Unit 18 · Dynamics

HARDER PRACTICE QUESTIONS

Full marks 21

Write your answers on separate paper. Show your working. Take $g = 9.8$ m/s^2 and ignore air resistance.

1 Over the wall [6]

A ball is thrown at 25 m/s from the ground to hit a window 30 m away across level ground and 10 m up.

a. Show that the angle of projection θ satisfies $7.056\tan^2\theta - 30\tan\theta + 17.056 = 0$.

b. Find the two angles that work, and the time each throw takes to reach the window.

c. Kabita says, "For a throw to reach 30 m, $\frac{u^2}{g} \geq 30$, so 17.2 m/s is enough." Find the least speed that can reach the window, and explain why her reasoning fails.

2 Off a cliff [5]

Nirmala throws a stone at 15 m/s from the top of a cliff 20 m above the sea.

a. Find how far out from the foot of the cliff it lands if she throws it at 45°, and if she throws it at 30°.

b. Sanjay says 45° always gives the greatest range. Explain why a lower angle wins here.

3 The scale in the lift [5]

Dorje, of mass 60 kg, stands on a bathroom scale in a lift. The scale shows the force it pushes up on him, in kilograms (newtons ÷ 9.8).

a. The scale reads 70 kg. Find the lift's acceleration. His friend says, "So the lift is going up." Is that certain?

b. What does the scale read while the lift moves down at a steady 3 m/s?

c. What would it read if the cable broke and the lift fell freely?

4 A bullet in wood [5]

A bullet of mass 20 g moving at 400 m/s goes 10 cm into a block of wood before it stops.

a. Find the resisting force, taken as constant, and how long the bullet takes to stop.

b. Check your answer with the impulse on the bullet.

c. The same bullet is fired at 400 m/s through a plank of the same wood, 5 cm thick. Pasang says it comes out at 200 m/s, "half the wood, half the speed lost". Find the true speed, and explain.