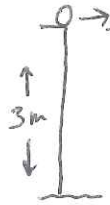
TSOKOS 2.10 Projectiles p.140 #3-7, 10, 11, 12, 15 | SL1 HW #6

(3) $\to V_{ox} = 5\,m\cdot s^{-1}$



s	u	v	a	t
X	V_{ox}	V_x	a_x	t
~~X~~	+5 m/s	+5 m/s	0	

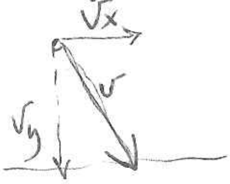
s	u	v	a	t
y	V_{oy}	V_y	a_y	t
-3 m	0		-9.8 m/s²	

a) Time t=? (use vertical data)

$S = \cancel{ut} + \frac{1}{2}at^2 \qquad t = \sqrt{\frac{2\cdot S_y}{a_y}} = \sqrt{\frac{(-3\cdot 2)}{-9.8}} = \boxed{0.78s}$

b) Speed v before hitting the ground = combination of V_x and V_y

$V_y = U_y + a_y t = 0 + (-9.8\frac{m}{s^2})(0.78s) = -12.6\frac{m}{s}$



$V = \sqrt{(V_x)^2 + (V_y)^2} = \sqrt{(5\frac{m}{s})^2 + (-12.6\frac{m}{s})^2} = \boxed{13.6 m/s}$

*I used 9.8 m/s² instead of 10.

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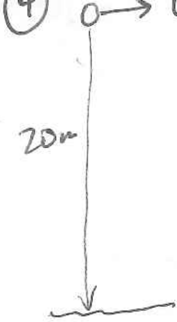
(4) $\to U_x = +8.0\,m\cdot s^{-1}$

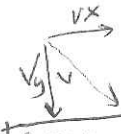


S_x	U_x	V_x	a_x	t
	+8.0 m/s	+8.0 m/s	0	2.0

S_y	U_y	V_y	a_y	t
-20 m	0		-9.8 m/s²	2.0 s

a) time to land - use vertical data

$S_y = \cancel{U_y t} + \frac{1}{2}a_y t^2 \quad t = \sqrt{\frac{2\cdot S_y}{a_y}} = \sqrt{\frac{2(-20)}{-9.8}} = \boxed{2.02s} = \boxed{2.0}$

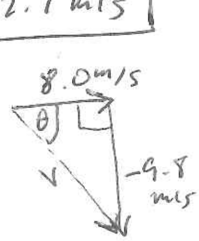


b) Speed 1s after launch $V_x = +8.0\,m/s$ always

$V_y = \cancel{U_y} + at = (-9.8\,m/s^2)(1s) = -9.8\,m/s \quad$ Speed $V = \sqrt{(V_x)^2 + (V_y)^2}$

$V = \sqrt{(+8.0)^2 + (-9.8)^2} = \boxed{12.7\,m/s}$

c) Angle θ (w/ horizontal) at 1 s



$\theta = \tan^{-1}\left(\frac{9.8}{8.0}\right) = \boxed{50.8° \text{ below } +X}$

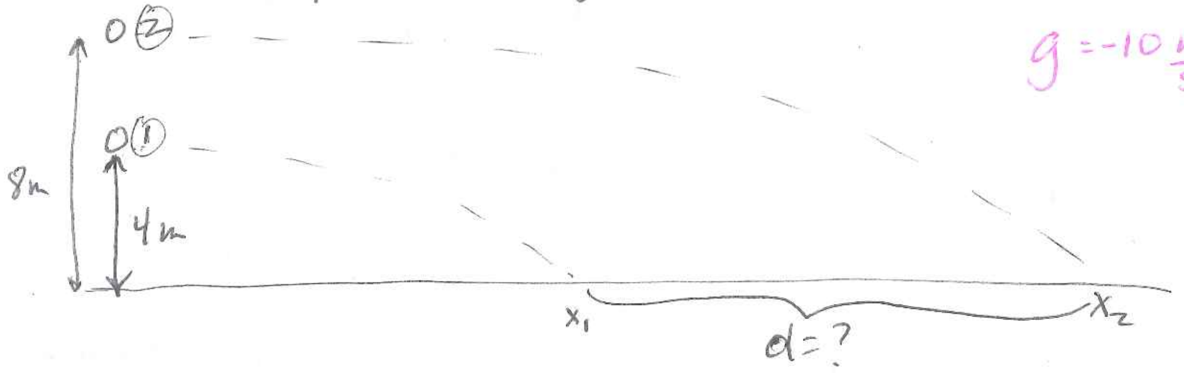
d) V of impact. Find $V_y = U_y + at = (-9.8\frac{m}{s^2})(2.0s) = -19.6\,m/s$

V_x is always +8.0 m/s So $V = \sqrt{(V_x)^2 + (V_y)^2} = \sqrt{(8.0)^2 + (-19.6)^2}$

$\boxed{V = 21.2\,m/s}$ $\qquad g = -9.8\,m/s^2$

⑤ 2 objects thrown horizontally w/ $u_x = +4.0\ m/s$
One object was 4.0 m above ground and the other 8.0 m.
How far apart are they on impact?

$g = -10\ \frac{m}{s^2}$



* Find time to drop (vertically) for each and use this time to find horizontal distance x (range)

ball 1 $\quad S_y = \cancel{u_y}^{0} + \frac{1}{2} a_y t_1^2 \qquad t_1 = \sqrt{\frac{2S_{y1}}{a_y}} = \sqrt{\frac{2(-4)}{-10}} = 0.89\ s$

ball 2 $\quad t_2 = \sqrt{\frac{2S_{y2}}{a_y}} = \sqrt{\frac{2(-8)}{-10}} = 1.26\ s$

horizontally $a_x = 0$ so....

$X_1 = V_x \cdot t_1 = (+4.0\ \frac{m}{s})(0.89s) = 3.56\ m \qquad X_2 = V_x \cdot t_2 = (4.0\ \frac{m}{s})(1.26s)$
$= 5.04\ m$

$d = X_2 - X_1 = 5.04 - 3.56 = \boxed{1.48\ m}$

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⑥ Speed of 4.0 m object from above problem needed to land in same spot as 8.0 m object (launched at +4.0 m/s)

$V_{x1} = \frac{X_2}{t_1} = \frac{5.04\ m}{0.89\ s} = \boxed{+5.7\ m/s}$

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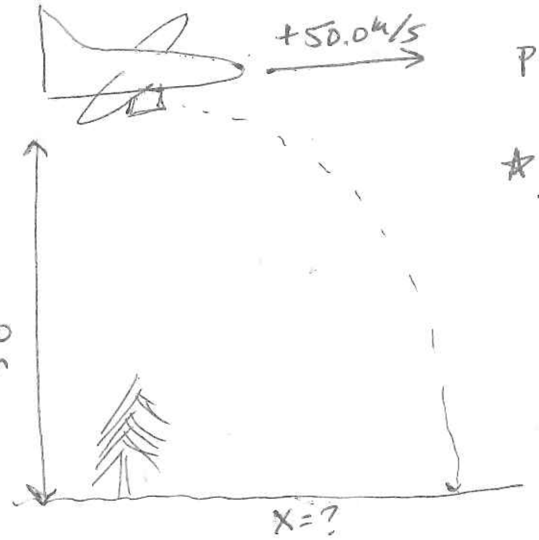
7



package has same horizontal speed as plane

★ Find t vertically

$S_y = \frac{1}{2} a_y t^2 \quad t = \sqrt{\frac{2 S_y}{a_y}} = \sqrt{\frac{2(-200)}{-10}}$

$t = 6.32\text{ s}$

$x = v_x \cdot t = (50.0\,\frac{m}{s})(6.32\text{ s}) = \boxed{316\text{ m}}$

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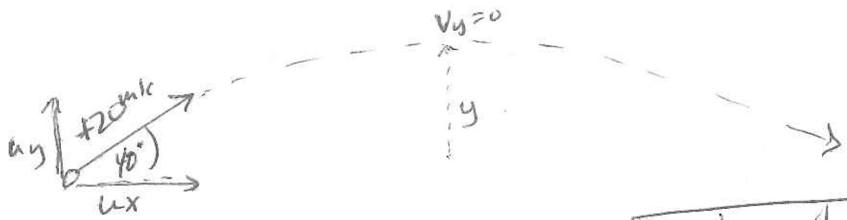
10 Object thrown at 40° to horizontal w/ u = +20 m/s

Draw graphs



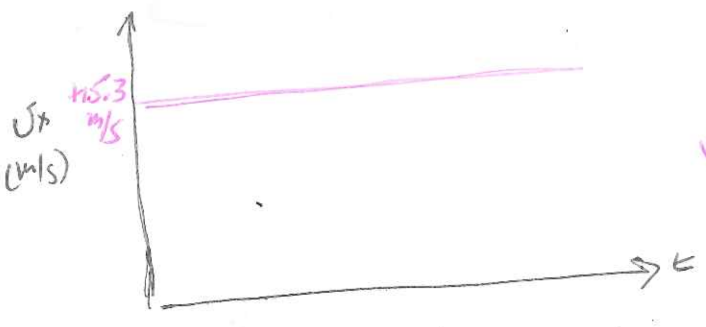
S_x	u_x	v_x	a_x	t
	+15.3	+15.3	0	

$u_x = v_x = 20\text{ m/s} \cdot \cos(40°) = 15.3\text{ m/s}$

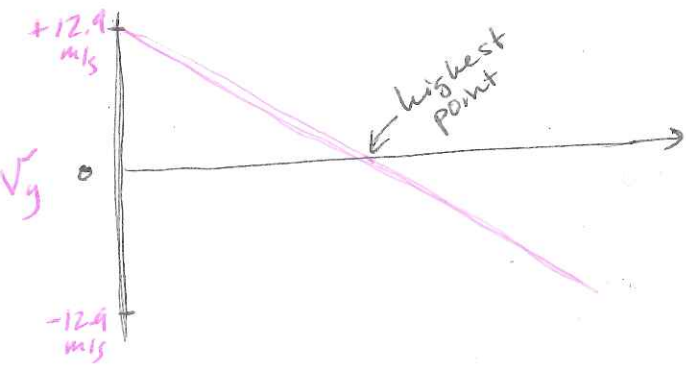
S_y	u_y	v_y	a_y	t
	+12.9	0	−10 m/s²	

$u_y = 20\text{ m/s} \cdot \sin(40°) = +12.9\text{ m/s}$

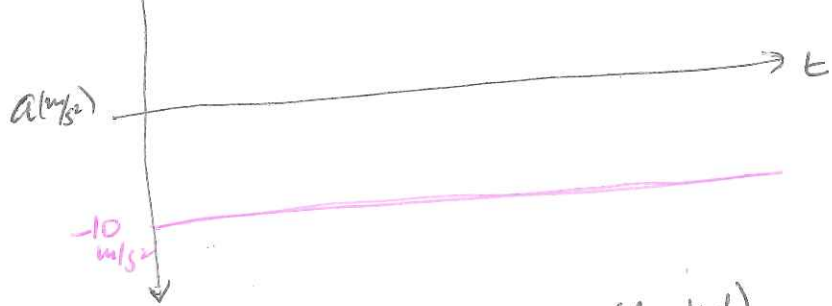
a) v_x vs. time



b) v_y vs. time



c) a_y vs time



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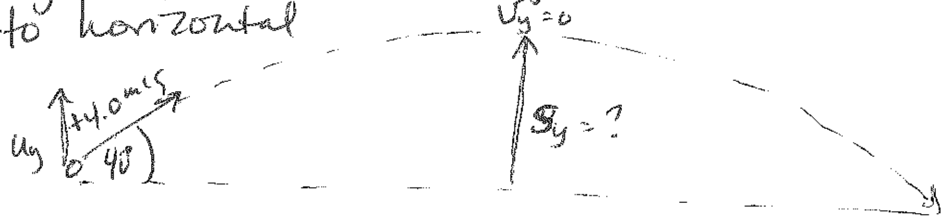
(11) Highest point (S_y) for object thrown at $u = 4.0\,\frac{m}{s}$ at $40°$ to horizontal



$$v_y^2 = u_y^2 + 2a_y S_y \qquad u_y = (+4.0\,m/s)(\sin 40°) = +2.57\,m/s$$

$$S_y = \frac{v_y^2 - u_y^2}{2a_y} = \frac{0^2 - (2.57\,\frac{m}{s})^2}{2(-10\,m/s^2)} = \boxed{0.33\,m}$$

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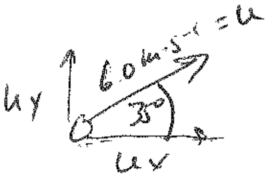
(12) Stone thrown w/ $u = +6.0\,m \cdot s^{-1}$ at $35°$.

What is angle of v after 1 s?



$$u_x = (6.0\,\tfrac{m}{s})(\cos 35°) = 4.91\,m/s$$

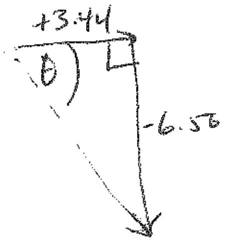
$$u_y = (6.0\,\tfrac{m}{s})(\sin 35°) = 3.44\,m/s$$

After 1 s

$v_x = u_x = 4.91\,m/s \quad (a_x = 0)$

$v_y = u_y + a_y t = (+3.44\,\frac{m}{s}) + (-10\,\frac{m}{s^2})(1\,s) = -6.56\,m/s$

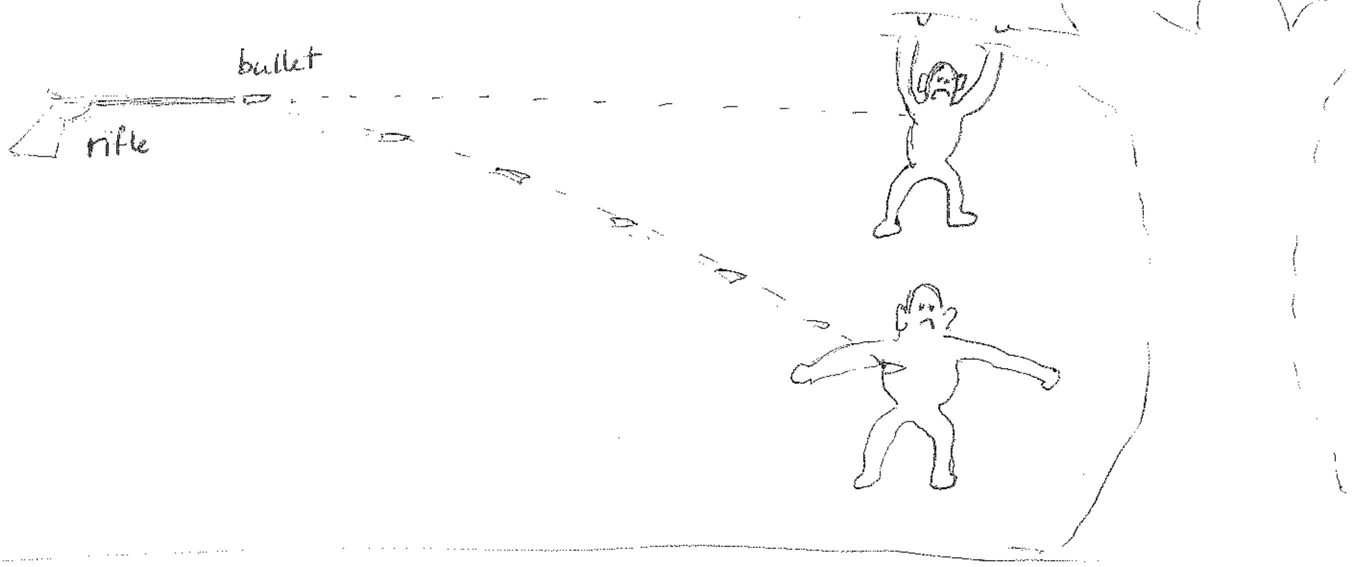
Angle θ



$$\theta = \tan^{-1}\left(\frac{6.56}{3.44}\right) = \boxed{62.3° \text{ below } +x}$$

(over for famous "shoot the monkey" problem)

15



If the monkey lets go at the same time the rifle is fired and they start at the same height, the bullet and monkey will fall together at the same acceleration ($a_y = -10 \frac{m}{s^2}$) so the bullet will always hit the monkey.