Exercise 10D

Q. 1. (i) **Speed at impact:**

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

$\Rightarrow v^2 = 0^2 + 2gh$

$\Rightarrow v = \sqrt{2gh}$

Speed after impact $= \frac{3}{4}\sqrt{2gh}$

New Height:

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

$\Rightarrow 0^2 = \frac{9}{16}(2gh) + 2(-g)s$

$\Rightarrow s = \frac{9}{16}h$

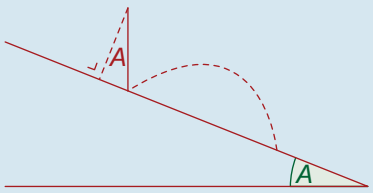
(ii) Each new height $= \frac{9}{16}$ths of the previous height

$\therefore$ Total distance $= 2h + \frac{9}{16}(2h) + \left(\frac{9}{16}\right)^2(2h) + \ldots$

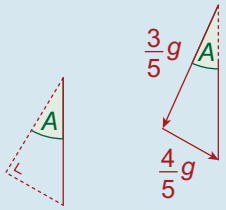
$= s_\infty$ of a G.P. with $a = 2h, r = \frac{9}{16}$

$= \frac{2h}{1 - \frac{9}{16}} = \frac{32h}{7}$

Q. 2. (i)



Gravity **Resolved**



$\vec{u} = u\sin A\vec{i} - u\cos A\vec{j}$

$= 20\left(\frac{4}{5}\right)\vec{i} - 20\left(\frac{3}{5}\right)\vec{j} = 16\vec{i} - 12\vec{j}$

Before	**(Mass)**	**After**
$16\vec{i} - 12\vec{j}$	M	$16\vec{i} + p\vec{j}$

$\frac{\text{NEW}}{\text{OLD}} = -e$

$\Rightarrow \frac{p}{-12} = \frac{-2}{3}$

$\Rightarrow p = 8$

New initial speed $= 16\vec{i} + 8\vec{j}$

Find length of hop means find s_x when $s_y = 0$

$s_y = 0$

$\Rightarrow 8t - \frac{1}{2}\left(\frac{3}{5g}\right)t^2 = 0$

$\Rightarrow t = 0$ **OR** $t = \frac{80}{3g}$

At $t = \frac{80}{3g}$,

$s_x = 16t + \frac{1}{2}\left(\frac{4}{5g}\right)t^2$

$= 16\left(\frac{80}{3g}\right) + \frac{1}{2}\left(\frac{4}{5g}\right)\left(\frac{6{,}400}{9g^2}\right)$

$= \frac{6{,}400}{9g}$ metres

(ii) At $t = \frac{80}{3g}$,

$v_x = 16 + \frac{4}{5}gt$

$= 16 + \frac{4}{5}g\left(\frac{80}{3g}\right) = \frac{112}{3}$

At $t = \frac{80}{3g}$,

$v_y = 8 - \frac{3}{5}gt$

$= 8 - \frac{3}{5}g\left(\frac{80}{3g}\right)$

$= -8$

If L is the landing angle, $\tan L = \frac{-v_y}{v_x}$

$= \frac{8}{\frac{112}{3}}$

$= \frac{3}{14}$

$\Rightarrow \tan L = 0.2143$

$\Rightarrow L = 12°\,6' = 12°$ (to nearest degree)