75. (a) Let the height of the diving board be $h$. We choose *down* as the $+y$ direction and set the coordinate origin at the point where it was dropped (which is when we start the clock). Thus, $y = h$ designates the location where the ball strikes the water. Let the depth of the lake be $D$, and the total time for the ball to descend be $T$. The speed of the ball as it reaches the surface of the lake is then $v = \sqrt{2gh}$ (from Eq. 2-16), and the time for the ball to fall from the board to the lake surface is $t_1 = \sqrt{2h/g}$ (from Eq. 2-15). Now, the time it spends descending in the lake (at constant velocity $v$) is

$$t_2 = \frac{D}{v} = \frac{D}{\sqrt{2gh}} \ .$$

Thus, $T = t_1 + t_2 = \sqrt{\frac{2h}{g}} + \frac{D}{\sqrt{2gh}}$, which gives

$$D = T\sqrt{2gh} - 2h = (4.80)\sqrt{(2)(9.80)(5.20)} - (2)(5.20) = 38.1 \text{ m} \ .$$

(b) Using Eq. 2-2, the average velocity is

$$v_{\text{avg}} = \frac{D+h}{T} = \frac{38.1 + 5.20}{4.80} = 9.02 \text{ m/s}$$

where (recalling our coordinate choices) the positive sign means that the ball is going downward (if, however, upwards had been chosen as the positive direction, then this answer would turn out negative-valued).

(c) We find $v_0$ from $\Delta y = v_0 t + \frac{1}{2}gt^2$ with $t = T$ and $\Delta y = h + D$. Thus,

$$v_0 = \frac{h+D}{T} - \frac{gT}{2} = \frac{5.20 + 38.1}{4.80} - \frac{(9.8)(4.80)}{2} = -14.5 \text{ m/s}$$

where (recalling our coordinate choices) the negative sign means that the ball is being thrown upward.