

NCERT ANALOG

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question 11.15.2: A stone dropped from the top of a tower of height 300 m splashes into the water of a pond near the base of the tower. When is the splash heard at the top given that the speed of the sound in air is 340 m s^{-1} . ($g=9.8 \text{ m s}^{-2}$)

solution:

Given the height of the tower $s=300 \text{ m}$, acceleration $a=+g$ (because the stone is moving down).

Assume speed of the sound in air is V , initial velocity of the stone is $u = 0 \text{ m s}^{-1}$.

s	g	V	u
300 m	9.8 m s^{-2}	340 m s^{-1}	0 m s^{-1}

Table 1: Given inputs

For finding the time from dropping the stone to hitting the water by using kinematics 2D the formula of displacement

$$s = ut + \frac{1}{2}at^2 \quad (1)$$

by substituting the values of s , a , u in the equation 1

$$300 = (0)t + \frac{1}{2}9.8(t)^2 \quad (2)$$

$$600 = 9.8(t)^2 \quad (3)$$

by solving the above equation we get

$$t = \frac{10\sqrt{30}}{7} \text{ s} \quad (4)$$

Given that the speed of the sound $V=340 \text{ m s}^{-1}$

After the hitting of the stone to the water, the sound of the splash travels with the speed V to the top of the tower of height s .

Time taken by the sound to travel to top of the tower is

$$t = \frac{s}{V} \quad (5)$$

by substituting the values of V , s in the equation 5, we get

$$t = \frac{300}{340} s \quad (6)$$

$$t = \frac{15}{17} s \quad (7)$$

The splash heard at the top of the tower after dropping the stone from the top of the tower is

$$t = \left[\frac{10\sqrt{30}}{7} + \frac{15}{17} \right] s \quad (8)$$