Description: Find the initial speed of a drop of water that an archerfish spits to hit a floating insect, given the position of the insect and the launch angle.

Constants | Periodic Table

The archerfish is a type of fish well known for its ability to catch resting insects by spitting a jet of water at them. This spitting ability is enabled by the presence of a groove in the roof of the mouth of the archerfish. The groove forms a long, narrow tube when the fish places its tongue against it and propels drops of water along the tube by compressing its gill covers.
When an archerfish is hunting, its body shape allows it to swim very close to the water surface and look upward without creating a disturbance. The fish can then bring the tip of its mouth close to the surface and shoot the drops of water at the insects resting on overhead vegetation or floating on the water surface.

Part A

At what speed v should an archerfish spit the water to shoot down an insect floating on the water surface located at a distance 0.800 m from the fish? Assume that the fish is located very close to the surface of the pond and spits the water at an angle 60° above the water surface.

Express your answer in meters per second.

View Available Hint(s) (3)

ANSWER:

$$v = \sqrt{\frac{\frac{x_1 \cdot 9.81}{2}}{\frac{\cos\left(\frac{60\pi}{180}\right)}{\sin\left(\frac{60\pi}{180}\right)}}} = 3.01 \quad \mathrm{m/s}$$

Some archerfish can "shoot" as far as 3.5 m, hitting their targets with reasonable accuracy as far as 1.2 m. They have binocular vision, which helps them judge distance.

Part B

Now assume that the insect, instead of floating on the surface, is resting on a leaf above the water surface at a horizontal distance 0.600 m away from the fish. The archerfish successfully shoots down the resting insect by spitting water drops at the same angle 60° above the surface and with the same initial speed v as before. At what height h above the surface was the insect?

Express your answer in meters.

View Available Hint(s) (2)

ANSWER:

$$h = \tan\left(\frac{60\pi}{180}\right) x_2 \left(1 - \frac{x_2}{x_1}\right) = 0.260 \quad \mathrm{m}$$

Experiments have shown that the archerfish can predict the point where the disabled prey will fall and hit the water by simply looking at the initial trajectory of the dislodged insect for only 10 ms. The archerfish then darts to the place where it has "calculated" the insect will hit the water, planning to get there before another fish does.