



## Announcements

- CBTF Quiz 7 this week!
- Last day of office hours and Piazza help: Wed, Dec. 13

### ☐ Upcoming deadlines:

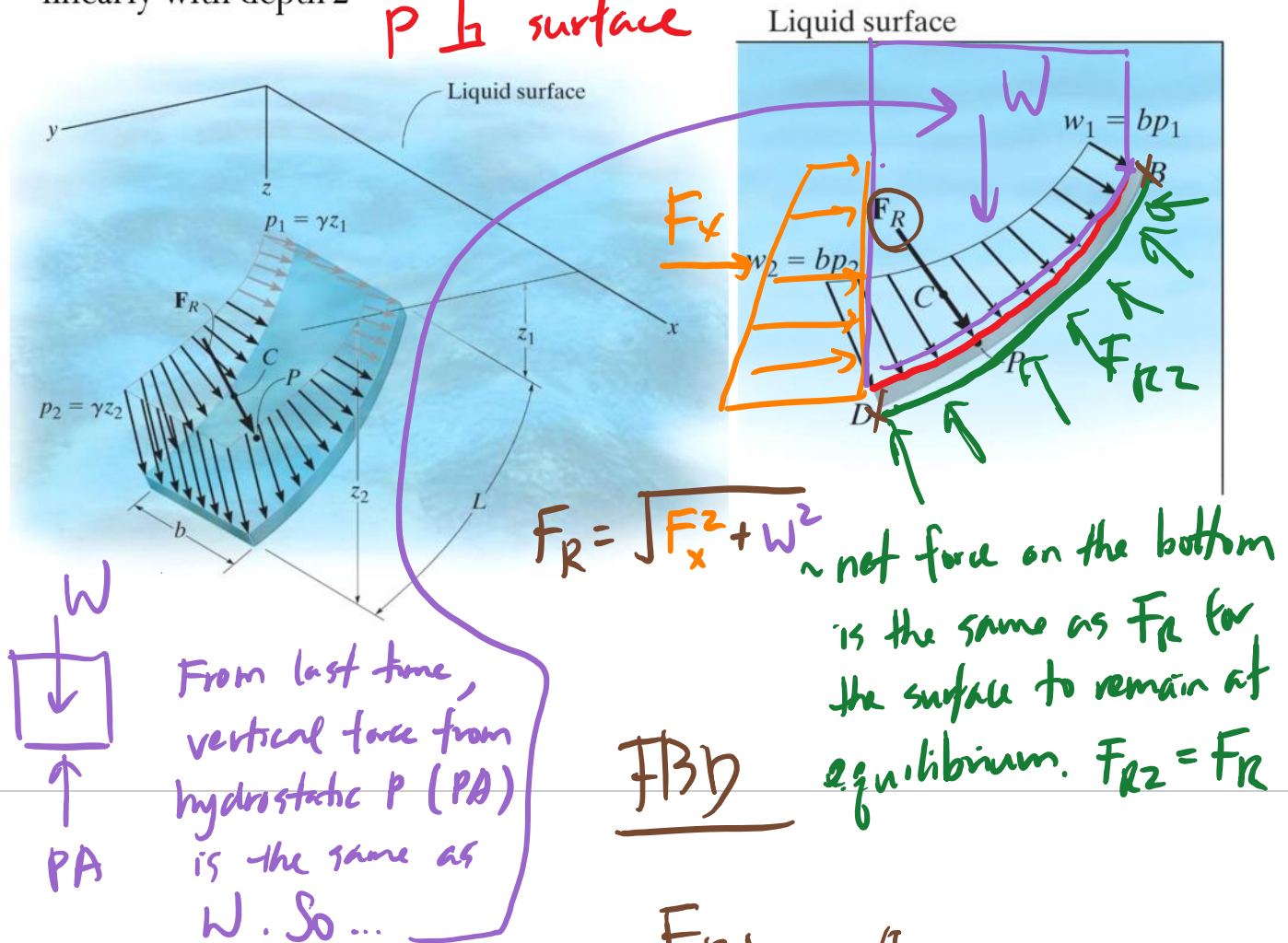
- Tuesday (12/5)
  - PL HW24
- Saturday (12/9)
  - ME HW27



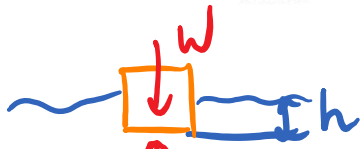
## Recap: Fluid Pressure

For an incompressible fluid at rest with mass density  $\gamma$ , the pressure varies linearly with depth  $z$

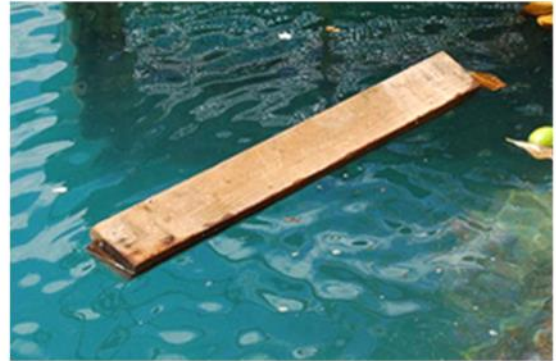
$P \perp$  surface



When a rectangular block of wood of cross sectional area  $A$ , height  $h$ , and mass  $m$  is placed in a lake. How far below the surface  $z$  is the bottom of the block? ( $\rho_{\text{water}} = 1 \text{ Mg/m}^3$ )

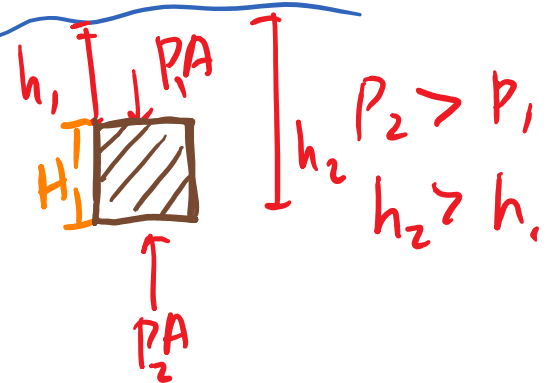


What happens when you replace the block of wood with block of steel?



sink:  $m_0 g > \rho_w g V = m_w g$

float:  $m_0 g < m_w g$



$$-P_1 A + P_2 A = -\rho g h_1 A + \rho g h_2 A \\ = \rho g A (h_2 - h_1)$$

$$F_b = \rho g A H$$

~ buoyant force on submerged object  
independent of  $h$ !

## Chapter 11: Virtual Work

### Main goals and learning objectives

- Introduce the principle of virtual work
- Show how it applies to determining the equilibrium configuration of a series of pin-connected members

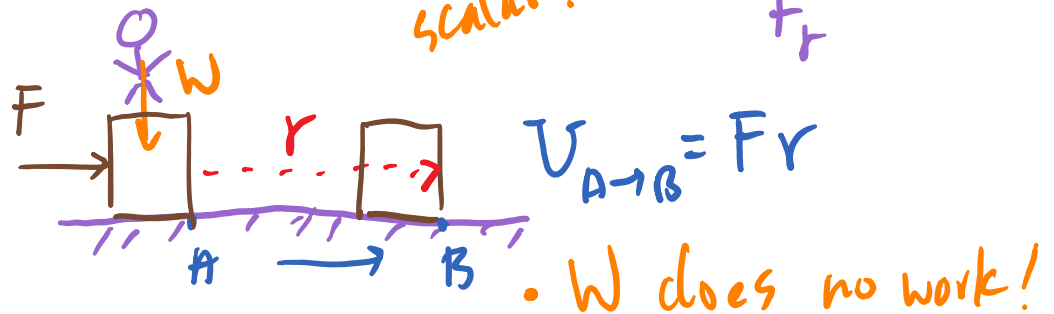
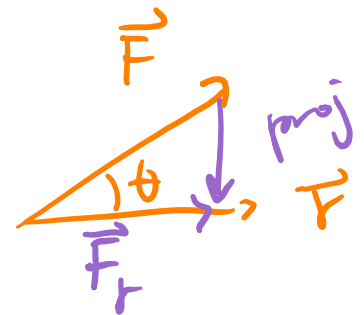
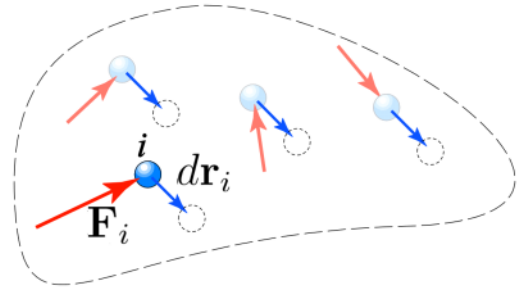
# Definition of Work ( $U$ )

## Work of a force

A force does work when it undergoes a displacement in the direction of the line of action.

The work  $dU$  produced by the force  $\mathbf{F}$  when it undergoes a differential displacement  $d\mathbf{r}$  is given by

$$dU = \mathbf{F} \cdot d\mathbf{r} = F \cos\theta dr \quad \text{scalar.}$$



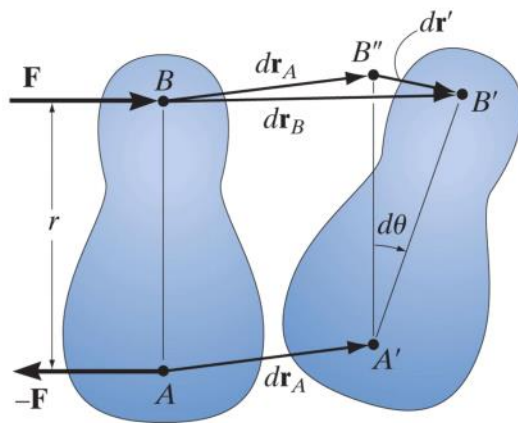
• only  $F \parallel r$  does work.

Advantage : only consider forces that do work in analysis.

## Definition of Work

**Work of a couple**  $dU = M \mathbf{k} \cdot d\theta \mathbf{k} = M d\theta$

*scalar*



Since  $\vec{F}$  and  $d\vec{r}_B$  have same direction,  $F$  does positive work.  
 $-\vec{F}$  &  $d\vec{r}_A$  have opposite directions, so  $-F$  does negative work here.  
 Hence, net work done by force couple due to translation is zero.