Name: David Jelts

Be sure to use correct units and significant figures throughout all your answers.
Showing full work for answers will unlock possible partial credit. Save as .pdf and upload to Canvas assignment.

1. The average human hair grows 1.5cm longer per month. After a 2 hour 45 minute physics lab how much longer will your hair be in <u>μm</u> from the time lab started? FYI: average human hair width is 17-180μm.

$.015 \frac{m}{\cancel{mo}} \cdot \frac{\cancel{mo}}{30.416 \cancel{days}} \cdot \frac{\cancel{day}}{24 \cancel{hrs}} \cdot \frac{\cancel{hr}}{60 \cancel{min}} \cdot 165 \cancel{min} = 5.651 \times 10^{-5}\ m = 56 \mu m$

$2h\ 45m = 165 min$

2. (a) How many regulation sized ping pong balls would fill the entire volume of a standard size faculty member's office in the College of Arts & Sciences (125sqft with 9ft ceilings)? Assume you can obtain the optimal sphere packing fraction of 74% volume. radius of PPB: $\frac{1.5in}{2} = .0625 ft$

$V_{facility} = 125ft^2 \cdot 9ft = 1125 ft^3$

$V_{PPB} = \frac{4}{3}\pi(.0625ft)^3 = .00102 ft^3$

Packing fraction: $V \cdot .74 = 832.5 ft^3$

$\frac{V_{facility}}{V_{PPB}} = \frac{832.5 ft^3}{.00102 ft^3} = 814058$ ping pong balls

(b) Same question, but for regulation tennis balls.

r of tennis ball $= \frac{2.635 in}{2} = 1.3175 in = .10979 ft$

$V_{TB} = \frac{4}{3}\pi(.10979ft)^3 = .0055 ft^3$

$\frac{V_F}{V_{TB}} = \frac{832.5 ft^3}{.0055 ft^3} = 150171$ tennis balls

3. How long is the Legacy walk (including an uncertainty) in <u>meters</u> from where it starts opposite the roadway from Henderson Building to where it ends at the landscaping below the Eagle/Plane sculpture? You must devise a physical means of measuring the distance, NOT using a map or app. Explain your measurement method including an estimate of your uncertainty. Error propagation will probably be necessary, if so show it.

1192.5 ± 10 David Feet $\cdot \frac{32cm}{1 \text{ David ft}} \cdot \frac{1m}{100cm} = 381.6 \pm 3.2m$

Our method of measuring the legacy walk was to measure the number of shoe lengths it was. My shoe is about 32cm.

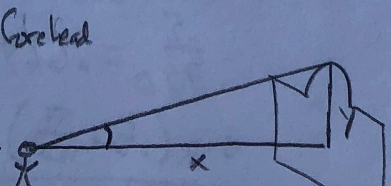
The uncertainty is based off of accidentally missed counting & walking perfectly with feet exactly in line.

4. Devise a measurement method to determine the vertical height from ground level to the top of the telescope dome of the COAS Building, without the ability to be on the building's roof. Describe your method and give an estimation for this height. Hint: Think how you would estimate the height of a tree without climbing it.

$x = 133$ David Feet $\cdot \frac{32.0cm}{1 \text{ David ft}} = 4256cm$

$\theta = 55°$ from Rahil's forehead

$Y_2 = 170cm$



144 57°

$\tan\theta = \frac{y}{x}$

$y = x \tan\theta$

$y = 4256 \tan(55 \cdot \frac{\pi}{180})$

$y = 6078.2cm$

$y + Y_2 = 6248.2cm = 62 \pm 5m$

5. The equation that describes the motion of an object is $s = \frac{1}{2}at^2 + v_o t + s_o$, where *s* is position, *a* is acceleration, *t* is time, and *v* is velocity. Using standard SI units, show that the dimensional units in the equation are consistent. $a = \frac{m}{s^2}$ $v = \frac{m}{s}$ $s = m$ $t = s$

$m = \frac{1}{2}\left(\frac{m}{s^2}\right)(s)^2 + \left(\frac{m}{s}\right)(s) + m$

$m = \frac{m}{\cancel{s^2}}\cancel{s^2} + \frac{m}{\cancel{s}}\cancel{s} + m \Rightarrow m = m + m + m \Rightarrow m = m$

6. Give the number of significant figures in each of the following numbers:

a. 112.4±0.2 4
b. 10.0 3
c. 3.14159 6
d. 1700 2
e. 1250±50 3
f. 5.0030 5
g. 9.33x10³ 3
h. 0.02240 4

7. Discuss the merits and drawback of using a person's foot as a length standard in terms of accessibility, invariability, indestructibility, reproducibility, and uncertainty. Consider both *(a)* a particular person's foot, and *(b)* any person's foot.

Accessibility - a) foot of Queen Elizabeth II Can be hard if you need the
b) Everyone (usually) has a foot. Very easy access

Invariability a) As long as the person is an adult the magnitude won't change
b) very high variability because everyone's foot size will be slightly different

Indestructibility - a) & b) Most peoples' feet are fairly indestructable, excluding rare bone disorders

Reproducability - a) It is easy to reproduce results when you use only 1 foot from a specific person
b) Every person's foot is a slightly different size so no reproducability when using just "a foot" instead of "her foot"

Uncertainty - a) Uncertainty will be in mm after adulthood
b) Uncertainty will be large, possibly on an order of inches

8. You measure the radius of a wheel to be 4.16cm. If you multiply by 2 to get the diameter, should you record the result as 8cm or 8.32cm? Justify your answer.

8.32cm; 2 is an exact constant and effectively has an infinite amount of significant figures. When multiplying you stick with the lowest amount of significant figures and 3 < ∞

9. What is the percent uncertainty for each of the following measurements?

a. 3.75±0.25m

$\frac{.25}{3.75} \cdot 100 = 6.67\%$

b. 116.3±0.1g

$\frac{.1}{116.3} \cdot 100 = .08598\%$

10. Find the percent uncertainty in θ and in sinθ for the two following measurements. Note: for error propagation of sinθ the uncertainty in θ must be in radians where 180° = π radians.

a. θ=15.0°±0.5°

$\frac{.5}{15.0} = 3.33\%$

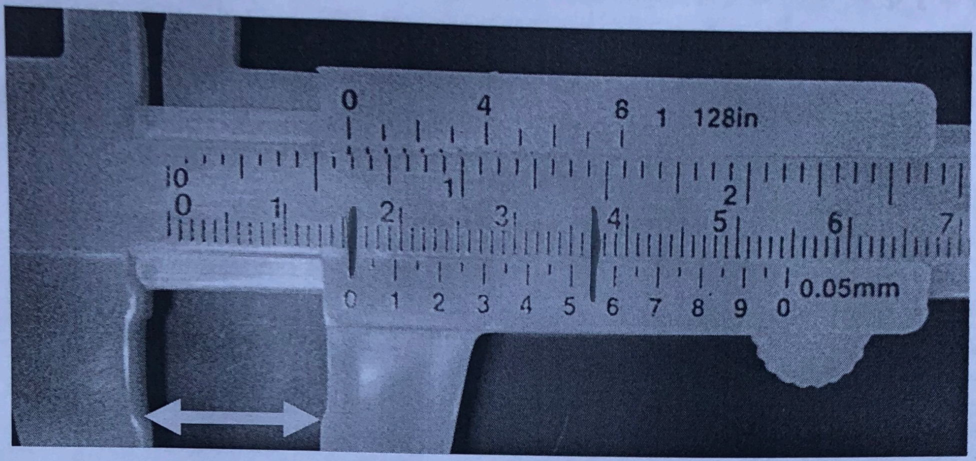
$\frac{\sin\left(.5 \cdot \frac{\pi}{180}\right)}{\sin\left(15 \cdot \frac{\pi}{180}\right)} = 3.33\%$

b. θ=75.0°±0.5°

$\frac{.5}{75.0} = .667\%$

$\frac{\sin\left(.5 \cdot \frac{\pi}{180}\right)}{\sin\left(75 \cdot \frac{\pi}{180}\right)} = .667\%$

11. Given the image, what is:

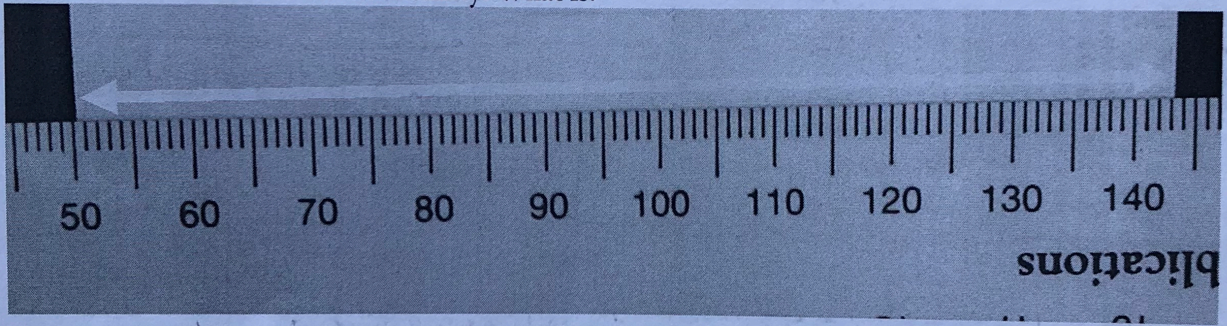


(a) The resolution of the Vernier caliper [mm]? 1mm

(b) The width reading on the Vernier caliper in [mm]? 15.55mm

(c) The uncertainty of the above width reading in [mm]? ±.05mm

12. The ruler in the image is marked to the nearest mm. Note: Each edge measurement is technically a position measurement with its own uncertainty. What is:



(a) The resolution of the ruler in [mm]? 1mm

(b) The position measurement uncertainty you feel possible with the ruler in [mm]? ±.5mm

(c) The width of the piece of paper in [mm]? 43mm

(d) The propagated uncertainty on the paper width in [mm]?

$$\delta = \sqrt{(1 \cdot .5)^2 + (1 \cdot .5)^2}$$

$$= \sqrt{.25 + .25}$$

$$= \sqrt{.5} \approx .71\text{mm}$$