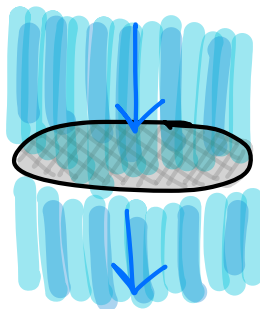## Flux & the Flux Integral

Flux : Flow Rate

- volume of fluid passing through a surface per unit time

Most Basic Case

- fluid has constant velocity
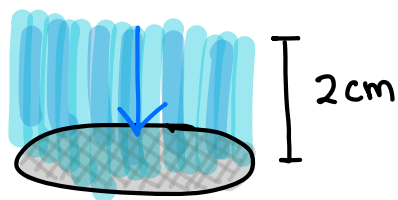- surface is flat & $\perp$ fluid velocity

flat drain

area : 20 cm²

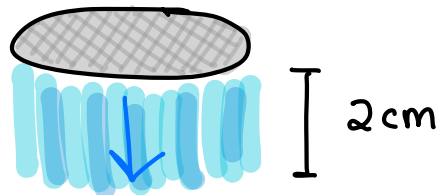water flows straight through

speed : 2 cm/sec.

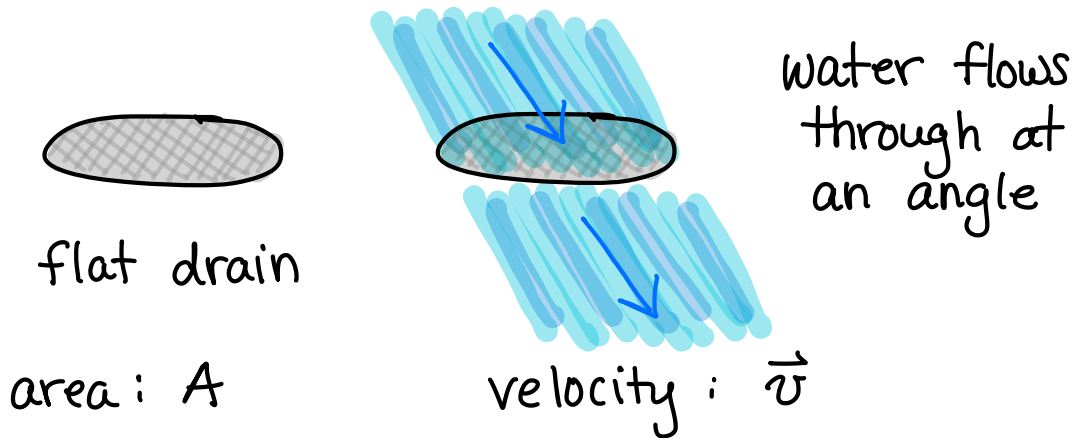How much water passes through drain per second?
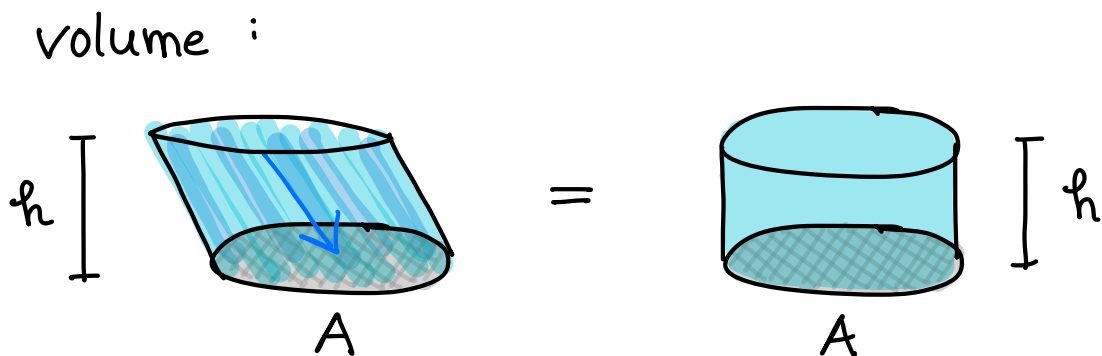
2cm

1 sec.

2cm

volume : _____ × _____ = _____

Flow Rate : speed × area = _____

Basic Case

- fluid has constant velocity
- surface is flat

flat drain

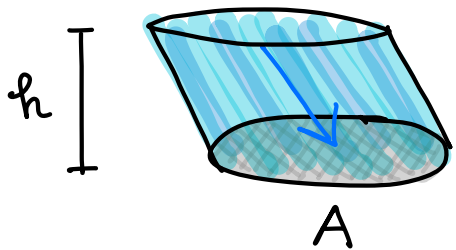area: A

velocity: $\vec{v}$

water flows through at an angle

How much water passes through drain per second?
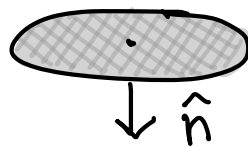
1 sec.

volume:

h

A

=

h

A
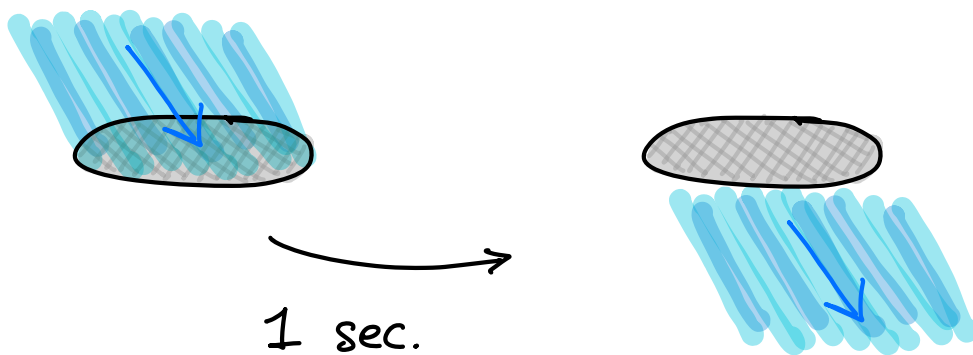
Need to find h.

volume :

unit normal for surface: $\hat{n}$

$h =$ scalar component of $\vec{v}$ parallel to $\hat{n}$ $=$ _____

volume $= ($ ___ $)($ ___ $) =$ ___ $($ $)$

area vector : $\vec{A} = A\hat{n}$

$\Rightarrow$ volume $=$ _____

Flow Rate : _____ ("flux")

Flux Integral

If the fluid velocity is NOT _____
or if the surface is NOT _____ we
typically need a flux integral.

Divide surface into small patches
- $\vec{F}$ approx const.
- patch approx flat

$\Big\}$ flux thru' $\approx \vec{F} \cdot \Delta\vec{A}$ patch

$\begin{matrix} \text{Total} \\ \text{Flux} \end{matrix} = \int_S \vec{F} \cdot d\vec{A} = \int_S (\vec{F} \cdot \hat{n})\, dA$