Conceptual Questions

AP Physics Chapter 4 CQ (4-9, 11,12)

(4) a. No. $\vec{v}$ & $\vec{a}$ never parallel
b. Yes $\vec{v} \perp \vec{a}$ at top

(5) Constant: v_x, a_x, a_y
Zero: a_x

(6) Lands in tube b/c horizontal motion does not affect verticle & so ball continues moving with same $\vec{v}_x$ as cart.
b. Yes, ball lands behind - (diff $\vec{a}_x$ ball & cart)

(7) a. $= \vec{g}$ only force actin is gravity
b. greater, gravity accelerates it

(8) shortest — longest time
$a = b = c = d < e$

(9) 1 was thrown faster
would have to be $v_1 = 15 m/s$
to approach Anita at 10m/s
($v_2 = 5 m/s$)

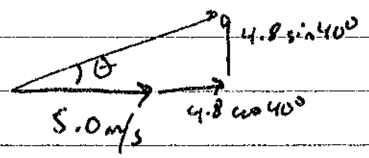
(11) throw 3, otherwise book would continue moving forward at same speed as car & land past driveway on grass

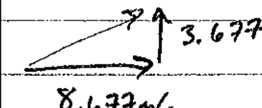
(12) throw 2 - cars have same forward speed - in frame of moving cars, everything at rest

AP Physics Chapter 4 EP(5, 6, 9, 10, 12, 16)

(5) $0.80\,m/s^2 \times 6.0\,s = 4.8\,m/s$

40° N of E





$\theta = \tan^{-1}\left(\frac{3.677}{8.677}\right)$

$= 23^\circ$

9.4 m/s @ 23° N of E

(6) $x = (\frac{1}{2}t^3 - 2t^2)\,m$

$y = (\frac{1}{2}t^2 - 2t)\,m$

a). at t = 0s

$x(0s) = 0$, position = (0,0)

$y(0s) = 0$

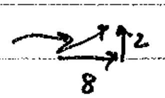
$v_x = \frac{dx}{dt} = \frac{3}{2}t^2 - 4t$

$v_y = \frac{dy}{dt} = t - 2$ $\quad v_y(0s) = -2\,m/s$

$t = 4s$ $\quad x(4) = 0$

$y(4) = 0$

$v_x(4) = 8\,m/s$ $\quad$ speed



$v_y(4) = 2\,m/s$

$8^2 + 2^2 :$ 8.2 m/s

at (0,0)

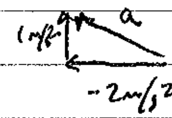
$\tan^{-1} 2/8$

b) at t = 0s $\quad \vec{v}$ = −y direction

at t = 4s $\quad \vec{v}$ = 8.2 m/s 14° above +x

(9) $a_x = \frac{\Delta v_x}{\Delta t} = \frac{-20\,m/s}{10\,s} = -2\,m/s^2$

$a_y = \frac{\Delta v_y}{\Delta t} = \frac{10\,m/s}{10\,s} = 1\,m/s^2$



a. $a = \sqrt{-2^2 + 1^2}$

$a = 2.2\,m/s^2$

b.

$v_x(t) = -2\,m/s^2\,t + 10\,m/s$ $\quad x(t) = \int v_x(t)\,dt$

$v_y(t) = 1\,m/s^2\,t + 0$ $\quad y(t) = \int v_y(t)\,dt$

$x(t) = -1t^2 + 10t$

$y(t) = \frac{1}{2}t^2$

t = 0 (0,0)

t = 5s (25m, 12.5m)

t = 10s (0m, 50m)

0m

28m (25, 12.5)

50m

(10) $\vec{v}_1 = (2.0\hat{i} + 2.0\hat{j})\,m/s$ $\quad \vec{v}_0 = (2.0\hat{i} + 4.0\hat{j})\,m/s$

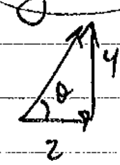
$\vec{v}_2 = (2.0\hat{i} + 0\hat{j})\,m/s$

$\vec{v}_3 = (2.0\hat{i} - 2.0\hat{j})\,m/s$

horiz. unchanged, vertical changes by same amt. each time & zero at top

b) $\vec{g} = -2.0\,m/s^2$

c)



$\tan^{-1} 4/2 = \theta$ $\quad$ 63.4°

(12.) $x = 50m$

$y = -2.0 \times 10^{-2} m$

$a_y = -9.80 m/s^2$

$y = v_{0y} t + \frac{1}{2} a_y t^2$

$-2E{-2} = 0 + \frac{1}{2}(-9.80)(t^2)$

$t = 6.39 \times 10^{-2}$ sec

a. $t = 0.064$ sec

b. in that time bullet went

50m

$v_x = \frac{50m}{6.39\ldots E{-2} sec} = 782.6\ m/s$

780 m/s

(16) $\frac{30km}{3hr} = 10 km/hr$ down river

$\frac{30km}{5hr} = 6 km/hr$ up river

$v_{BOAT} + v_{RIVER} = 10$

$+ \quad v_{BOAT} - v_{RIVER} = 6$

$v_{River} + 6 + v_{River} = 10$

$v_{River} = 2 km/hr$

AP Physics Chapter 4 E&P (17, 41, 42, 43, 45)

(17) $v_{\text{~~}} = \frac{x}{50}$

~~$x = (50s)(v_0)$~~

$x = (75s)(v_{sw})$

~~$50 v_0 = 75 v_{sw}$~~

~~$\frac{50}{75} = \frac{v_{sw}}{v_0}$~~

~~$\frac{2}{3} = \frac{v_{sw}}{v_0}$~~

$(v_0 + v_{sw}) = \frac{x}{t}$

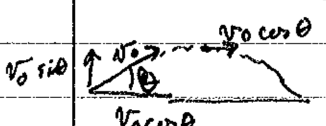
$\frac{x}{50} + \frac{x}{75} = \frac{x}{t}$

$1/50 + 1/75 = 1/t$

$t = 30$ sec

(41) v_0, θ

h = max height



x	y
$v_{0x} = v_0 \cos\theta$	$v_0 \sin\theta = v_{0y}$
	$0 = v_{top\,y}$
	$g = a$
	$h = y$

$v_f^2 = v_0^2 + 2ax$

$0 = (v_0 \sin\theta)^2 + 2(g)h$

$h = \frac{(v_0 \sin\theta)^2}{2g}$

(41 cont.) distance $v_0 \cos\theta \, t$ $\quad t = \frac{(v_0 \sin\theta)2}{g}$ $\quad a = \frac{v_f - v_0}{t}$

Range $= \frac{v_0 \cos\theta \cdot v_0 \sin\theta \cdot 2}{g}$

Range $= \frac{2v_0^2 \sin\theta \cos\theta}{g}$ $\quad$ Height: $\frac{(v_0 \sin\theta)^2}{2g}$

if $v_0 = 33.6$ m/s

$\theta = 30°$ $\quad$ R = 99.8 m $\quad$ H: 14.4 m

$\theta = 45°$ $\quad$ R = 115 m $\quad$ H: 28.8 m

$\theta = 60°$ $\quad$ R = 99.4 m $\quad$ H = 43.2 m

(42) $v_0 = 30$ m/s $\quad$ Assume ground = zero

$\theta = 60°$

$t = 7.5s$

$y(t) = \frac{1}{2}at^2 + v_{0y}t + y_0$

$y(t) = \frac{1}{2}(-9.8)(7.5)^2 + (30\sin 60°)(7.5) + y_0$

$y(t) = -4.9t^2 + (30\sin 60°)t + 80.77$ m

$a_y = \frac{v_{fy} - v_{0y}}{t}$

$y(t) = -4.9t^2 + (30\sin 60)t$

assum L.P. = 0

$-9.8 = \frac{v_{fy} - 30\sin 60°}{7.5}$

$v_{fy} = -47.52$ m/s

$v_f^2 = v_0^2 + 2ax$

$(-47.52)^2 = (30\sin 60)^2 + 2(-9.8)(\Delta y)$

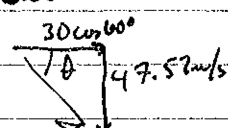
$\Delta y = -80.77$ m

a) launch point 81m higher than landing

b) $H = \frac{(v_0 \sin\theta)^2}{2g} = \frac{(30\sin 60°)^2}{2g}$ $\quad$ 34.4 m above launch point

$v_{fy} = -47.52$ m/s

c) $v_{fx} = 30\cos 60°$



49.8 m/s $\quad$ 72.5° below horiz.

(43) Excel Spreadsheet

→ From before (#41

~~$R = \frac{2v_0^2 \sin\theta \cos\theta}{g}$~~

~~$H = \frac{(v_0 \sin\theta)^2}{2g}$~~

Oops forgot it started 1.8m above ground

$x(t) = v_0 t + \frac{1}{2}at^2 + x_0$

$y(t) = v_0 t + \frac{1}{2}at^2 + y_0$

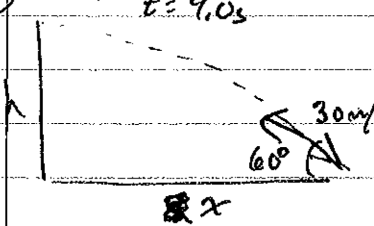
$y(t) = 0 = (12 \sin 40°)\,t - 4.9t^2 + 1.8$

$0 = -4.9t^2 + (12\sin 40°)t + 1.8$

Solve the quadratic in calc. $R = 12\cos\theta \cdot t$

t = 1.7805 sec.	40°	16.4m
t = 1.8528 sec	42.5°	16.4m * "by a hair"
t = 1.9227 sec	45°	16.3m
t = 1.9902 sec	47.5°	16.1m

(45) t = 4.0s



$y(t) = \frac{1}{2}at^2 + v_0 t + y_0$ ($y_0 = 0$)

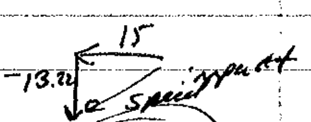
$h = \frac{1}{2}(-9.8)(4)^2 + (30\sin 60°)(4)$

a) $h = 25.5\text{m}$

b) $H = \frac{(v_0 \sin\theta)^2}{2g} = \frac{(30\sin 60)^2}{19.6}$ (from #41) $H_{max} = 34.4\text{m}$

c) $v_x = 30\cos 60° = 15\,\text{m/s}$

$v_y = 30\sin 60 - 9.8(4) = -13.22\,\text{m/s}$



20m/s