 against V will result in a line because the equation $r^2 = \frac{2m}{qB^2} V$ can be linearized/written in the form $y = mx + b$, where $y = r^2$, $x = V$, $m = \frac{2m}{qB^2}$, and $b = 0$.

(b) slope (gradient) = $\frac{2m}{qB^2}$

$$r^2 \pm \Delta r^2$$

$$r^2 = (r)^2$$

$$\Delta r^2 = \frac{r_{\max}^2 - r_{\min}^2}{2}$$

$$\% \Delta r = \frac{\Delta r}{r} \times 100$$

$$\% \Delta r^2 = 2(\% \Delta r)$$

$$\Delta r^2 = \frac{\% \Delta r^2}{100} * r^2$$

$$r_1^2 = (4.5 \text{ cm})^2 = 20.25 \text{ cm}^2 \quad \text{2 SF!}$$

$$\Delta r_1^2 = \frac{(4.6 \text{ cm})^2 - (4.4 \text{ cm})^2}{2}$$

$$\Delta r_1^2 = 0.9 \text{ cm}^2 \quad \boxed{20. \pm 1 \text{ cm}^2}$$

$$\% \Delta r_1 = \frac{0.1 \text{ cm}}{4.5 \text{ cm}} * 100 = 2.22\%$$

$$\% \Delta r_1^2 = 2(\% \Delta r) = 2(2.22\%) = 4.44\%$$

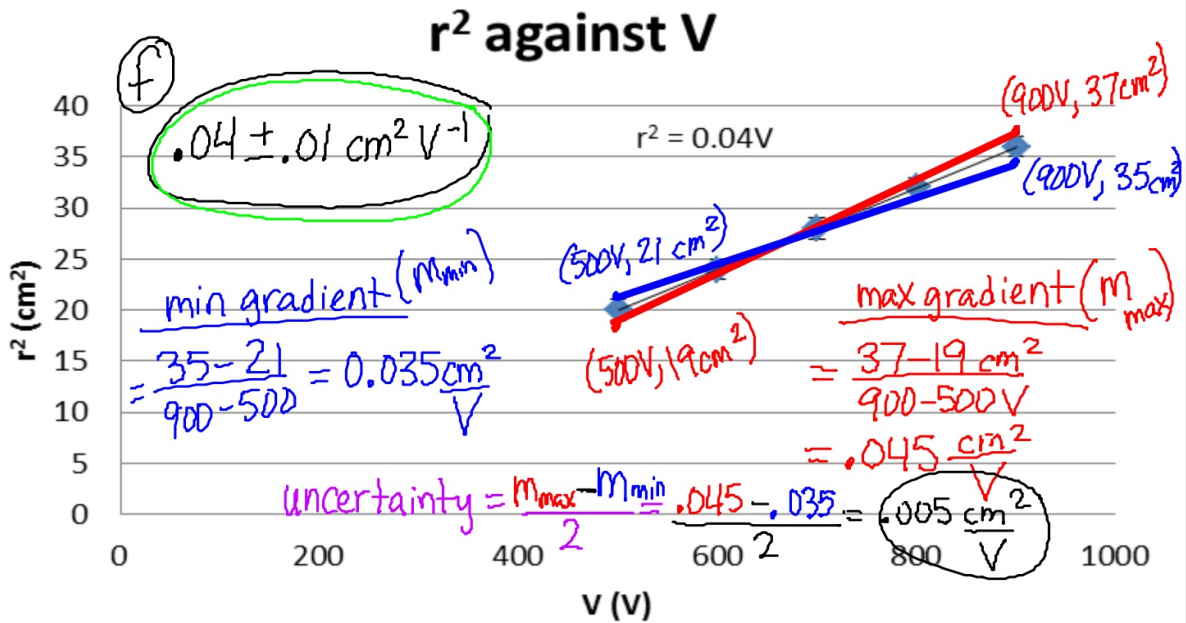
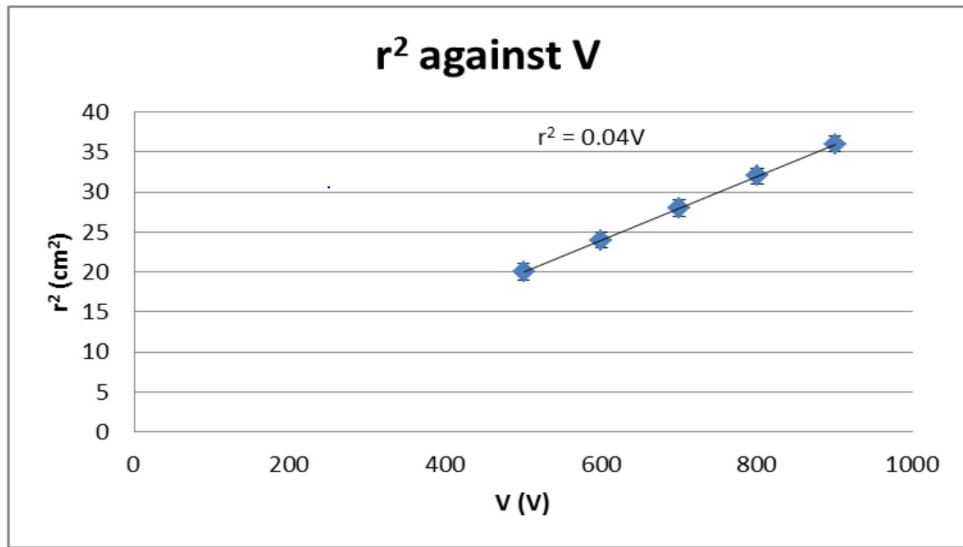
$$\Delta r_1^2 = \frac{\% \Delta r_1^2}{100} * r_1^2 = \frac{4.44\%}{100} * 20.25 \text{ cm}^2 = 0.8991 \text{ cm}^2$$

(c) r^2/cm^2

- 0V 20 ± 1
- 0V 24 ± 1
- 0V 28 ± 1
- 0V 32 ± 1
- 0V 36 ± 1

(e)

$$\text{gradient} = \frac{y_2 - y_1}{x_2 - x_1} = 0.04 \frac{cm^2}{V}$$



$$r^2 = \frac{2mV}{qB^2}$$

$$\therefore \frac{q}{m} = \frac{2V}{r^2 B^2} = \frac{2}{B^2} \left(\frac{V}{r^2} \right)$$

$$B = 1.80 \times 10^{-3} \text{ T}$$

$$\frac{V}{r^2} = \frac{1}{\text{slope (gradient)}} = \frac{1}{0.04 \text{ cm}^2 \text{ V}^{-1}}$$

$$\frac{q}{m} = \frac{2}{(1.80 \times 10^{-3} \text{ T})^2} \left(\frac{1}{0.04 \text{ cm}^2 \text{ V}^{-1}} \right)$$

$$\frac{q}{m} = 27777.78 \text{ VT}^{-1} \text{ cm}^{-2}$$

$$= 6944.44 \leftarrow$$

$$\frac{\Delta q}{m} = \frac{\% \Delta \frac{q}{m}}{100} * \frac{q}{m} = \frac{25\%}{100} * 27777.78$$

$$\% \Delta \frac{q}{m} = \% \Delta \frac{V}{r^2} = \% \Delta \frac{r^2}{V} = \% \Delta \text{ slope}$$

$$= \frac{.01}{.04} \times 100 = 25\%$$

$$(28 \pm 7) \times 10^3 \text{ VT}^{-1} \text{ cm}^{-2}$$