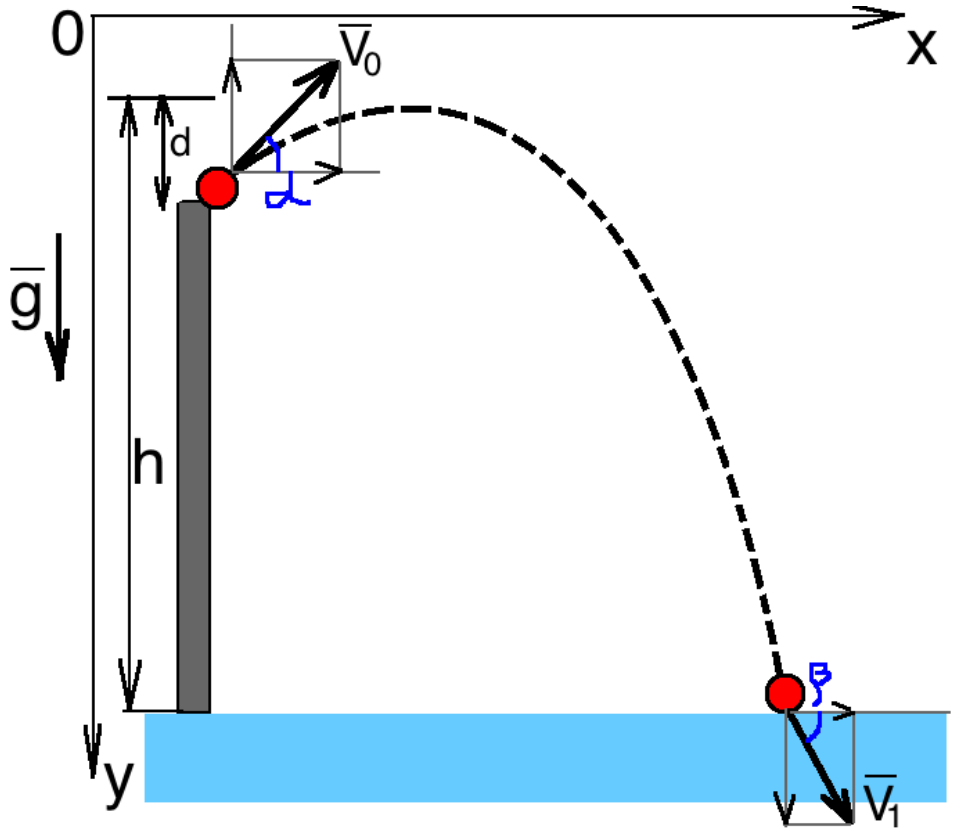
A diver springs upward from a board that is 4.50 m above the water. At the instant she contacts the water her speed is 15.4 m/s and her body makes an angle of 66.0 ° with respect to the horizontal surface of the water. Determine her initial velocity, both (a) magnitude and (b) direction.



Solution:

β – given angle 66^o.

The Y (vertical) component of the velocity is

$$\sin 66^o \cdot 15.4\frac{m}{s} = 14.07\frac{m}{s}$$

The X (horizontal) component of the velocity is

$$\cos 66.0^o \cdot 15.4\frac{m}{s} = 6.26\frac{m}{s}$$

The horizontal component of the velocity is the same on take-off.

The angle is the arc tangent of the vertical component over the horizontal component.

Rate equation for the diver along Y-axis:

$$V(y) = gt, g = 9.8\frac{m}{s^2}, t - \text{time from the top of the flight}$$

$$t = \frac{14.07\frac{m}{s}}{9.8\frac{m}{s^2}} = 1.44 \text{ sec}$$

h - height at the top of the flight to the water:

$$y:\ h = \frac{gt^2}{2} = \frac{9.8\frac{m}{s^2}\cdot(1.44\ s)^2}{2} = 10.2\ m$$

d - height at the top of the flight to the board:

$$d = 10.2m - 4.5m = 5.7m$$

$$d = \frac{1}{2}gT^2, \text{where } T - \text{ the time to the top of the flight from the board.}$$

$$T = \sqrt{\frac{2d}{g}} = \sqrt{\frac{2\cdot 5.7m}{9.8\frac{m}{s^2}}} = 1.08\ sec$$

$$V_{y-init} = gT = 9.8\frac{m}{s^2}\cdot 1.08sec = 10.6\frac{m}{s}$$

$$V_{x-init} = \cos 66.0^o \cdot 15.4\frac{m}{s} = 6.26\frac{m}{s}$$

$$V_0 = \sqrt{V_{x-init}^2 + V_{y-init}^2} = \sqrt{\left(10.6\frac{m}{s}\right)^2 + \left(6.26\frac{m}{s}\right)^2} = 12.31\frac{m}{s}$$

$$\text{Angle} = \arctan\frac{V_{y-init}}{V_{x-init}} = \arctan\frac{10.6\frac{m}{s}}{6.26\frac{m}{s}} = 59.44 \text{ degrees}$$

Answer: (a) $V_0 = 12.31\frac{m}{s}$

(b) Angle $= \alpha = 59.44$ degrees