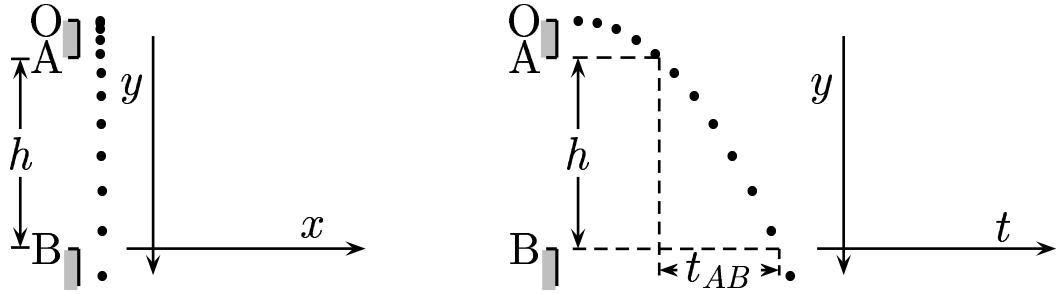
A ball is dropped from rest at O. It passes a window which has a height h, in a time interval t_{AB}. *Let down be positive.*



Let $\|\vec{v}\| \equiv v$ be the speed of the ball. Identify the correct pair of equations for the speeds v_A and v_B that one may use to solve for v_B, where v_A and v_B are speeds and $\Delta t = t_{AB} = t_B - t_A$.

A) $v_A - v_B = g\,t_{AB}$ and $v_A + v_B = \dfrac{h}{t_{AB}}$

B) $v_A - v_B = g\,t_{AB}$ and $\dfrac{v_A + v_B}{2} = \dfrac{h}{t_{AB}}$

C) $v_B - v_A = g\,t_{AB}$ and $v_A + v_B = \dfrac{h}{t_{AB}}$

D) $v_B - v_A = g\,t_{AB}$ and $\dfrac{v_A + v_B}{2} = \dfrac{h}{t_{AB}}$

The definition of acceleration implies that $v_B - v_A = g\,t_{AB}$. For a constant acceleration, the average speed between A and B is given by $v_{avg} = \dfrac{v_A + v_B}{2} = \dfrac{h}{t_{AB}}$. Multiply the first by one-half and add to the second

$$\frac{1}{2}\,v_B - \frac{1}{2}\,v_A = \frac{1}{2}\,g\,t_{AB}$$
$$\frac{1}{2}\,v_B + \frac{1}{2}\,v_A = \frac{h}{t_{AB}} \quad \text{adding, we have}$$
$$v_B = \frac{h}{t_{AB}} + \frac{1}{2}\,g\,t_{AB}\,.$$

Answer **D**.