Mechanics

Chapter 1: Projectile (Classwork)

Solutions

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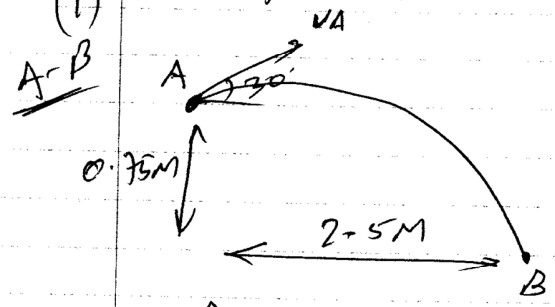
Navlakhi's

Projectile (Classwork)

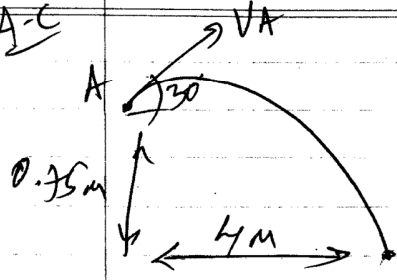
(1) A-B



A-B

Horizontal	Vertical
$s = 2.5M$	$s = -0.75m$
$u = v_0 \cos 30°$	$u = v_0 \sin 30°$
$t = \frac{s}{u}$	$s = ut - \frac{1}{2}gt^2$
$= \frac{2.5}{v_0 \cos 30°}$	$-0.75 = v_0 \sin 30° \left(\frac{2.5}{v_0 \cos 30°}\right) - \frac{1}{2} \times 9.81 \left(\frac{2.5}{v_0 \cos 30°}\right)^2$
	$\therefore v_0 = 4.317 m/s$

A-C



Horizontal	Vertical
$s = 4M$	$s = -0.75m$
$u = v_A \cos 30°$	$u = v_A \sin 30°$
$t = \frac{s}{u}$	$s = ut - \frac{1}{2}gt^2$
$= \frac{4}{v_A \cos 30°}$	$-0.75 = v_A \sin 30° \left(\frac{4}{v_A \cos 30°}\right) - \frac{1}{2} \times 9.8 \left(\frac{4}{v_A \cos 30°}\right)^2$
	$v_A = 5.848 m/s$

(2) Time between them
$= t_{AC} - t_{AB}$

From previous one

A-B

$$t = \frac{2.5}{V_0 \cos 30^\circ}$$

$$= \frac{2.5}{4.317 \cos 30^\circ}$$

$$= 0.669\ s.$$

A-C

$$t = \frac{4}{V_A \cos 30^\circ}$$

$$= \frac{4}{5.848 \cos 30^\circ}$$

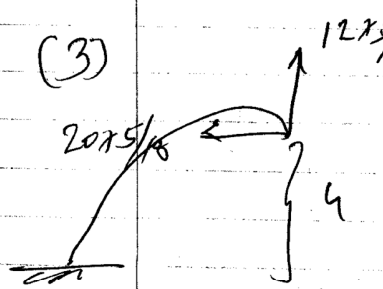
$$= 0.790\ s$$

Time both throws

$$= 0.790 - 0.669$$

$$0.121\ s$$

(3)



$t = 8s$

Vertical

$s = h$ [No need for sign as it's a complete unknown]

$t = 8\ s$

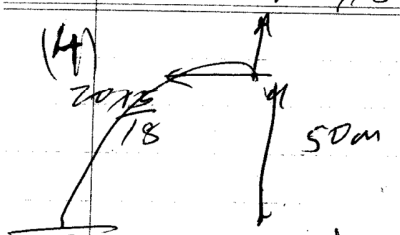
$4 = 12 \times 5/18$

$$s = ut - \frac{1}{2} g t^2$$

$$h = \frac{12 \times 5}{18} \times 8 - \frac{1}{2} \times 9.81 \times (8)^2$$

$$h = -287.253 m$$

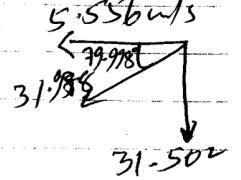
(4)



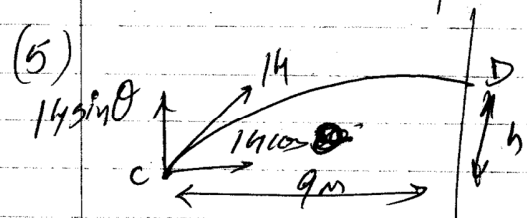
Horizontal	Vertical
$s = ?$	$s = -50\,m$
	$u = 12\times5/18$
	$s = ut - \frac{1}{2}gt^2$
	$-50 = 12\times5/18 \times t - \frac{1}{2}\times9.81\times t^2$
	$\therefore t = 3.551\,s$
$u_H = 20\times5/18$	$v = u - gt$
$v_H = 20\times5/18$	$= 12\times5/18 - 9.81\times3.551$
$= 5.556\,m/s$	$= -31.502\,m/s$

$v_{final} = \sqrt{5.556^2 + 31.502^2}$

$= 31.988\,m/s$



(5)



Horizontal	Vertical
$s = 9\,m$	$s = h-1$
$u = 14\cos\theta$	$u = 14\sin\theta$
$t = \frac{s}{u}$	$s = ut - \frac{1}{2}gt^2$
$= \frac{9}{14\cos\theta}$	$h-1 = \frac{14\sin\theta\times9}{14\cos\theta} - \frac{1}{2}\times\frac{9.81\times9^2}{(14\cos\theta)^2}$
	$h-1 = 9\tan\theta - 2.027\sec^2\theta$ ①
	Diff. w.r.t θ
	$\frac{dh}{d\theta} = 9\sec^2\theta - 2.027\times2\sec\theta\tan\theta$

Vertical

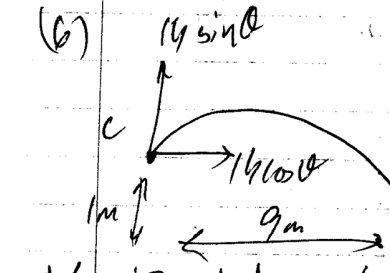
Put $\frac{dh}{d\theta} = 0$

$\therefore \tan\theta = 2.22$

$\theta = 65.751^\circ$

Substitute in (i) and get h= 8.96m

(6)

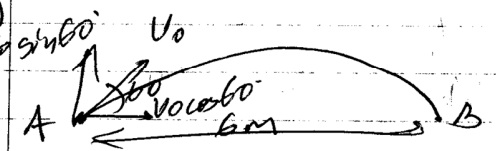


Horizontal	Vertical
$S = 9m$	$S = -1m$
$u = 14\cos\theta$	$u = 14\sin\theta$
$t = \frac{S}{u}$	$S = ut - \frac{1}{2}gt^2$
$= \frac{9}{14\cos\theta}$	$-1 = 14\sin\theta\left(\frac{9}{14\cos\theta}\right) - \frac{1}{2}\times 9.81\left(\frac{9}{14\cos\theta}\right)^2$

$\therefore \theta = 76.975^\circ$ or 6.685°

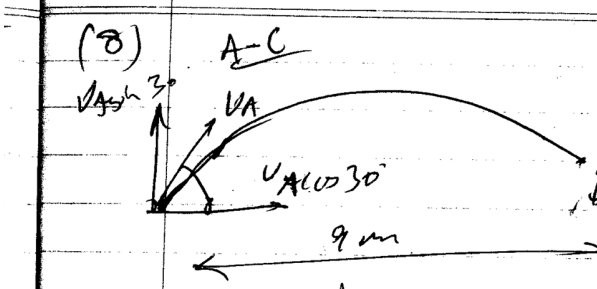
Smallest angle $= 6.685^\circ$

(7)



Horizontal	Vertical
$S = 6m$	$S = 0$
$u = V_0\cos 60$	$u = V_0\sin 60$
$t = \frac{S}{u}$	$S = ut - \frac{1}{2}gt^2$
$= \frac{6}{V_0\cos 60}$	$0 = V_0\sin 60 - \frac{1}{2}\times 9.81\left(\frac{6}{V_0\cos 60}\right)$
	$\therefore V_0 = 8.244 m/s$

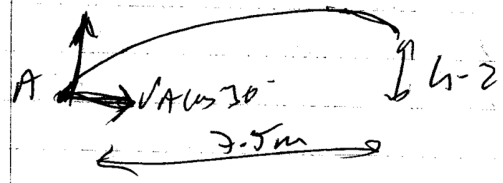
(8) A–C



Horizontal	Vertical
$s = 9m$	$s = 1m$
$u = V_A \cos 30$	$u = V_A \sin 30$
$t = \frac{s}{u}$	$s = ut - \frac{1}{2}gt^2$
$= \frac{9}{V_A \cos 30}$	$1 = \frac{V_A \sin 30 \times 9}{V_A \cos 30} - \frac{1}{2} \times 9.8 \left(\frac{9}{V_A \cos 30}\right)^2$
	$\therefore V_A = 11.236 m/s$

A-B

$V_A \angle 30°$



Horizontal	Vertical
$s = 7.5$	$s = h-2$
$u = V_A \cos 30°$	$u = V_A \sin 30° = 5.688$ m/s
$t = \frac{s}{u}$	$t = 0.771$ s
$= \frac{7.5}{V_A \cos 30°}$	$s = ut - \frac{1}{2}gt^2$
$= 0.771$ s	$h-2 = 5.688 \times 0.771 - \frac{1}{2} \times 9.81 \times (0.771)^2$
	$h = 3.416$ m

(9)

Ax - Horizontal

$s = d$

$u = V_0 \cos\theta_2$

$t = \frac{s}{u}$

$t = \frac{d}{V_0 \cos\theta_2}$

Bx - Horizontal

$s = d$

$u = kV_0 \cos\theta_1$

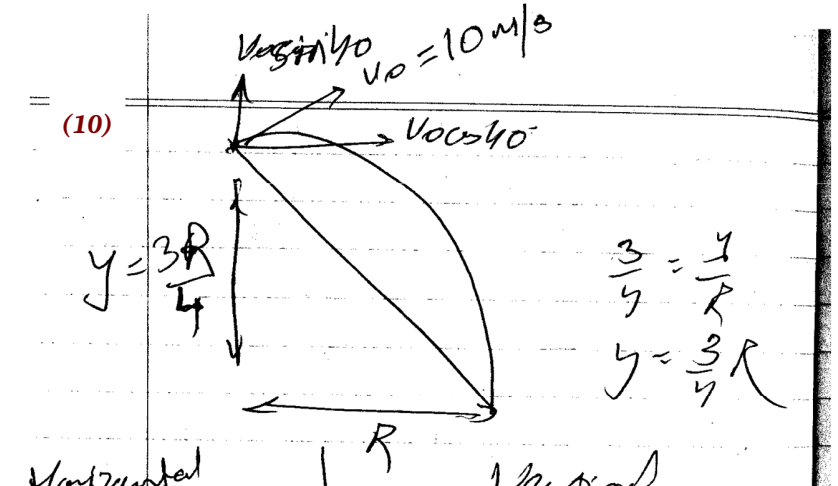
$t = \frac{s}{u}$

$t = \frac{d}{kV_0 \cos\theta_1}$

$\therefore \frac{d}{V_0 \cos\theta_2} = \frac{d}{kV_0 \cos\theta_1}$

$\therefore k = \cos\theta_2 / \cos\theta_1$

(10)



$\frac{3}{y} = \frac{4}{R}$

$y = \frac{3}{4}R$

Horizontal

$s = R$

$u = v_0 \cos 40°$

$t = \frac{s}{u}$

$= \frac{R}{v_0 \cos 40°}$

Vertical

$s = -\frac{3}{4}R$

$u = v_0 \sin 40°$

$s = ut - \frac{1}{2}gt^2$

$-\frac{3R}{4} = v_0 \sin 40° \left(\frac{R}{v_0 \cos 40°}\right) - \frac{1}{2} \times 9.81 \times \left(\frac{R}{v_0 \cos 40°}\right)^2$

$R = 19.02$ m

$\therefore t = 2.482$ s

(11)

From previous part

Vertical

$t = 2.482$ s

$v = u - gt$

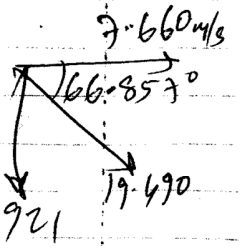
$= v_0 \sin 40 - 9.81 \times 2.482$

$= -17.921$ m/s

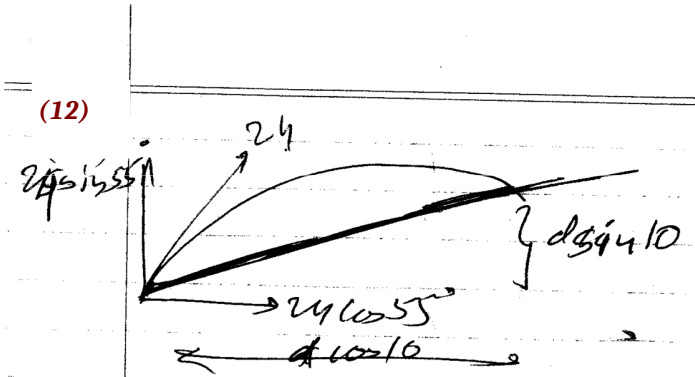
$v_{final} = \sqrt{(v_0 \cos 40)^2 + (17.921)^2}$

$= 19.490$ m/s

Max acc^n $= -9.81$ m/s^2



(12)



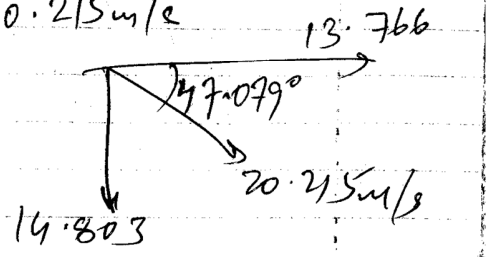
Horizontal	Vertical
$s = d\cos 10$	$s = d\sin 10$
$u = 24\cos 55$	$u = 24\sin 55$
$t = \frac{s}{u}$	$s = ut - \frac{1}{2}gt^2$
$= \frac{d\cos 10}{24\cos 55}$	$d\sin 10 = 24\sin 55\left(\frac{d\cos 10}{24\cos 55}\right) - \frac{1}{2}\times 9.81\left(\frac{d\cos 10}{24\cos 55}\right)^2$
	$\therefore d = 49.109\text{ m}$

(13) From previous answer

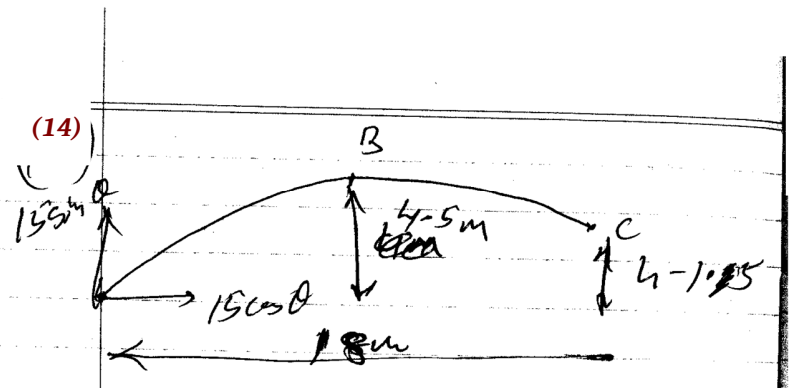
Horizontal	Vertical
$t = \frac{d\cos 10}{24\cos 55}$	$v = u - gt$
$= 3.513\text{s}$	$= 24\sin 55 - 9.81\times 3.513$
	$= -14.803\text{m/s}$

$v_{final} = \sqrt{(24\cos 55)^2 + 14.803^2}$

$= 20.215\text{m/s}$



(14)



A - B

Vertical

$u = 0$

$u = 15 \sin\theta$

$s = 4.5\ m$

$v^2 = u^2 - 2gs$

$0 = (15\sin\theta)^2 - 2 \times 9.81 \times 4.5$

$\therefore \theta = 38.786°$

A - C

Horizontal	Vertical
$s = 18\ m$	$s = 4 - 1.5$
$u = 15\cos\theta$	$t = 1.540$
$= 11.692\ m/s$	$u = 15\sin\theta = 9.396\ m/s$
$t = \frac{s}{u}$	$s = ut - \frac{1}{2}gt^2$
$= \frac{18}{11.692}$	$4 - 1.5 = 9.396 \times 1.540 - \frac{1}{2} \times 9.81 \times (1.54)^2$
$= 1.540 s$	$\therefore 4 = 4.337\ m$

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