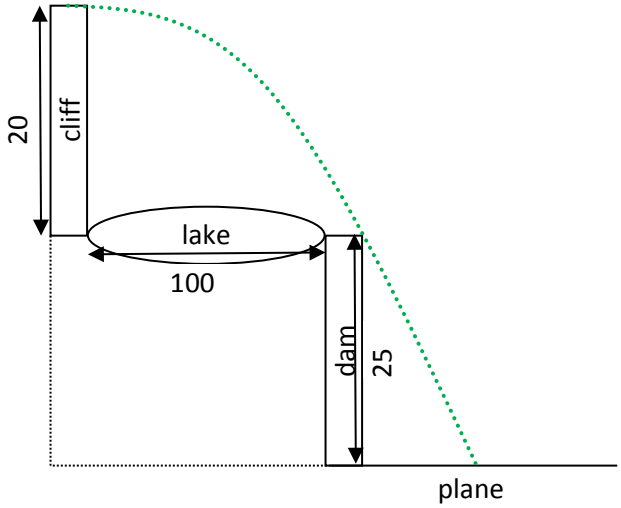
Answer on Question#69950 –Physics– Mechanics – Relativity

A 76.0-kg boulder is rolling horizontally at the top of a vertical cliff that is 20m above the surface of a lake, the top of the vertical face is a dam located 100m from the foot of the cliff, with the top of the dam level with the surface of the water in the lake. a level plain is 25m below the top of the dam. (a) what must be the minimum speed of the rock just as it leaves the cliff so it will travel to the plain without striking the dam? (b) how far from the foot of the dam does the rock hit the plane.

Solution.

The conditional trajectory of the boulder is shown in the figure



Consider the motion of the boulder in the horizontal and vertical planes separately. Neglecting the air resistance in the horizontal plane, the boulder moves uniformly with speed v_0 and the traversed path at the time t $L = v_0 t$. In the vertical plane, the boulder moves with acceleration $g = 9.8\frac{m}{s^2}$ without initial speed. Hence the height of the boulder at the time t $h = \frac{gt^2}{2}$. As a result, the general motion can be written as a system of equations

$$\begin{cases} L = v_0 t \\ h = \frac{gt^2}{2} \end{cases}$$

a) In order for the boulder not to hit the dam it is necessary that until the boulder reaches the level of the dam it overcomes the lake. This condition can be described by a system of equations

$$\begin{cases} 100 = v_0 t \\ 20 = \frac{gt^2}{2} \end{cases} \rightarrow 20 = \frac{g}{2}\left(\frac{100}{v_0}\right)^2 \rightarrow v_0 = \sqrt{250g} \approx 49.5\frac{m}{s}.$$

(b) Find how far from the foot of the dam does the rock hit the plane. From (a) speed $v_0 = 49.5\frac{m}{s}$. Using system of equation for $h = 45m$ get

$$\begin{cases} L = 49.5t \\ 45 = \frac{gt^2}{2} \end{cases} \rightarrow L = 49.5\sqrt{\frac{90}{g}} \approx 150m$$ (how far from the foot of the cliff does the rock hit the plane). Hence the required distance $d = 150 - 100 = 50m$

Answer. (a) $49.5\frac{m}{s}$; (b) $50m$.