(391)

FIG L2.1

1) Error & Taylor 2-3

- rules for sig. figures? [2.2]

flipped style note [* uncertainty to 1 sig fig. (2 if ~1), then determines best value sig fig.]

- discrepancy? (Fig 2.1) [2.3]

~~accept~~ agreement accepted or exact value

precision is high (errors small)

- "interesting conclusions" compare 2 or more numbers

- though probable that ^true value [2.4]

lies between $x_{best} - \delta x < \text{value} < x_{best} + \delta x$

is possible it lies outside this range

compare |discrepancy| to $|\delta x|$

9.823

error of δx

0.2

So

9.8 ± 0.2 $\frac{m}{s^2}$

- provisional rules developed [2.5]

for $q = x + y$

$\delta_q = \delta x + \delta y$

- graphic representation + fit

include eg. when $y = Ax^2$

plot y vs. x^2 ⇒ straight line slope A

- fractional uncertainties [2.7]

if $x = x_0 \pm \delta x$, frac. uncertain ≡ $\frac{\delta x}{|x_0|}$

(b = best)

F16
2.2

1). continued) [2.7]

frac uncertainty (or relative uncerty or precision)

can be stated as %. no units?

- (not much here...) [2.8]

- mult 2 numbers [2.9]

state in terms of frac unc

$q = x \cdot y \Rightarrow$

$$x = x_b \left(1 \pm \frac{\delta x}{|x_b|}\right) \equiv \delta x_f, \quad y = \text{etc}$$

$$q_{max} = x_b \cdot y_b (1 + \delta x_f + \delta y_f + \delta x_f \delta y_f)$$

ignore this

$$q_{min} \doteq x_b \cdot y_b (1 - \delta x_f - \delta y_f)$$

$$\Rightarrow \quad q = q_b \left[1 \pm (\delta x_f + \delta y_f)\right]$$

provisional

Chapter 3

- "problems of definition" ⇒ challenges in estimating error [3.1]
- reporting measurements many times generally good

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File L2.3

1.) continued Chapt 3

- $\sqrt{\ }$ rule for counting (rates) [3.2] {stable time interval}

usual rule is $q = q_{obs} \pm \sqrt{q_{obs}}$

- provisional rules (not very compelling) [3.3]

$q = x + y \Rightarrow$

$\delta q = \delta x + \delta y$ (same for $-$)

$q = x \cdot y \Rightarrow$

$\frac{\delta q}{q} = \frac{\delta x}{x} + \frac{\delta y}{y}$ (same for $\div$)

- Two special cases [3.4]

1) $q = Bx$ no uncertainty in B

$\Rightarrow \delta q = |B| \delta x$

2.) $q = x^n \Rightarrow$ (n power)

$\frac{\delta q}{|q|} = n \frac{\delta x}{|x|}$

- here it gets interesting ?? [3.5]

if $q = x + y$, and measurement of $x \pm \delta x$ made randomly, so uncorrelated w/ measure of $y \pm \delta y$, then better est of error is

$q \pm \delta q = (x+y) \pm \sqrt{(\delta x)^2 + (\delta y)^2}$

FIG
L 2.4

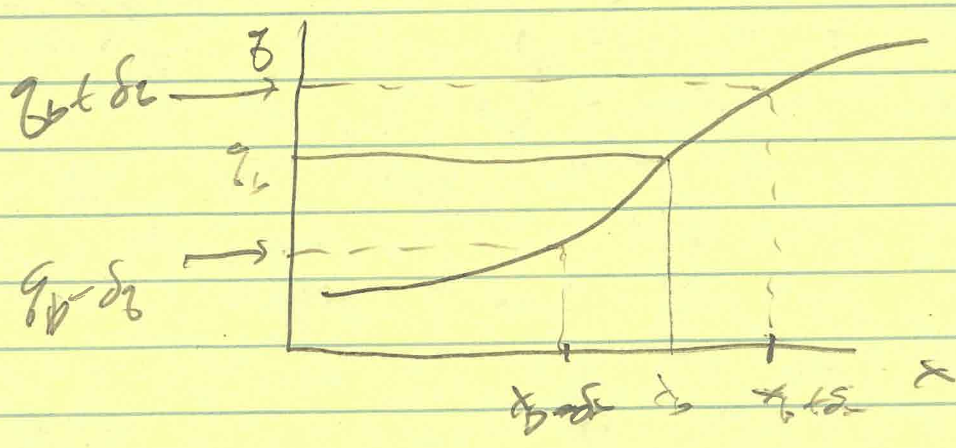
1.) Contd Chapt 3.

- continuing w [3.5]
  use adding error in quadrature
  $\delta_q = \sqrt{(\delta x)^2 + (\delta y)^2}$ when measurements
  are uncorrelated:
  one doesn't (likely) expect a larger measure of y
  when obs larger measure in x.

- $q = x \cdot y \cdot z \Rightarrow$ [3.6]

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

- fctn one variable [3.7]



Can use calculus to est δ_q?

$$\delta_q = q(x_0 + \delta x) - q(x_0)$$

FAC

$$q(x + u) - q(x) = \frac{dq}{dx} u \quad \epsilon$$

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F16
L25

(1,) cont'd

$\therefore \quad \delta q = \frac{dq}{dx} \delta x$

$\rightarrow \quad \delta q = \left| \frac{dq}{dx} \right| \delta x$

- some examples (3.8)

$q = x(y - z \sin \varphi)$

do $\sin \varphi$, then $z \sin \varphi$ for error
then $y - z \sin \varphi \Rightarrow$ error
then $\cdot x$ (above)

- examples (3.9 + 3.10)

- general formula (not provisional)
uncertainty in fctn of sev. variables
$q(x, y, \ldots)$

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

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reference Lec 7

L2.6

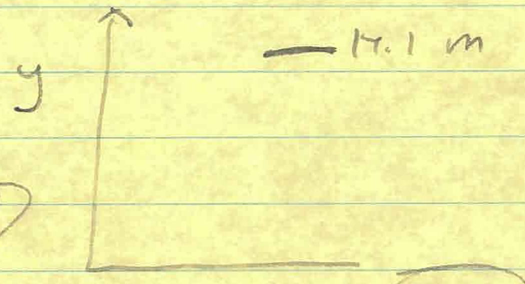
Sp 16 L2.6

2) Coding in for loops for air resistance

note, we didn't account for air resistance in previous problem?

$\Rightarrow$ could we fix this computationally? signs?

need new F on steel ball, $= F_g + F_{drag}$



$D = 2e^{-4}$

.00002

eqn $\frac{F_{tot}}{m} = a = \frac{v_f - v_i}{dt}$

$v_f - v_i = \left(\frac{F_{tot}}{m}\right) dt$

$v_f = v_i + \left(\frac{F_{tot}}{m}\right) dt$

what sets the #

$F_a = \frac{F_{tot}}{m} = ge - \frac{F_d}{m}$

$= ge - Dv^2$

$= ge - D(v_{avg})^2$

$\frac{h_f - h_i}{dt} = v_{avg} * dt$

ge = -9.8 (trial)

$v = v_f$

$v_f = \frac{v_{avg}}{dt}$

$v_{avg} = \frac{y(i)-y(i-1)}{dt}$

$v_{avg}\ dt$

```
y(1) = 14.1
t(1) = 0
Vi = 0
dt = 0.1 (s)
Fam = ge
V(1) = Vi + Fam * dt
Vavg = 0.5 * V(1)
y(2) = y(1) + Vavg * dt
for i = 2 : 1000
    Fd = + D*Vavg(i-1)^2;
    Fam = ge*m + Fd;
    V(i) = Vi + (Fam/m) * dt;
    Vavg(i) = (Vi + V(i))/2;
    Vi = V(i);
    y(i) = y(i-1) + Vavg(i) * dt;
```