Question #58098, Physics / Other

12 A 10-g bullet of unknown speed is shot horizontally into a 2-kg block of wood suspended from the ceiling by a cord. The bullet hits the block and becomes lodged in it. After the collision, the block and the bullet swing to a height 30cm above the original position. What was the speed of the bullet? (This device is called the ballistic pendulum). Take
g=9.8ms−2
700 m/s
640 m/s
354 m/s
<u>487 m/s</u>

Solution:
When the bullet hits the block, its momentum is transferred to the block. So, the block and the bullet in it reach obtain speed and therefore kinetic energy, which allows them to reach the height of 30 cm above original position.

1. Conservation of momentum:

$m_b v_0 = (m_b + m_{bl})v$;

$v_0 = \frac{(m_b + m_{bl})v}{m_b}$

2. Energy transformation:

$\Delta E_k = \Delta PE$;

$\Delta E_k = \frac{(m_b + m_{bl})v^2}{2}$;

$\Delta PE_b = (m_b + m_{bl})g\Delta h$;

$\frac{(m_b + m_{bl})v^2}{2} = (m_b + m_{bl})g\Delta h$;

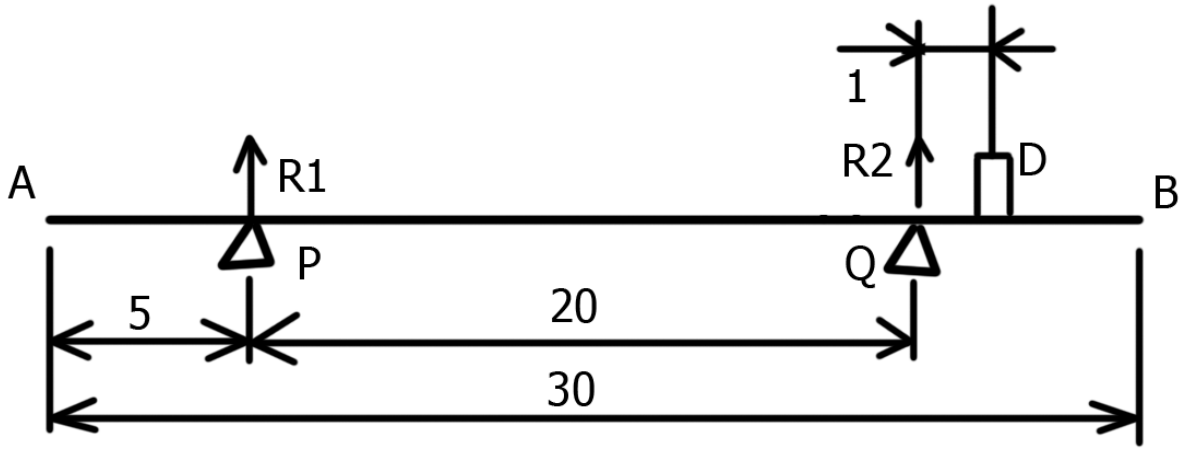
$v = \sqrt{2g\Delta h}$;

$v_0 = \frac{(m_b + m_{bl})\sqrt{2g\Delta h}}{m_b} = 487.4$ m/s

Answer: 487 m/s

13 A uniform plank AB 30 m long, weighing 100 N is pivoted at points P, Q which are 5 m from the ends A and B respectively. A boy of weight 250 N stands at a point D on the plank, 1 m away from Q and the arrangement is in equilibrium. Determine the reaction
R1
and
R2
at the supports.
77.5 N, 245.5 N
105.5 N 33.5 N
<u>37.5 N, 312.5 N</u>
27.5 N, 232.5 N

Solution



To determine R1, one should consider the sum of moments around Q. Since the arrangement is in equilibrium, the sum of all moments is zero.

$$\sum M_Q = 0;$$

$$W_{AQ} l_{AQ} + W_D l_D - W_{QB} l_{QB} - R_1 l_{R1} = 0;$$

$$R_1 = \frac{W_{AQ} l_{AQ} + W_D l_D - W_{QB} l_{QB}}{l_{R1}};$$

Where l_i = distances from Q to center of application of respective force.

l_{AQ} = 12.5 m;

l_D = 1 m;

l_{QB} = 2.5 m;

l_{R1} = 20 m;

$$R_1 = \frac{\frac{5}{6} \times 100 \times 12.5 - 250 \times 1 - \frac{1}{6} \times 100 \times 2.5}{20} = 37.5 \text{ N}$$

To determine R2, one should consider the sum of all forces. Since the arrangement is in equilibrium, the sum of all forces is zero.

$$\sum F = 0;$$

$$W_{AB} + W_D - R_1 - R_2 = 0;$$

$$R_2 = W_{AB} + W_D - R_1;$$

$$R_2 = 100 + 250 - 37.5 = 312.5 \text{ N}$$

Answer: R_1 = 37.5 N; R_2 = 312.5 N.