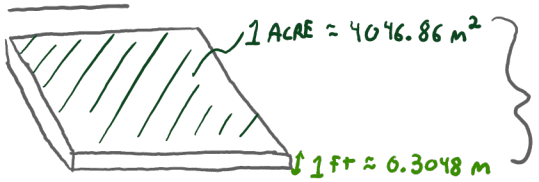
**Week 0 Challenge HW**

A unit of volume of water that engineers often use is the *acre-foot*, which equals the volume of water that will cover an acre of land to a foot depth. It rains a lot at OSU.

(a) If Corvallis receives two inches of rain in an 4 hours, what volume of water, in acre-feet, fell on our town.
(b) Use *Dimensionality* sense-making to check any conversions made and your final answer to part (a). (c) How many pint glasses would this fill?
(d) How many Olympic-size swimming pools would this fill?
(e) Use *Related Quantities* sense-making to compare your answers in part (c) and (d).
(f) Estimate how many water droplets this is, stating any assumptions and citing any data sources.

PHYSICAL REPRESENTATION



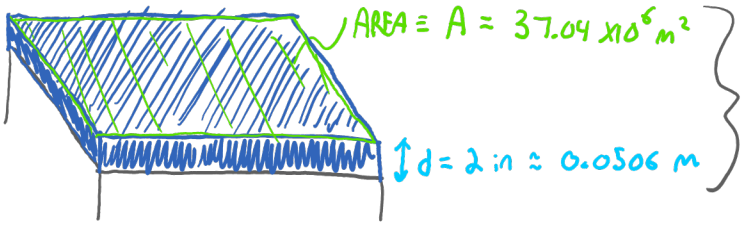

MATH

... So CONVERSION OF ACRE-FOOT TO $m^3$ ...

1 ACRE-FOOT ≈ $(4046.86\ m^2)(0.3048\ m)$

1 ACRE-FOOT ≈ $1233.483\ m^3$

(a)




... SO VOLUME OF WATER ...

$V = Ad$

$V = (37.04 \times 10^6\ m^2)(0.0506\ m)$

$V \approx 1881632\ m^3$

* GOOGLE SEARCH "ARE OF CORVALLIS IN SQUARE METERS"

08/18/2019

$V \approx 1881632\ m^3 \times \frac{1\ \text{ACRE-FOOT}}{1233.483\ m^3} \approx 1525.5\ \text{ACRE-FOOT}$

$V \approx 1530\ \text{ACRE-FOOT}$

(b)

$V = (A \cdot d)$

$(m^2 \cdot m) = m^3$ ✓ :)

$m^3 \times \frac{1\ \text{ACRE-FOOT}}{m^3} = \text{ACRE-FOOT}$ ✓ :)

**Instructor Guide (a,b):**

1. Drawing a clear physical representation is a very important first step.
2. Encourage students to approximate Corvallis as a square/rectangle when drawing representation. This helps with how to find volume (length x width x height)

(c)

CONVERSIONS

$1\ m^3 = 2113.38$ PINTS

MATH

$$1891632\ m^3 \times \frac{2113.38\ \text{PINTS}}{1\ m^3} \approx 3.9766 \times 10^9\ \text{PINTS}$$

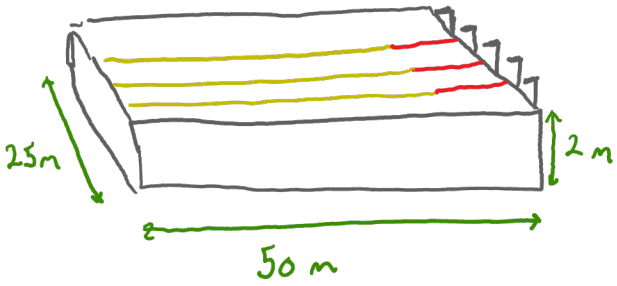
SO WE WOULD NEED ABOUT $3.98 \times 10^9$ PINT GLASSES TO CONTAIN THE VOLUME OF RAIN WATER THAT FELL IN THOSE 4 HOURS IN THE PROBLEM STATEMENT...

... HOPE YOU'RE THIRSTY!

(d)

PHYSICAL REPRESENTATION

OLYMPIC SWIMMING POOL




*GOOGLE SEARCH "OLYMPIC SWIMMING POOL DIMENSIONS" 09/18/2019

... SAMPLE CONVERSION FOR 1 OLYMPIC POOL TO $m^3$ ...

1 OLYMPIC POOL = (50m)(25m)(2m)

1 OLYMPIC POOL = $2500\ m^3$

$$1891632\ m^3 \times \frac{1\ \text{OLYMPIC POOL}}{2500\ m^3} \approx 752.65\ \text{OLYMPIC POOLS}$$

SO WE WOULD NEED ABOUT 753 OLYMPIC POOLS TO CONTAIN THE VOLUME OF RAIN WATER.

(e)

# PINT GLASSES ~ $10^9$

# OLYMPIC POOLS ~ $10^2$

SO OUR ANSWERS TO # PINT GLASSES AND # OLYMPIC POOLS MAKE SENSE B/C THE ORDER OF MAGNITUDE OF PINT GLASSES IS MUCH MUCH LARGER THAN THAT OF POOLS. I.E. PINT GLASSES ARE MUCH MUCH SMALLER THAN OLYMPIC POOLS.

**Instructor Guide (c,d,e):**

1. Encourage students to look up dimensions of Olympic pool rather than volume because you can go to a pool and measure length, width, and height, but can't directly measure volume.
2. Find a pint glass (or any water bottle that is roughly that size) to help visualize how small a pint glass is in comparison to the room you are in, then by extension an Olympic pool.

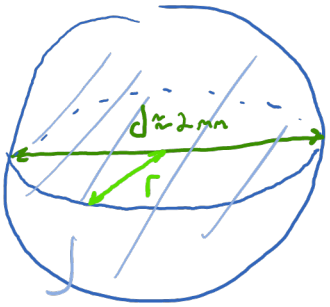
(F)

PHYSICAL REPRESENTATION

WATER DROPS ARE BASICALLY SPHERES WITH A DIAMETER OF ABOUT $d$ $\sim 1\,mm \rightarrow 3\,mm$

pmm.nasa.gov/education/anatomy-raindrop

ACCESSED 08/18/2019




$V_{RAIN\ DROP}$

GEOMETRY

$$V_{RAIN\ DROP} = \frac{4}{3}\pi r^3 \qquad r = \frac{d}{2}$$

MATH

$$V_{RAIN\ DROP} = \frac{4}{3}\pi\left(\frac{d}{2}\right)^3$$

$$V_{RAIN\ DROP} = \frac{1}{6}\pi d^3$$

$$= \frac{1}{6}\pi\left(2\times10^{-3}\right)^3$$

$$V_{RAIN\ DROP} = 4.18879 \times 10^{-9}\ m^3$$

$$\text{TOTAL VOLUME OF RAIN} \times \frac{1\ \text{RAIN DROP}}{\text{VOLUME OF 1 DROP}} = \#\ \text{RAIN DROPS}$$

$$1881632\ m^3 \times \frac{1\ \text{RAIN DROP}}{4.18879\times10^{-9}\ m^3} = 4.49207 \times 10^{14}\ \text{DROPS}$$

SO THE VOLUME OF WATER IN THE PROBLEM STATEMENT IS EQUIVALENT TO ABOUT $4.49 \times 10^{14}$ AVERAGE SIZED RAIN DROPS

**Instructor Guide (f):**

1. Encourage students to take an initial guess the **shape** of a raindrop.
2. Use a metric ruler to help estimate the diameter of the raindrop if needed.