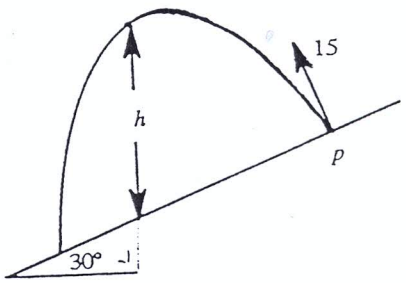
1997

3. *(a)* A golf ball, at rest on horizontal ground, is struck so that it starts to move with velocity $3u\vec{i} + u\vec{j}$ where $\vec{i}$ and $\vec{j}$ are unit vectors along and perpendicular to the ground, respectively. In its flight the ball rises to a maximum height of 15 m. Calculate

(i) the value of u,

(ii) the magnitude and direction of the velocity with which the ball strikes the ground.

(b) A particle is projected from a point p with initial speed 15 m/s, down a plane inclined at an angle of 30° to the horizontal. The direction of projection is at right angles to the inclined plane. (The plane of projection is vertical and contains the line of greatest slope). Find



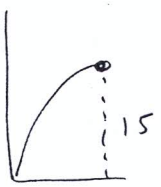
(i) the perpendicular height of the particle above the plane after t seconds and hence, or otherwise, show that the vertical height h of the particle above the plane after t seconds is
$$10\sqrt{3}\,t - 4.9t^2$$

(ii) the greatest vertical height it attains above the plane (i.e. the maximum value of h) correct to two places of decimals.

1997 (a)

(i) y-direction

$u = u$
$a = -g$
$s = 15$
$v = 0$



$v^2 = u^2 + 2as$

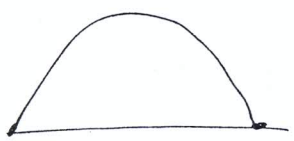
$0 = u^2 + 2(-9.8)(15)$

$u^2 = 294$

$u = \sqrt{294}$ $(= 17.15 \text{ m/s})$

$u = \sqrt{3}\sqrt{98}$

(ii)



x

$u = 3\sqrt{294}$

$a = 0$

$v_x = 3\sqrt{294}$

y

$u = \sqrt{294}$

$a = -9.8$

$v_y = \sqrt{294} - 9.8t$

$s_y = \sqrt{294}\,t - 4.9t^2$

$s_y = 0 \Rightarrow \sqrt{294}\,t - 4.9t^2 = 0$

$\Rightarrow t = \dfrac{\sqrt{294}}{4.9}$

when it lands: $v_x = 3\sqrt{294}$, $v_y = \sqrt{294} - 9.8\dfrac{\sqrt{294}}{4.9} = -\sqrt{294}$

$\vec{v} = 3\sqrt{294}\,\vec{i} - \sqrt{294}\,\vec{j}$. $|\vec{v}| = \sqrt{9(294) + 294} = \sqrt{2940} = 54.22$