

## Homework 5

- 1) . A lift is initially at rest at the top of a building. At the instant the lift begins to descend with acceleration  $\frac{1}{9} g \text{ m s}^{-2}$ , a man in the lift releases a ball from a height of 1 metre above the lift floor by throwing it vertically upwards with a speed of  $3.5 \text{ m s}^{-1}$ .

The man then allows the ball to fall to the floor.

Assuming that the ball does not strike the ceiling of the lift, find the time taken for the ball to hit the floor from its moment of release.

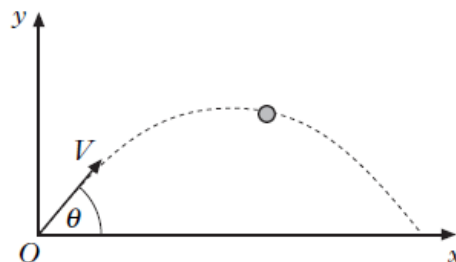
7

- 2) . A car and a motorcycle are travelling along straight, horizontal roads which intersect at right angles at a point  $O$ . The car is travelling northwards at a constant speed, while the motorcycle is travelling eastwards at twice the speed of the car. At the instant when the motorcycle passes through  $O$ , the car is 40 metres south of  $O$ . Calculate the minimum distance between the car and the motorcycle.

7

- 3) . Bobbie kicks a football from the origin  $O$  on a horizontal football pitch. The ball is projected at speed  $V \text{ m s}^{-1}$  at an angle  $\theta$  to the horizontal and moves freely under gravity.

*MARRS*



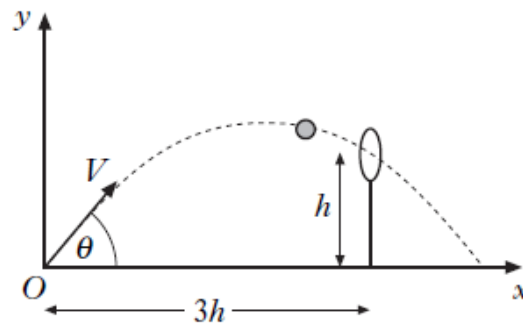
- (a) Given that  $Ox$  and  $Oy$  are rectangular axes as indicated in the diagram, show from the equations of motion that the trajectory of the ball is given by

$$y = x \tan \theta - \frac{gx^2}{2V^2} (1 + \tan^2 \theta).$$

3

[Note that  $\sec^2 \theta = 1 + \tan^2 \theta$ .]

- (b) The ball passes through the centre of a hoop with its trajectory unchanged. The centre of the hoop is at  $(3h, h)$  and the speed of projection is given by  $V = 3\sqrt{\frac{gh}{2}}$ .



Determine the two possible values of  $\tan \theta$ .

4

When  $\tan \theta$  takes the larger of these values, find an expression for the range of the football in terms of  $h$ .

3

- 4) A car travelling at  $12 \text{ ms}^{-1}$  starts to accelerate 40 metres before leaving a built-up area. The acceleration of the car  $t$  seconds later is given by  $\frac{1}{3}(13 - 2t) \text{ ms}^{-2}$ .

a) How long will it be before the speed of the car reaches  $26 \text{ ms}^{-1}$ ?

b) How far outside the built-up area will the car be at this time?

5