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391
[illegible]
L1-6

2) Error continued

i) error estimation: measured w/ meter stick 30.9 cm means measuring to ± 0.1 mm hard to do. Likely could measure to ± 0.5 cm

⇒ measurement stated as $l_i = (30.9 \pm 0.5)$ cm ("standard")

ii) measures ∧ 10 complete oscillations each time, does error prop →

(32. ± 2) cm → from Taylor Chpt. 3

⇒ OK measurements by itself? yes

b.) why study error part 2

1904-05 (15), Einstein postulates special then general theory of relativity.

predicts light passing our sun bent by $\alpha_R = 1.8''$ (seconds of arc), double the $\alpha_c = 0.9''$ predicted by "classical" arguments

1920 Dyson, Eddington, Davidson do "small experiment" & get ~~$\alpha = (2.0 \pm 0.3)''$~~ show later

Eddington → Principe (island w of Africa)
Dyson → Sobral, Brazil

why 2 measures?

observed stars "near" Sun during eclipse to compare angular separation bent by sun, and unbent by sun (at night, other than eclipse) at 2 places on Earth

(writing) sci. adv. books turn into blockbuster movies: Capt. Jack Sparrow Scarlett kidnaps Dyson, etc.

→ result consistent with G.R. but not classical ←

$\alpha = (2.0 \pm 0.3)''$

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3) Intro to scientific programming (to L1-75)

- suppose we want to "simulate" a ball dropped from 14.1 m height above the floor?

do this with ball drop video

- first, "simulate" means to write a computer program that gives details about the balls position during the drop, etc.

- second, let's make some assumptions. We will initially ignore air resistance (drag), but want to add this in later.

(P)

(391)

F17
L1-7b

3) Intro to Intro to Scientific Programming

? Suppose we want to simulate a ball drop?

- 1st, simulate means to develop a computer code that gives fine-grained details about the ball's position, velocity, acceleration vs. time, as it drops.

(step 1) - 2nd we have assumptions and initial conditions. Assumption: for now we ignore air resistance but will add in later

could solve for, say, drop time analytically, but much much harder to do with air resistance

(step 2) - Draw experiment to help visualize. (our later graphs also should help visualize). For simulation, think of creating high speed video of drop, get info frame by frame

need initial conditions:

(step 3)

$mass = m = ??$

ball shape = ? = ??

accel gravity constant = g = ?? on Earth? elsewhere?

are we near planet's surface?

color of ball?

dropping through normal air?

T of air through which dropped?, density?

initial height = y_i = ??

initial velocity = v_i = ??

initial accel of ball = a_i = ??

(39)

[F17
L1-8]

3) contd Sci. Proj.

(step 3b) assign symbols to characteristics
e.g. y = height
v = velocity, etc.
(will need to do this, also, in code)

(step 4) consider physics to get "governing equations" ("theory")

$F_{tot} = ma \Rightarrow \frac{F_{tot}}{m} = a = \frac{v_f - v_i}{\Delta t}$

Δt = time step, you choose!

further: $v_f = v_i + \frac{F_{tot}}{m} \Delta t$ ⟸ (looks useful)

and $\bar{v} = \frac{y_f - y_i}{\Delta t} \Rightarrow y_f = y_i + \frac{\bar{v}}{\Delta t}$

gives new ball position (y_f) ~~after time step Δt~~ + ball velocity (v_f) ~~then~~ after Δt

also $t_f = t_i + \Delta t$ helps develop "time array"

(a few words about "arrays")

F17
L1-9

3) cont'd Sci. Prog.

Step 5

construct "function*" (bit of computer code) to simulate ball drop. We give the function initial conditions, it gives us arrays t, y, v, a, etc

[Call part]

you choose which

[set some! constants, initial conditions]

["for" or "while" loop, step through ball drop in steps Δt]

(if time) note that we:

a) described the scene both pictorally + with symbols, before charging ahead

b) we made assumptions (ignore air resistance) + used physics to develop specific "theory" in form on governing eqns

c) built "function" using a standard form

* function here is a bit of code, not something like $F=ma$