Unit Conversion For each of the following, convert the physical quantity into the specified units.

a) $32\frac{m}{s} = ?\frac{km}{h}$

b) $1000\frac{kg}{m^3} = ?\frac{g}{cm^3}$

c) $9.8\frac{m}{s^2} = ?\frac{cm}{s^2}$

a) $32\frac{m}{s}\left(\frac{1\ km}{1000\ m}\right)\left(\frac{60\ s}{1\ min}\right)\left(\frac{60\ min}{1\ hr}\right) = 115.2\ \frac{km}{h}$

b) $1000\frac{kg}{m^3}\left(\frac{1\ m}{100\ cm}\right)^3\left(\frac{1000\ g}{1\ kg}\right) = 1\ g/cm^3$

c) $9.8\frac{m}{s^2}\left(\frac{100\ cm}{1\ m}\right) = 980\frac{cm}{s^2}$

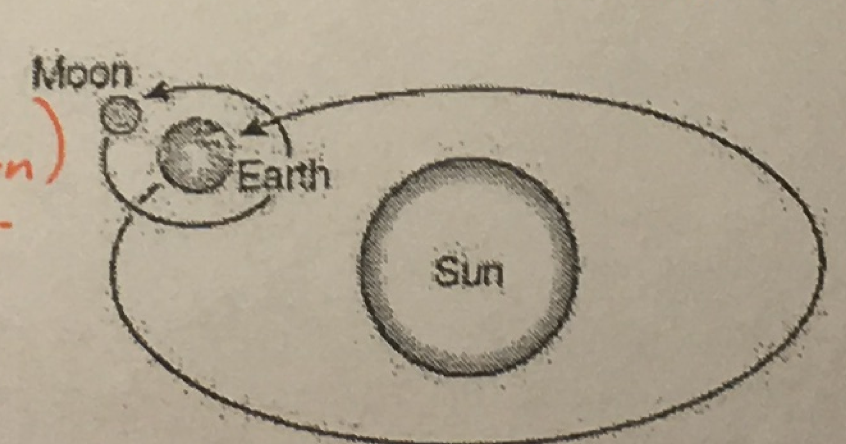
Sun vs. Moon The famous 17th century physicist Isaac Newton was the first person to mathematically describe the principle of gravity. We can summarize Newton's Law as it applies to the interaction between planet Earth and other celestial bodies in the following equation:

$$F = \frac{GM_{\oplus}m}{r^2}$$

In this equation, $M_{\oplus}$ is the mass of the Earth, m is the mass of the other body, and r is the distance between said object and Earth. G is a constant factor, and F is the resultant force the planet Earth feels as a response to this gravitational tug.

The sun is approximately 2.7×10^7 times more massive than the moon. However, the Sun is also 380 times farther away from the Earth than the moon. How much stronger is the Sun's gravitational pull on Earth compared to the moon's gravitational pull? ratio

$$F_{sun\text{-}earth} = \frac{GM_{\oplus}(2.7\times10^7 \cdot m_{moon})}{(380\cdot r_{moon})^2}$$



$$F_{moon\text{-}earth} = \frac{GM_{\oplus}m_{moon}}{r_{moon}^2}$$

$$\frac{F_{sun\text{-}earth}}{F_{moon\text{-}earth}} = \frac{\left(\frac{GM_{\oplus}(2.7\times10^7\cdot m_{moon})}{(380\cdot r_{moon})^2}\right)}{\left(\frac{GM_{\oplus}m_{moon}}{r_{moon}^2}\right)}$$

$$= \left(\frac{GM_{\oplus}\,2.7\times10^7\, m_{moon}}{380^2\cdot r_{moon}^2}\right)\left(\frac{r_{moon}^2}{GM_{\oplus}\, m_{moon}}\right)$$

$$= \frac{2.7\times10^7}{380^2} \simeq 187$$

=> the sun's gravitational pull on Earth is 187 times stronger than the moon's.

Dimensional Analysis:

Frustum of a Cone The figure shows a frustum of a cone. Match each of the three expressions:

C 1. $\pi(r_1 + r_2)[h^2 + (r_2 - r_1)^2]^{1/2}$ → ([length] + [length])([length]^2 + ([length] − [length])^2)$^{1/2}$ → [length]^2

A 2. $2\pi(r_1 + r_2)$ → [length] + [length] → [length]

B 3. $\pi h(r_1^2 + r_1 r_2 + r_2^2)/3$ → [length]([length]^2 + [length][length] + [length]^2) → [length]^3

with the quantity it describes:

expect:

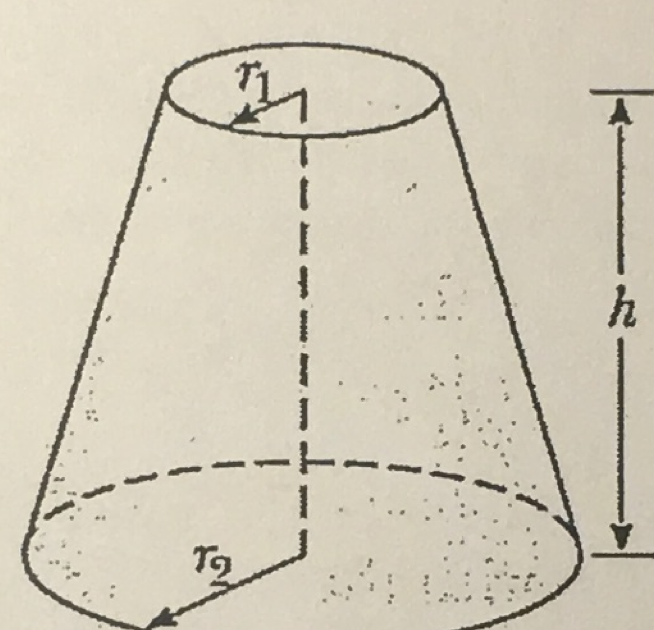
[length] → A the total circumference of the flat circular faces

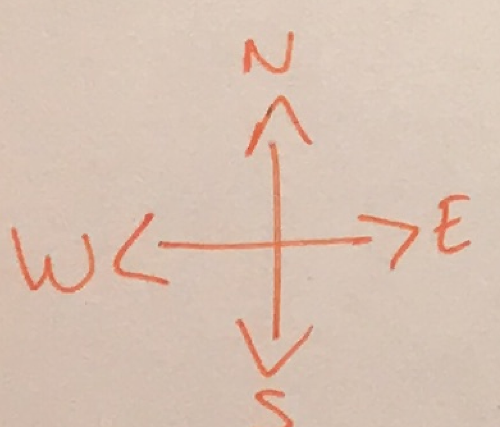
[length]^3 → B the volume

[length]^2 → C the area of the curved surface.

Show your work and explain your reasoning.

* can also match to familiar equations





Sally Bicycles Around Campus Sally bicycles from her dorm 500 meters north and then 500 meters east to get to her physics class. After physics class is done, she then proceeds to bicycle 200 meters south and 700 meters east to get to her biology class.

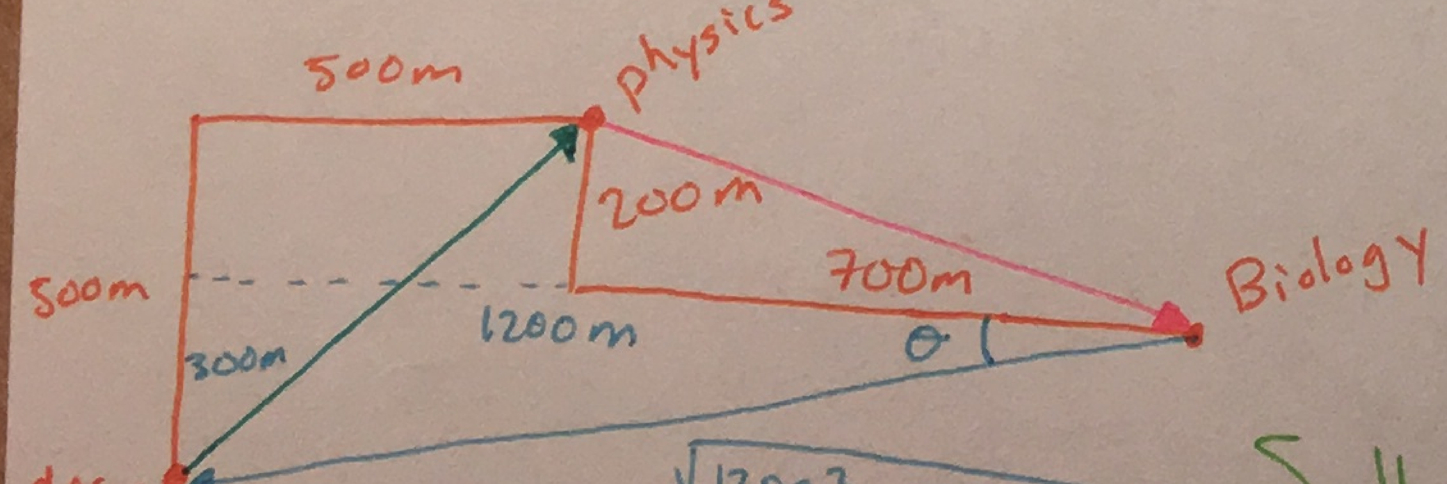
Write vectors in component form to represent Sally's trip from:

- her dorm to physics class
- physics class to biology class

How should Sally bike to get back to her dorm from biology class? Express it both in word and vector form.

For each of these, determine what the magnitude and direction (angle) of the vector is.

You can assume east to be the +x direction, and north to be the +y direction.



⟨500m, 500m⟩

⟨700m, 200m⟩

⟨1200m, 300m⟩

$\sqrt{1200^2 m + 300^2 m} \approx 1237m$

Sally should bike 1237m in a direction 14° south of west.

SOH-CAH-TOA

accidentally found opp. angle

$\tan\theta = \frac{1200m}{300m}$ (oops) $\frac{300m}{1200m}$

$\theta = \tan^{-1}\left(\frac{1200m}{300m}\right)$ (oops) $\left(\frac{300m}{1200m}\right)$

~~θ = 76°~~ (oops)

θ = 14°