2018 Ph H2 Q1

Section: Our Dynamic Universe
Topic: Projectiles

Question Summary

A sponge is thrown at **7.4 m s⁻¹**, at an angle of **30°** to the horizontal, from a height of **1.5 m**.
We calculate:

1. Horizontal and vertical velocity components.
2. Time to reach maximum height.
3. The height at which it hits the teacher.
4. Why throwing it faster at the same angle does not reduce the time.

(a)(i) Horizontal and vertical components

✅ **Answer:**

- $u_x = 6.4\,\text{ms}^{-1}$
- $u_y = 3.7\,\text{ms}^{-1}$

Working:

$u_x = u\cos\theta = 7.4\cos 30 = 6.4\,\text{ms}^{-1},$

$u_y = u\sin\theta = 7.4\sin 30 = 3.7\,\text{ms}^{-1}.$

(a)(ii) Time to maximum height

✅ **Answer:**
$t = 0.38\,\text{s}$

Working:
At the top $v = 0$:
$v = u_y + at,$

$0 = 3.7 - 9.8t \Rightarrow t = 0.38\,\text{s}.$

(a)(iii) Height at which it hits the teacher

✅ **Answer:**
$h = 1.2\,\text{m}$

Working:
The sponge takes **0.38 s up** and **0.45 s down**, total **0.83 s** from launch.

Vertical displacement:
$s = u_y t + \frac{1}{2}at^2,$

$s = 3.7(0.83) + 0.5(-9.8)(0.83^2) = 3.07 - 3.35 = -0.28\,\text{m}.$

Height above ground:
$h = 1.5 + s = 1.5 - 0.28 = 1.2\,\text{m}.$

(b) Explanation

Answer:
The **vertical motion** (and therefore time in air) depends only on **vertical velocity and height**, not the horizontal velocity. A faster throw at the same angle does **not change the vertical motion time**, so the total flight time is unchanged.

Quick Tips

- Split initial velocity into horizontal and vertical components first.
- Vertical motion is independent of horizontal motion.
- Use $v = u + at$ for times and $s = ut + \frac{1}{2}at^2$ for heights.