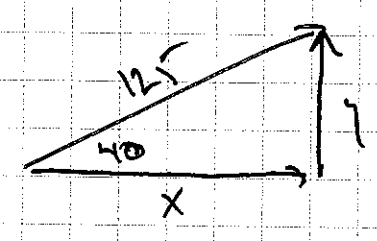
Projectiles 3

① 

$\cos 40 = \frac{x}{125}$ $\quad \sin 40 = \frac{y}{125}$

$x = 125 \cos 40$ $\quad y = 125 \sin 40$

$x = \boxed{95.8 \text{ m/s}}$ $\quad y = \boxed{80.3 \text{ m/s}}$

② a) Since gravity is the only force acting on the shell:

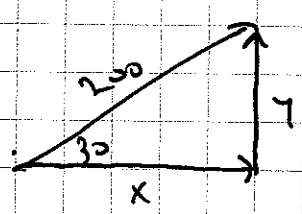
$\Sigma F = F_g = mg = (5)(9.8) = \boxed{49 \text{ N [Down]}}$

b) -49 N

c) 0

d) $a = -9.8 \text{ m/s}^2$

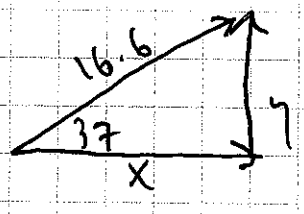
e) $a = 0$

f) 

$y = 200 \sin 30 = \boxed{100 \text{ m/s}}$

g) $x = 200 \cos 30 = \boxed{173.2 \text{ m/s}}$

③ a)



$x = 16.6 \cos 37$ $\quad y = 16.6 \sin 37$

$x = \boxed{13.257 \text{ m/s}}$ $\quad y = \boxed{9.990 \text{ m/s}}$

b) Vertical

$v_i = 9.990$ m/s
$d = 0$
$a = -9.8$ m/s^2
$t = ?$

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

$0 = 9.99t + \frac{1}{2}(-9.8)t^2$

$0 = 9.99t - 4.9t^2$

$0 = t(9.99 - 4.9t)$

$t = 0$ or $9.99 - 4.9t = 0$

$t = \boxed{2.039 \text{ s}}$

c) Horizontal

$v = 13.257$ m/s
$t = 2.039$ s
$d = ?$

$d = vt = (13.257)(2.039) = \boxed{27.031 \text{ m}}$

d) Horizontal

$d_x = vt$

$= (13.257)(0.6)$

$d_x = 7.954$ m

Vertical

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

$= (9.99)(0.6) + \frac{1}{2}(-9.8)(0.6)^2$

$d_y = 4.23$ m

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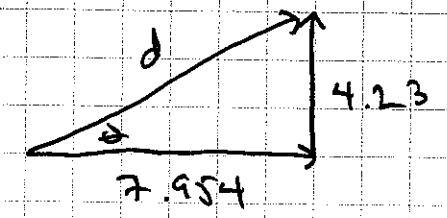
(8) d) continued



$\theta = \tan^{-1}\left(\frac{4.23}{7.954}\right)$

$\theta = 28°$

$d^2 = 4.23^2 + 7.954^2$

$d = \boxed{9.0 \text{ m } [28° \text{ ATH}]}$

e) Horizontal

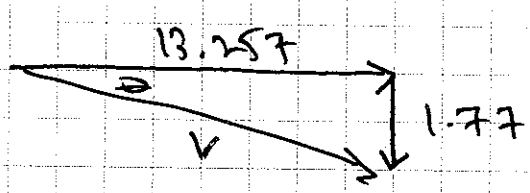
$v_x = 13.257 \text{ m/s}$

Vertical

$v_y = v_f = v_i + at$

$= 9.99 - 9.8(1.2)$

$v_y = -1.77 \text{ m/s}$



$\theta = \tan^{-1}\left(\frac{1.77}{13.257}\right) = 7.6°$

$v^2 = 13.257^2 + 1.77^2$

$v = \boxed{13.4 \text{ m/s } [7.6° \text{ BTH}]}$

f) Vertical

$v_f = 0$

$v_f^2 = v_i^2 + 2ad$

$0 = 9.99^2 + 2(-9.8)d$

$d = \boxed{5.09 \text{ m}}$

(3) g) At max height, the vertical velocity is 0.

The horizontal is 13.257 m/s

∴ $v = \boxed{13.257 \text{ m/s } [\text{Horizontal}]}$

h) 16.6 m/s [37° BTH]

Same as initial speed, but BTH instead of ATH.

(4)

Vertical	Horizontal
$v_i = 16.6 \sin 37 = 9.99$ m/s	$v = 16.6 \cos 37 = 13.257$ m/s
$a = -9.8$ m/s^2	$d = vt$
$d = -122.5$ m	$= (13.257)(6.122)$
$t = ?$	$d = \boxed{81.159 \text{ m}}$

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

$-122.5 = 9.99t + \frac{1}{2}(-9.8)t^2$

$4.9t^2 - 9.99t - 122.5 = 0$

$t = \dfrac{9.99 \pm \sqrt{(9.99)^2 - 4(4.9)(-122.5)}}{2(4.9)}$

$t = \dfrac{9.99 \pm 50.008}{9.8}$

$t = \boxed{6.122 \text{ s}}$ or ~~-4.083 s~~

⑤ Vertical →

$v_i = 10 \sin 45 = 7.071$ m/s

$a = -9.8$ m/s^2
$d = 2.3$ m
$t = ?$

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

$2.3 = 7.071t + \frac{1}{2}(-9.8)t^2$

$4.9t^2 - 7.071t + 2.3 = 0$

$$t = \frac{7.071 \pm \sqrt{(7.071)^2 - 4(4.9)(2.3)}}{2(4.9)}$$

$$t = \frac{7.071 \pm 2.218}{9.8}$$

$t = 0.495$ s or $\boxed{0.948 \text{ s}}$

↑ on the way up

↑ on the way back down (more likely to actually happen, if you think about it)