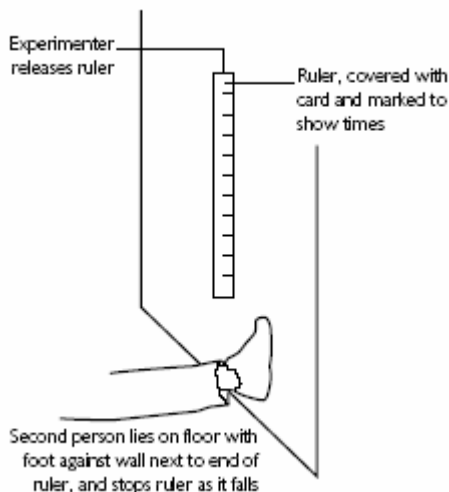


TAP 206- 4: Motion under gravity

Questions 1-3 are about free fall. Use the approximation $g = 10 \text{ m s}^{-1}$.

- 1) In the first part of a bungee jump, before the cord starts to stretch, the jumper is in free fall. Calculate the vertical displacement of a bungee jumper at 1.0 s, 2.0 s, 3.0 s, 4.0 s and 5.0 s after starting from rest.
- 2) Calculate the times taken for a bungee jumper to fall 1.25 m, $4 \times 1.25 \text{ m}$, $9 \times 1.25 \text{ m}$ and $16 \times 1.25 \text{ m}$ from rest. Comment on your answers.
- 3) The diagram below shows a simple reaction timer. The idea is that, as the ruler is released, a buzzer sounds. At the sound of the buzzer, the person traps the ruler with their foot (rather like braking in a car). The distance that the ruler falls indicates the person's reaction time.

Work out how the markings should be spaced if the timer is to be calibrated (marked) with times 0.1 s, 0.2 s, 0.3 s, etc.



Answers and worked solutions

1) $s = ut + \frac{1}{2} at^2$ $u = 0$ so $s = + \frac{1}{2} at^2$ $a = g = 10 \text{ m s}^{-2}$ so $s = 5t^2$
 $s = 5 \times 1 \times 1 = 5 \text{ m}$

Time / s	1.0	2.0	3.0	4.0	5.0
Distance / m	5	20	45	80	125

2) $s = + \frac{1}{2} at^2$ $a = g = 10 \text{ m s}^{-2}$
 for 1.25 m, $s = + \frac{1}{2} at^2$ $1.25 = 5t^2$ so $1.25/5 = t^2$ so $t^2 = 0.25$ and $t = 0.5 \text{ s}$

Distance / m	1.25	4 x 1.25	9 x 1.25	16 x 1.25
Time / s	0.5	1.0	1.5	2

When time doubled distance goes up 4 times

(Note the displacement s and g are both in the same direction and if vertically upwards is taken to be positive they should both have – signs.)

3) $s = + \frac{1}{2} at^2$ $a = g = 10 \text{ m s}^{-2}$

For 0.1 s then $s = \frac{1}{2} 10 (0.1)^2 = 5 \times 0.1 \times 0.1 = 0.05 \text{ m} = 5 \text{ cm}$

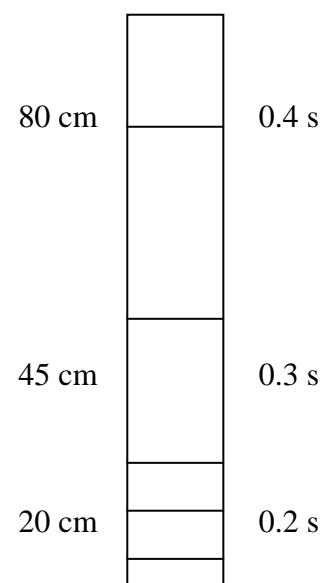
For 0.2 s then $s = \frac{1}{2} 10 (0.2)^2 = 5 \times 0.2 \times 0.2 = 0.2 \text{ m} = 20 \text{ cm}$

For 0.3 s then $s = \frac{1}{2} 10 (0.3)^2 = 5 \times 0.3 \times 0.3 = 0.45 \text{ m} = 45 \text{ cm}$

For 0.4 s then $s = \frac{1}{2} 10 (0.4)^2 = 5 \times 0.4 \times 0.4 = 0.8 \text{ m} = 80 \text{ cm}$

Note that 0.15 seconds is not exactly half way between 5 cm and 20 cm, consider if this is important error wise.

For 0.15 s then $s = \frac{1}{2} 10 (0.15)^2 = 5 \times 0.51 \times 0.15 = 0.1125 \text{ m} = 11.25 \text{ cm}$ (11.3 cm).



External references

This activity is taken from Salters Horners Advanced Physics, AS, Section Higher, Faster, Stronger, HFS, Additional Activity 6