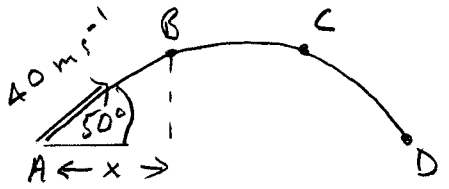
MEI M1 JAN 2005 Q7 PROJECTILES

7)



i) $x = (40\cos 50°)t$

$y = (40\sin 50°)t - 4.9t^2$

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ii) At D, $y = 0 \Rightarrow 0 = (40\sin 50°)t - 4.9t^2$

$0 = t(40\sin 50° - 4.9t)$

At D $\quad 4.9t = 40\sin 50° \quad \Rightarrow t = \dfrac{40\sin 50°}{4.9} = 6.253$ s to 3dp

Range $= AD = (40\cos 50°) \times 6.253 = 160.77$ m $= 161$ m to 3 s.f.

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iii) At B, $x = 30 \Rightarrow 30 = (40\cos 50°)t \Rightarrow t = \dfrac{30}{40\cos 50°} = 1.167$ s

Time to reach B = 1.167 s, By symmetry time C to D also 1.167 s

∴ time A to C = time A to D − time C to D

$= 6.253 - 1.167 = 5.086$ s

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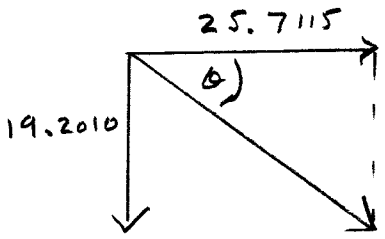
iv)



$V_x = 40\cos 50° = 25.7115$ ms^{-1}

$V_y = 40\sin 50° - gt$

$V_y = 40\sin 50° - 9.8 \times 5.086$

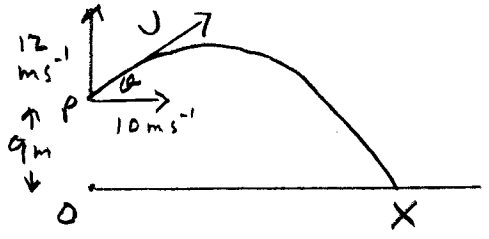
$= -19.2010$ ms^{-1}

$\tan\theta = \dfrac{19.2010}{25.7115}$

$\theta = 36.8°$

Direction of motion 36.8° below horizontal

MEI M1 JUN 2005 Q7 PROJECTILES



Take $g = 10\ ms^{-2}$

i) $V = \sqrt{10^2 + 12^2} = 15.6\ ms^{-1}$ to 3 s.f.

$\theta = \tan^{-1}\left(\frac{12}{10}\right) = 50.2°$

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ii) Vertical

$y = u_y t - \frac{1}{2}gt^2 + 9$

$y = 12t - 5t^2 + 9$

$y = 9 + 12t - 5t^2$

Horizontal

$x = 10t$

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iii) $v_y^2 = u_y^2 - 2g(y-9)$

At max height $v_y = 0$

$0 = 12^2 - 20(y-9)$

$20(y-9) = 144$

$y - 9 = \frac{144}{20} = 7.2m$

$y-9$ is height above point of projection $= 7.2m$

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iv) At X, $y = 0 \Rightarrow 0 = 9 + 12t - 5t^2$ By calc $t = 3s$

$OX = 10t = 10 \times 3 = 30m$

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v) For B, $x = (20\cos 60)t = 10t$ same as for A

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vi) For B $y = (20\sin 60)t - \frac{1}{2}gt^2 = 10\sqrt{3}t - 5t^2$

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vii) Horizontal displacements always equal so collide when vertical displacements are also equal

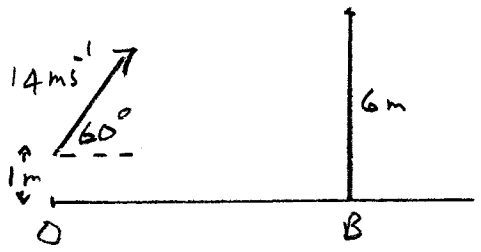
$\Rightarrow 9 + 12t - 5t^2 = 10\sqrt{3}t - 5t^2$

$\Rightarrow 9 = (10\sqrt{3} - 12)t$

$\Rightarrow t = \frac{9}{10\sqrt{3} - 12} = 1.69s = 1.7s$ to 2 s.f.

MEI M1 JAN 2006 Q8 PROJECTILES

8)



i) $x = (14\cos 60°)t = 7t$

$y = (14\sin 60°)t - \frac{1}{2}gt^2 + 1$

$y = 7\sqrt{3}\,t - 4.9t^2 + 1$

ii)

A) At highest point $v_y = 0$ $\quad v_y = 7\sqrt{3} - 9.8t \Rightarrow 0 = 7\sqrt{3} - 9.8t$

$t = \frac{7\sqrt{3}}{9.8} = 1.24\text{s}$ to 3 s.f.

B) $OB = 7 \times 1.24 = 8.68\text{m}$

C) When $t = 1.24\text{s}$ $\quad y = 7\sqrt{3} \times 1.24 - 4.9 \times 1.24^2 + 1 = 8.50\text{m}$ to 3 s.f

Wall is 6m high so clearance $= 8.5 - 6 = 2.5\text{m}$

iii) $x = 7t \Rightarrow t = \frac{x}{7}$ $\quad y = 7\sqrt{3}\,t - 4.9t^2 + 1$

so $y = 7\sqrt{3}\left(\frac{x}{7}\right) - 4.9\frac{x^2}{49} + 1$

$y = \sqrt{3}\,x - 0.1x^2 + 1$

iv) Find when height $= 6\text{m}$ $\quad 6 = 7\sqrt{3}t - 4.9t^2 + 1$

$4.9t^2 - 7\sqrt{3}\,t + 5 = 0$

$t = 0.523$ or $t = 1.951$

When $t = 1.951$, $\quad x = 7 \times 1.951 = 13.66\text{m}$

Girl needs to move away $13.66 - 8.68 = 4.98\text{m}$

then stone will be 6m high when it reaches wall

so $d = 4.98\text{m}$

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5)

i) $v^2 = u^2 + 2as$ $\quad v_y^2 = u_y^2 - 19.6y$

At max height $v_y = 0$ $\quad 0 = u_y^2 - 19.6 \times 22.5$

$\sqrt{19.6 \times 22.5} = u_y$

$21 \text{ ms}^{-1} = u_y$ $\quad \therefore$ vertical component of initial velocity $= 21 \text{ ms}^{-1}$

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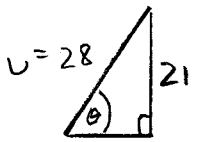
ii)



$\theta = \sin^{-1}\left(\frac{21}{28}\right) = 48.6^\circ$

Projected 48.6° above horizontal

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iii) $y = 21t - 4.9t^2$ $\quad$ Lands when $y = 0$

$0 = 21t - 4.9t^2$

$0 = t(21 - 4.9t)$

$t = \frac{21}{4.9} = \frac{30}{7}$ s

$x = (28\cos\theta)t$

$x = 28\cos 48.6 \times \frac{30}{7} = 79.4\text{m}$

Horizontal range $= 79.4\text{m}$
