$a \Rightarrow$ measurement

$\Delta a \Rightarrow$ absolute uncertainty

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

$\% \Delta a \Rightarrow$ % uncertainty

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

③ $R = \frac{V}{I}$

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

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

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

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

2Ω

④ $\frac{\Delta l}{l} = 0.02$

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

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

⑤ $\%\Delta m = 4\%$

$\%\Delta K = 6\%$

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

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

⑥ $y = mx + b$

$y = \_\_$ ⇓ $x = \_\_$ ⇓ $m = \_\_$ ⇓ $b = \_\_$ ⇓

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

⑧ typo on p.5 on packet in 2nd to last sentence

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

typo, should be $\pm 0.01V$

(a) mass scale

$5.344 \pm 0.001 g$

(b) graduated cylinder

67.0 ± 0.5 mL

(9) $r^2 = \frac{2m}{qB^2} V$

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

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

$r^2 = (r)^2$

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

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

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

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

2SF!

$r_1^2 = (4.5 cm)^2 = 20.25 cm^2$

$\Delta r_1^2 = \frac{(4.6 cm)^2 - (4.4 cm)^2}{2}$ (4.5+.1, 4.5−.1)

$\Delta r_1^2 = 0.9 cm^2$ **20. ± 1 cm^2**

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

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

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

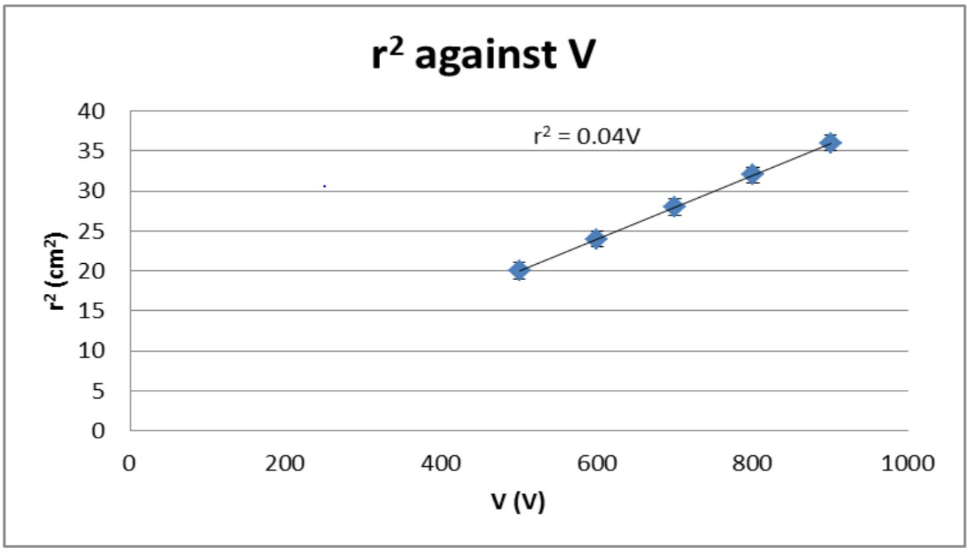
$= .8991 cm^2$

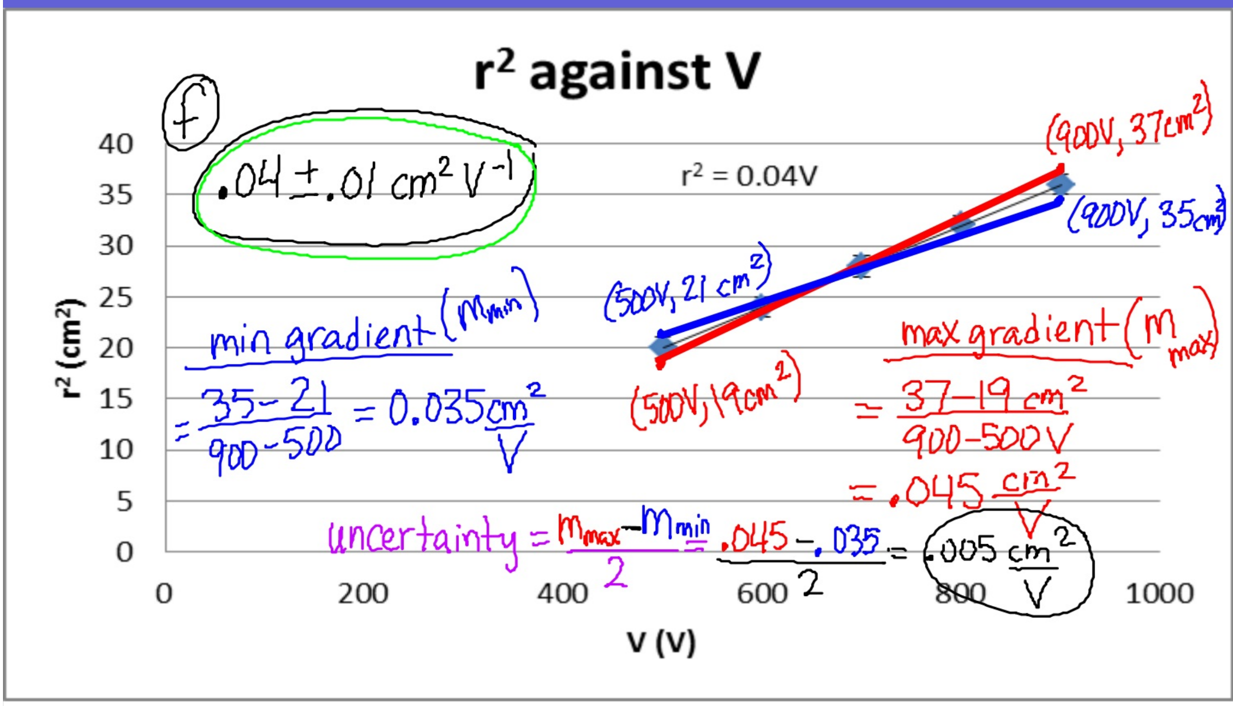
(c) r^2/cm^2

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

(e)

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





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

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

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

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

(gradient)

$$\frac{q}{m} = \frac{2}{(1.80\times10^{-3}T)}\left(\frac{1}{0.04\,cm^2V^{-1}}\right)$$

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

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

$= 6944.44$

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

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

$$(28 \pm 7)\times10^3\ VT^{-1}cm^{-2}$$