Physics 20 - Lesson 13
Projectiles – Answer Key

Possible 90 / 57

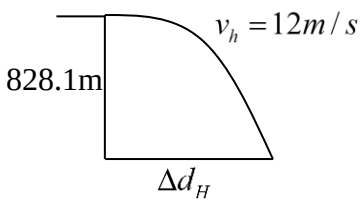
1) The bullet fired horizontally has an initial vertical velocity of zero as does the bullet being dropped. The horizontal motion does not effect the vertical acceleration, therefore both bullets hit the ground at the same time.

/2

2) The dart leaves the rifle at the same instant that the monkey begins to fall. Since both the dart and the monkey fall at the same rate, the hunter should aim directly at the monkey in order to hit it.

/2

3)



/7

Vertical (time)

$v_1 = 0$

$\Delta\vec{d} = -828.1m$

$\vec{a} = -9.81\,^{m}/_{s^2}$

$\Delta t = ?$

$\Delta\vec{d} = \cancel{\vec{v}_1\Delta t} + \frac{1}{2}\vec{a}\Delta t^2$

$\Delta t = \sqrt{\frac{2\Delta\vec{d}}{\vec{a}}} = \sqrt{\frac{2(-828.1m)}{(-9.81\,^{m}/_{s^2})}}$

$\Delta t = 13.0s$

Horizontal

$v_H = 12\,^{m}/_{s}$

$\Delta\vec{d}_H = ?$

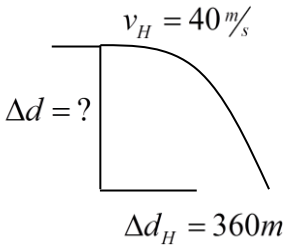
$\Delta t = 13.0s$

$\Delta\vec{d}_H = v_H\Delta t$

$\Delta\vec{d}_H = 12\,^{m}/_{s}(13.0s)$

$\boxed{\Delta\vec{d}_H = 156m}$

4)



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Horizontal (time)

$v_H = 40\,^{m}/_{s}$

$\Delta\vec{d}_H = 360m$

$\Delta t = ?$

$\Delta t = \frac{\Delta d_H}{V_H} = \frac{360m}{40\,^{m}/_{s}}$

$\Delta t = 9.0s$

Vertical (height)

$v_H = 0$

$\vec{a} = -9.81\,^{m}/_{s^2}$

$\Delta\vec{d} = ?$

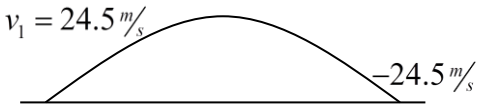
$\Delta t = 9.0s$

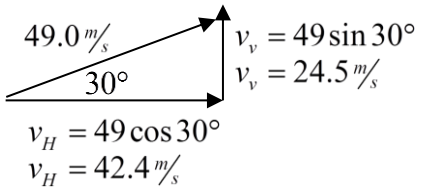
$\Delta\vec{d} = v_1\Delta t + \frac{1}{2}\vec{a}\Delta t^2$

$\Delta\vec{d} = 0 + \frac{1}{2}(-9.81\,^{m}/_{s^2})(9.0s)^2$

$\boxed{\Delta\vec{d} = -397m}$

5) /11





a) $\Delta t = \dfrac{\vec{v}_2 - \vec{v}_1}{\vec{a}} = \dfrac{0 - 24.5\,m/s}{-9.81\,m/s^2} \quad \Delta t = 2.50s$

c) Total time = $2.50 \times 2s = \boxed{5.00s}$

d)

range (*horizontal*)

$v_H = 42.4\,m/s$

$\Delta t = 5.00s$

$\Delta d_H = ?$

$\Delta d_H = v_H \times \Delta t$

$\Delta d_H = 42.4\,m/s\,(5.00s)$

$\boxed{\Delta d_H = 212m}$

b)

$v_1 = +24.5\,m/s$

$v_2 = 0$

$a = -9.81\,m/s^2$

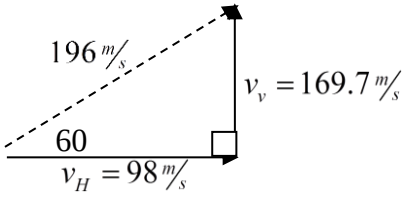
$\Delta d = ?$

$\vec{v}_2{}^2 = v_1{}^2 + \vec{a}\Delta\vec{d}$

$0 = (24.5)^2 + 2(-9.81\,m/s^2)\Delta d$

$\boxed{\Delta d = 30.6m}$

6) /11



<u>Vertical</u>

$v_1 = 169.7\,m/s$

$v_2 = 0$

$\Delta\vec{d} = ?$

$\vec{a} = -9.81\,m/s^2$

$\vec{v}_2{}^2 = v_1{}^2 + 2a\Delta d$

$0 = (169.7)^2 + 2(-9.81)\Delta d$

$\boxed{\Delta d = 1469m}$

$\Delta t = \dfrac{\vec{V}_2 - \vec{V}_1}{\vec{a}} = \dfrac{0 - 169.7}{-9.81}$

$\Delta t = 17.3s$

total=34.6*s*

<u>Horizontal</u>

$v_H = 98\,m/s$

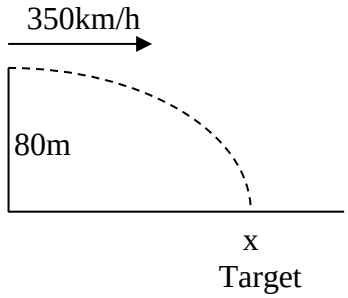
$\Delta\vec{d}_H = ?$

$\Delta t_t = 34.6s$

$\Delta d_H = v_H \times \Delta t = 98\,m/s\,(34.6s)$

$\boxed{\Delta d_H = 3391m}$

7)



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x	y
$v_x = 97.2 m/s$	$v_{iy} = 0$
d_x	$a_y = -9.81 m/s^2$
$t = 4.04 s$	$t = ?$
	$h_y = -80 m$

$d_x = v_x t$

$d_x = (97.2 m/s)(4.24 s)$

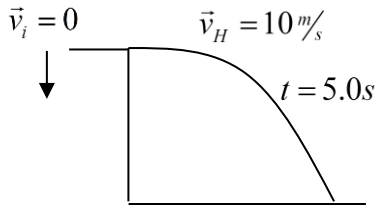
$\boxed{d_x = 392.6 m}$

$d = \cancel{v_i t} + \frac{1}{2} a t^2$

$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(-80 m)}{-9.81 m/s^2}}$

$t = 4.04 s$

8)



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a) How high

$v_1 = 0$
$\Delta\vec{d} = ?$
$\vec{a} = -9.81\,^m/_{s^2}$
$\Delta t = 5.0 s$

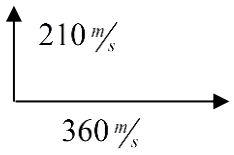
$\Delta\vec{d} = v_1 \Delta t + \frac{1}{2}\vec{a}\Delta t^2$
$\Delta\vec{d} = \frac{1}{2}(-9.81\,^m/_{s^2})(5.0 s)^2$
$\Delta\vec{d} = -123 m$ (window height)

b) How far away

$v_H = 10\,^m/_s$
$\Delta\vec{d}_H = ?$
$\Delta t_t = 5.0 ss$

$\Delta d_H = v_H \times \Delta t = 10\,^m/_s (5.0 s)$
$\Delta d_H = 50 m$ (range)

9)



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a)

$\vec{v}_i = +210 m/s$
$\vec{v}_f = -210 m/s$
$\vec{a} = -9.8 m/s^2$
$t = ?$

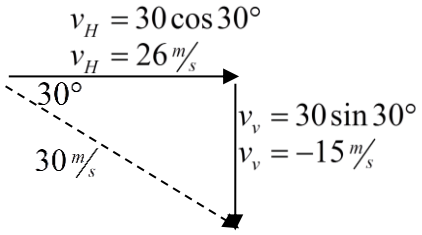
$\Delta t = \frac{-210\,^m/_s - 210\,^m/_s}{-9.81\,^m/_{s^2}}$

$\Delta t = 42.9 s$

b)

$v_H = 360\,^m/_s$
$\Delta t = 42.9 s$
$\Delta\vec{d}_H = v_H \times \Delta t = 360\,^m/_s (42.9 s)$
$\Delta\vec{d}_H = 1.54 \times 10^4 m$
$\boxed{\Delta\vec{d}_H = 15.4 km}$

10) bonus /10



Vertical (time)

$v_1 = -15\,m/s$
$v_2 = ?$
$\Delta\vec{d} = -50m$
$\vec{a} = -9.81\,m/s^2$
$\Delta t = ?$

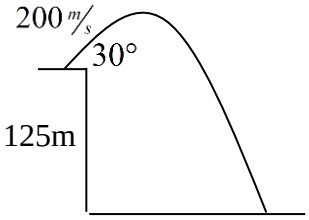
$\vec{v}_2^{\,2} = v_1^{\,2} + 2a\Delta d$
$\vec{v}_2^{\,2} = (-15)^2 + 2(-9.81)(-50)$
$\vec{v}_2^{\,2} = -34.7\,m/s$
$\Delta t = \dfrac{\vec{v}_2 - \vec{v}_1}{a} = \dfrac{-34.7\,m/s + 15\,m/s}{-9.81\,m/s^2}$
$\Delta t = 2.01s$

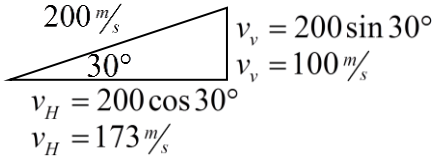
Horizontal

$v_H = 26\,m/s$
$\Delta\vec{d}_H = ?$
$\Delta t_t = 2.01s$

$\Delta d_H = v_H \times \Delta t = 26\,m/s\,(2.01s)$
$\Delta d_H = 52.3m$

11) bonus /10





Vertical (time)

$v_1 = 100\,m/s$
$v_2 = ?$
$\Delta\vec{d} = -125m$
$\Delta t = ?$
$a = -9.81\,m/s^2$

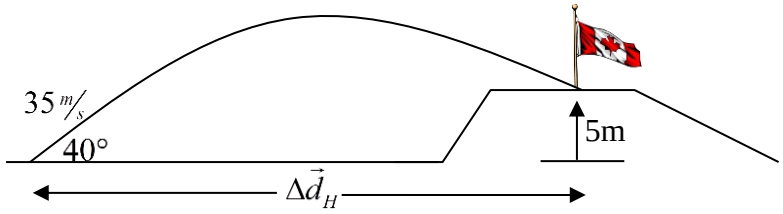
$\vec{v}_2^{\,2} = v_1^{\,2} + 2a\Delta d$
$\vec{v}_2^{\,2} = (100)^2 + 2(-9.81)(-125)$
$\vec{v}_2^{\,2} = -111.6\,m/s$
$\Delta t = \dfrac{\vec{v}_2 - \vec{v}_1}{a} = \dfrac{-111.6\,m/s - 100\,m/s}{-9.81\,m/s^2}$
$\Delta t = 21.6s$

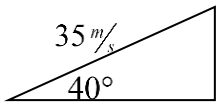
Horizontal (range)

$v_H = 173\,m/s$
$\Delta\vec{d}_H = ?$
$\Delta t = 21.6s$

$\Delta d = v_H \Delta t = 173\,m/s\,(21.6s)$
$\Delta d = 3.7\times 10^3 m$

12)





$v_v = 35\sin 40°$
$v_v = 22.5\,m/s$

$v_H = 35\cos 40°$
$v_H = 26.81\,m/s$

Bonus /13

Vertical (time)

$v_1 = 22.5\,m/s$
$v_2 = ?$ (find velocity as it enters the hole)
$\Delta\vec{d} = 15m$
$\Delta t = ?$
$a = -9.81\,m/s^2$
$\vec{v}_2{}^2 = \vec{v}_1{}^2 + 2a\Delta d$
$\vec{v}_2 = -\sqrt{(22.5)^2 + 2(-9.81)(15)}$
$\vec{v}_2 = -14.56\,m/s$
$\Delta t = \dfrac{\vec{v}_2 - \vec{v}_1}{a} = \dfrac{-14.56\,m/s - 22.5\,m/s}{-9.81\,m/s^2}$
$\Delta t = 3.78s$

Horizontal (range)

$\Delta d = v_H \Delta t$
$\Delta d = 26.81\,m/s\,(3.78s)$
$\Delta d = 101.3m$