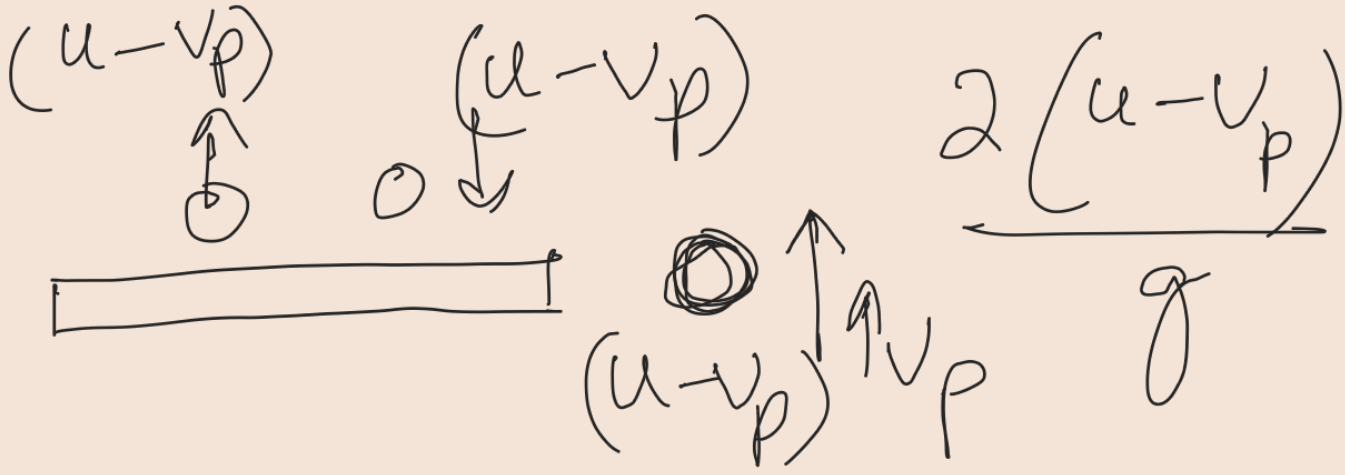
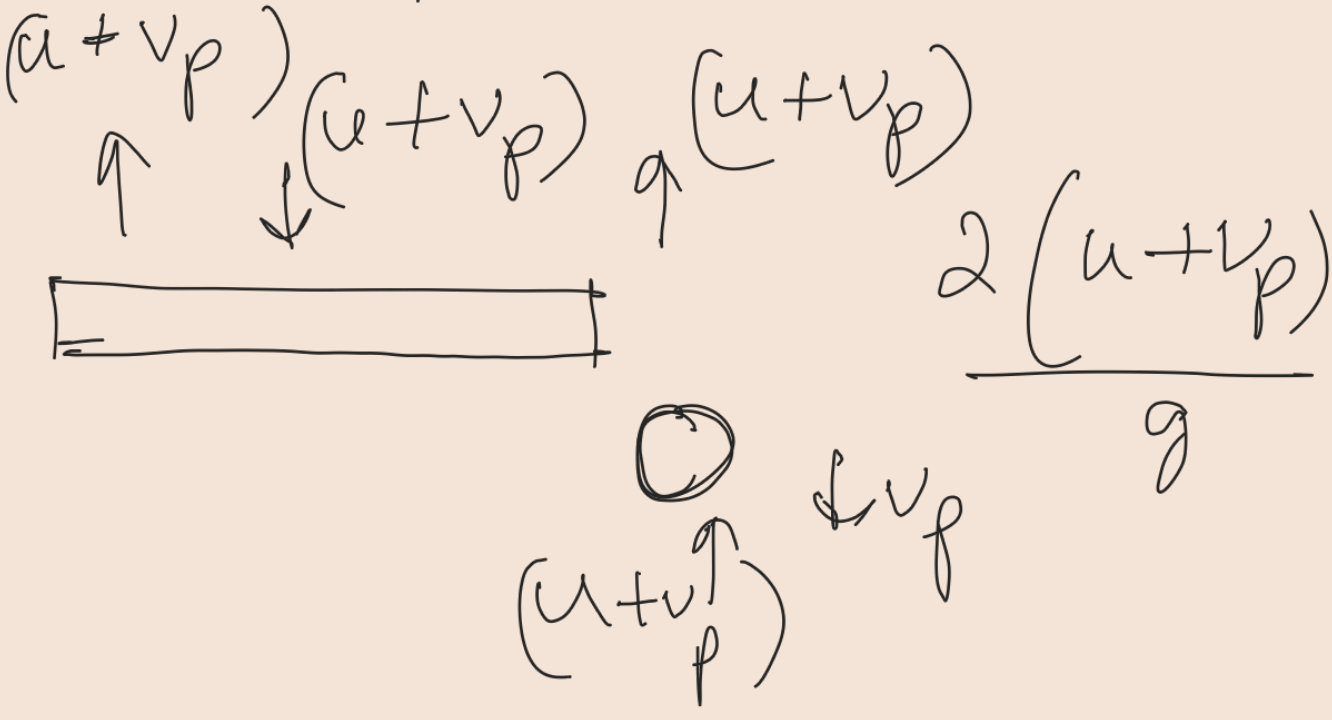
Time for 1st collision



Time for 2nd collision



$$\frac{v_p\left[\frac{u-v_p}{g}-\left(\frac{u+v_p}{g}\right)\right]}{2\left(\frac{u-v_p}{g}+\frac{u+v_p}{g}\right)}$$

$$= \frac{v_p \left(\frac{2v_p}{g}\right)}{\frac{2u}{g}} = \boxed{\frac{v_p^2}{u}}$$

After 2nd collision, the exact same cycle repeats itself again.

Hence $\langle v_{plate} \rangle$

$$= \boxed{\frac{v_p^2}{u}}$$ ✓