PHYS 399
HW # 1

2.4

a) $x = (3.3 \pm 1.4)$ mm

b) $t = (1.23 \pm 0.05) \times 10^{6}$ s

c) $\lambda = (5.33 \pm 0.03) \times 10^{-7}$ m

d) $r = (5.4 \pm 0.3) \times 10^{-7}$ mm

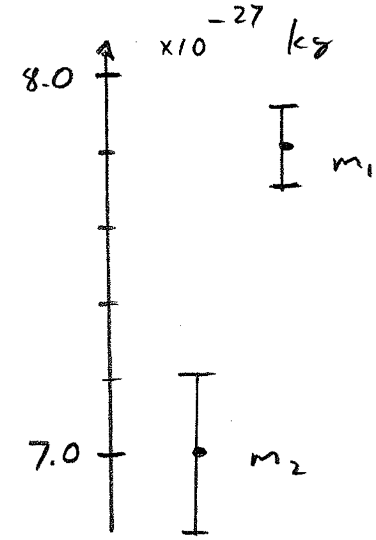
2.6

$m_1 = (7.8 \pm 0.1) \times 10^{-27}$ kg

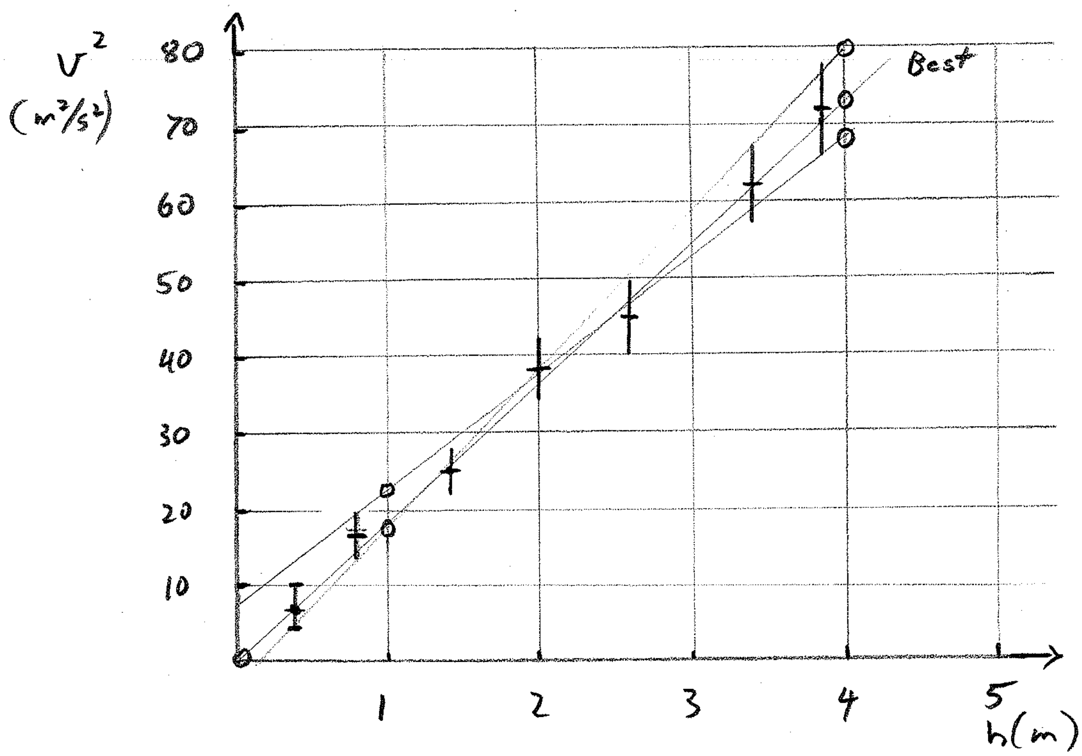
$m_2 = (7.0 \pm 0.2) \times 10^{-27}$ kg

Very unlikely to be the same particle.

Discrepancy is 8×10^{-28} kg (much larger than uncertainties)!



2.18



2.18/

a) It is consistent w/ $v^2 \propto h$

b) My "best fit" line has slope

$$m = 74/4.0 = 18.5 \ m/s^2$$

$$g = m/2 = 9.2 \ m/s^2$$

c) Max slope $= \dfrac{80-18}{4-1} = 20.7$

Min slope $= \dfrac{68-22}{4-1} = 15.3$ ← perhaps a bit too low

$$2g = (18 \pm 2) \ m/s^2 \quad \left(\text{really } {}^{+2}_{-3}\right)$$

$$g = (9.2 \pm 1.4) \ m/s^2$$ ← Made error symmetric

⇒ Perfectly consistent w/ accepted value $g = 9.8 \ m/s^2$

2.27/

a) $x = 6.1234 \quad \delta x = 0.02x = 0.12$

$$x = 6.12 \pm 0.12$$ ← 2 digits if less than 2 in leading digit.

b) $y = 1.1234 \quad \delta y = 0.02$

$$y = 1.12 \pm 0.02$$

The book rounds these all to 1 leading digit in the errors...

c) $z = 9.1234 \quad \delta z = 0.18$

$$z = 9.12 \pm 0.18$$

3.16 /

	δa	other	$\delta a^2 + \delta x^2$	quad.	linear
a + b	5	3	25 + 9	6	8
a + c	5	2	25 + 4	5	7
a + d	5	1	25 + 1	5	6
a + e	5	0.3	25 + 0.09	5	5

In quadrature, all can be ignored except for a+b. This is sometimes called the "factor of 2" rule. Any error less than ½ of the leading error will be nearly insignificant.

3.24 /

$$r = K \frac{D^2 V}{d^2 I^2}$$

Keep one extra digit for intermediate results...

First, find fractional uncertainty on measured values:

			Squared ?
$D = 661 \pm 2$ mm	$\delta D/D$ =	0.30%	0.6%
$V = 450 \pm 0.2$ V	$\delta V/V$ =	0.44%	0.4%
$d = 91.4 \pm 0.5$ mm	$\delta d/d$ =	0.55%	1.1%
$I = 2.48 \pm 0.04$ amps	$\delta I/I$ =	1.61%	3.2%

The error on the current I is going to dominate all other sources. Adding in quadrature

$$\frac{\delta r}{r} = \sqrt{\left(\frac{\delta I}{I}\right)^2 + \left(\frac{\delta d}{d}\right)^2 + \ldots} = 3.5\%$$

3.24/

We now must find r...

$$r = \frac{125}{32(4\pi \times 10^{-7})^2} \frac{1}{72^2} \frac{(661)^2\, 45.0}{(91.4)^2\,(2.48)^2} = 1.83 \times 10^{11}\ C/kg$$

$$\delta r = 0.06 \times 10^{11}\ (3.5\%\ \text{of}\ r)$$

$$r = (1.83 \pm 0.06) \times 10^{11}\ C/kg$$

b) Accepted value 1.759×10^{11} C/kg

discrepancy is 0.07×10^{11} which is just greater than the error of 0.06×10^{11}.

Result is (slightly) inconsistent!

3.31/

a) $\theta = 125 \pm 2°$

$$\delta(\sin\theta) = \left|\frac{d \sin\theta}{d\theta}\right| \delta\theta$$
$$= |\cos\theta|\, d\theta$$
$$= (0.57)(0.32)$$
$$= 0.02 \quad \hat{\text{radians}}!$$

$$\boxed{\sin\theta = 0.82 \pm 0.02}$$

b) $a = a_{best} \pm \delta a$

$f(a) = e^a \rightarrow f_{best} = e^{a_{best}}$

$$\delta f = \left|\frac{df}{da}\right| \delta a$$
$$= e^a\, \delta a$$

or $df/f = \delta a$

$a = 3.0 \pm 0.1$ $\boxed{f = 20 \pm 2}$

c) $f(a) = \ln a$ $\delta f = \left|\frac{1}{a}\right| \delta a$

$$\boxed{f = 1.10 \pm 0.03}$$

3.46

$x = 6.0 \pm 0.1 \qquad y = 3.0 \pm 0.1$

$$q = xy + x^2/y$$

Use general form (3.47)

First find partial derivatives:

$$\frac{\partial q}{\partial x} = y + 2x/y = 3.0 + \frac{12.0}{3.0} = 7.0$$

$$\frac{\partial q}{\partial y} = x - x^2/y^2 = 6 - 4 = 2.0$$

So

$$\delta q_x = \left|\frac{\partial q}{\partial x}\right| \delta x = 7.0 \times 0.1 = 0.7 \quad \leftarrow \text{This will dominate}$$

$$\delta q_y = \left|\frac{\partial q}{\partial y}\right| \delta y = 2.0 \times 0.1 = 0.2$$

$$\delta q = \sqrt{(\delta q_x)^2 + (\delta q_y)^2} = 0.7$$

$$\boxed{q = 30.0 \pm 0.7}$$