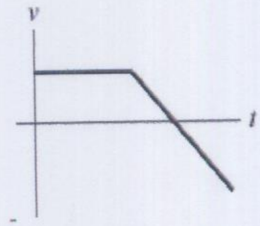
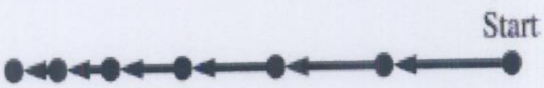
Review Problems unit 1

1. Draw a reasonable position and acceleration graphs for a particle moving with the velocity graph shown.



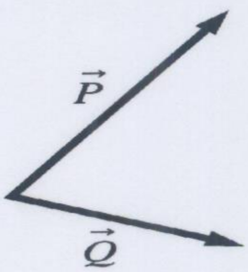
The particle is at x = 0 at t = 0.

2. A car moves along a straight road with the motion diagram shown. Sketch a reasonable v vs t graph for this motion.



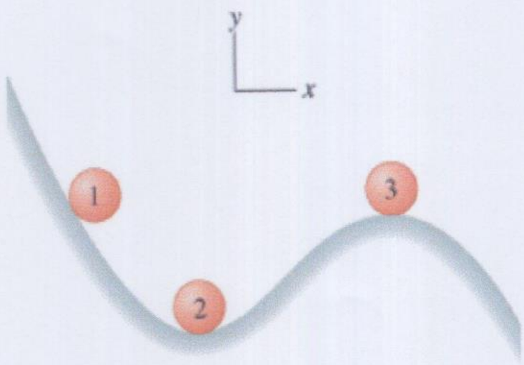
3. Shown are two vectors, $\vec{P}$ and $\vec{Q}$. Draw

a. $\vec{P}+\vec{Q}$
b. $\vec{P}-\vec{Q}$
c. $\vec{Q}-\vec{P}$
d. $\vec{Q}+2\vec{P}$



4. A ball is rolling from left to right along the ramp shown. The ball is already moving when you first observe it at point 1.

Sketch reasonable velocity vectors just before and just after each numbered point. Show how to use these vectors to find the acceleration of the ball at each numbered point.



5. You throw a rock straight upward. You have defined the ground as y = 0 and Up as the positive direction. At a moment when the rock is moving upwards, but slowing down, what is the sign (+, - , or zero) of the

displacement?
velocity?
acceleration?

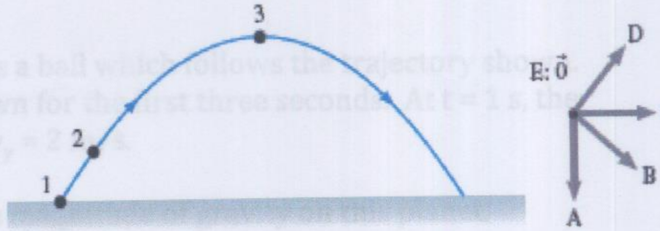
6. A tennis ball is fired from point 1 as shown. Five possible vectors are shown beside the trajectory (vector E has magnitude zero). Which vector best represents

a. the ball's velocity at point 2?

b. the ball's acceleration at point 2?

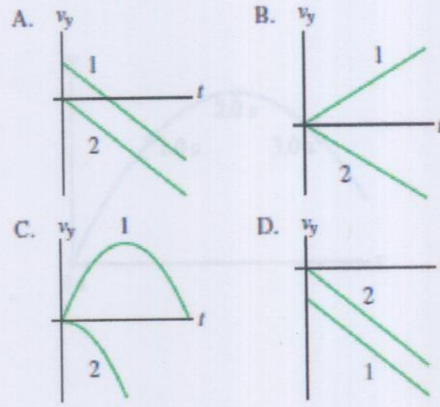
c. the ball's velocity at point 3?

d. the ball's acceleration at point 3?



7. You stand on a balcony holding two tennis balls. You throw ball 1 straight up in the air, and at the same instant you release your grip on ball 2 and let it drop over the side of the building. Which of these velocity graphs best represents the motion of the two balls?

Explain your reasoning.



8. A BMW is traveling at a constant speed of 33 m/s on a straight highway. A private detective waiting for this BMW sees it go past, and after a reaction time of 0.80 s, starts after the BMW. Then the detective maintains a constant acceleration and catches up to the BMW at the next exit, 2.5 km away.

a. make separate motion diagrams for the two vehicles.
b. make displacement graphs for both vehicles on the same set of axes.
c. make velocity graphs for both vehicles on the same set of axes.
d. find the detective's acceleration.

9. A swimmer stands on a diving platform, 3.0 m above the surface of the water. He jumps vertically upward with an initial velocity of 1.8 m/s.

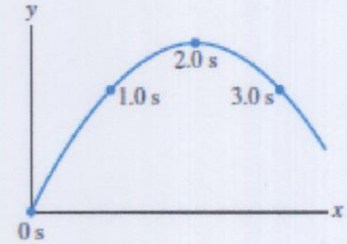
a. sketch the situation, including your coordinate system and relevant variables
b. how much time passes before he hits the water?
c. what is his speed just before hitting the water?

10. A physics student on another planet throws a ball which follows the trajectory shown. The ball's positions at 1.0 sec intervals are shown for the first three seconds. At t = 1 s, the components of the velocity are v_x = 2 m/s and v_y = 2 m/s.

Fill in the values in the table below and find the magnitude of gravity on this planet.

Hint: this is much more a conceptual problem than a mathematical one. You should be able to fill in all but 2 values without using kinematic equations.

time	0 s	1 s	2 s	3 s
v_x				
v_y				
v_{total}				

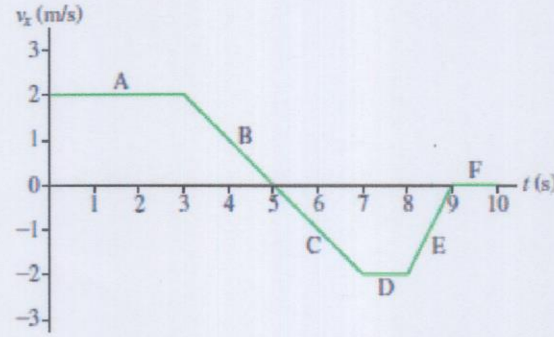


11. The velocity graph of a toy car is shown.

a. Use the method of "area under the velocity graph" to find the displacement of the car during each segment.

b. The car started at the position x = 0 at t = 0. Draw the position graph, including appropriate numbers on your axes. Does the car end up back at its starting position?

c. draw the acceleration graph. Include appropriate numbers on your axes.



12. While taking a hike, you walk 1.6 km in a direction 10° W of N, then 3.3 km in a direction 60° S of E, and finally 2.8 km in a direction 20° S of W.

a. make a reasonable diagram of your journey, showing distances and angles.

b. how far do you need to walk, in a straight line, to return to your starting point? What direction would you need to go?

13. A swallow is flying horizontally at 6.0 m/s with a coconut in its talons. It accidentally drops the coconut.

a. How much time passes before the coconut's speed doubles?

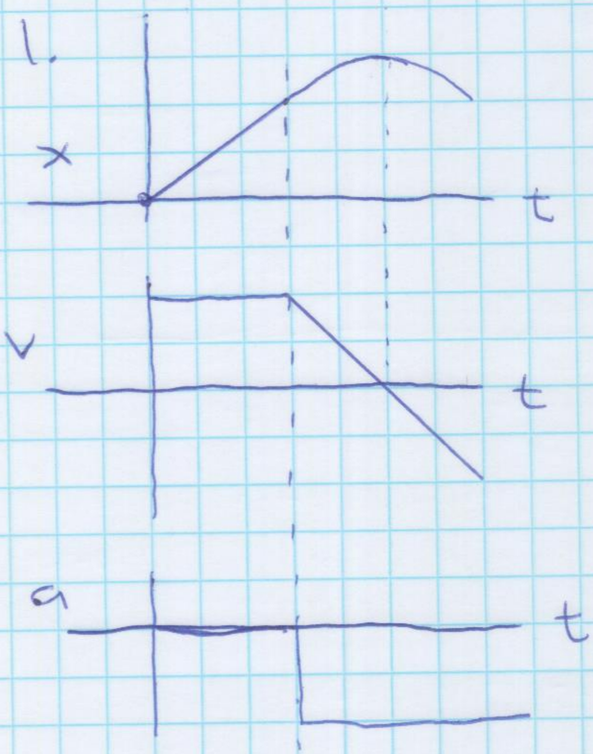
b. How far has the coconut dropped vertically at this point?

c. How far has the coconut traveled horizontally at this point?

Hint: remember that velocity is a vector. Does the horizontal velocity change? Does the vertical velocity change?

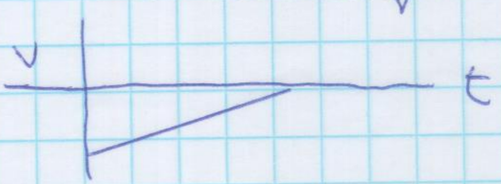
Review Unit 1

1.

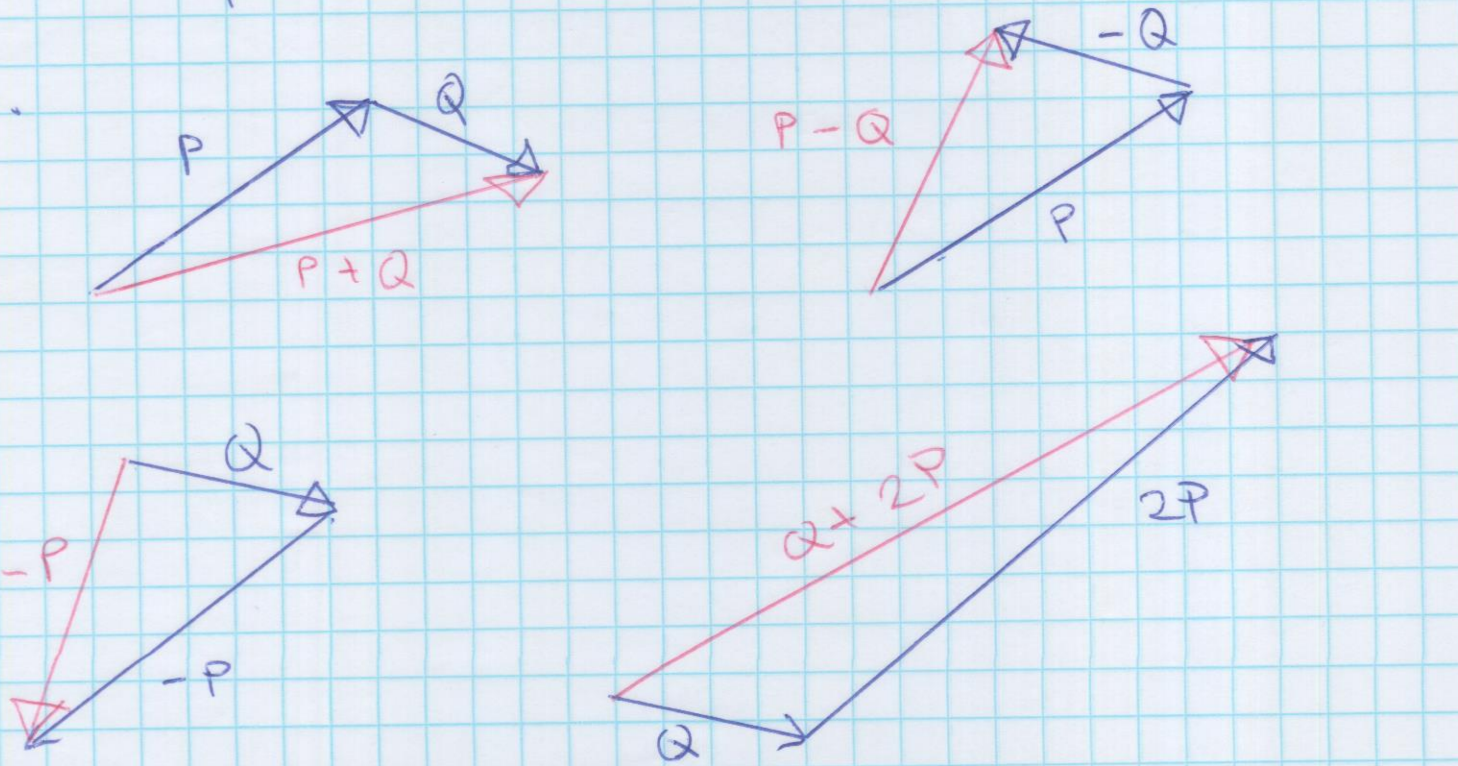


1st Segment straight.
2nd curving down: keeps in + x direction, slowing to a stop, then speeding up in -x direction

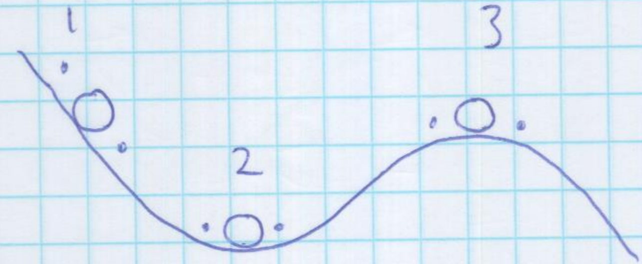
2. If to left is (-) direction:
v always (-) and decreasing.



3.

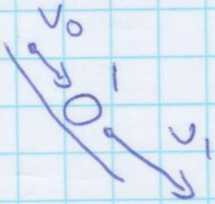


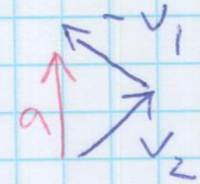
4. Pick points a little before + little after each to see how $\vec{v}$ changed.



$$\overrightarrow{\Delta V} = \vec{V}_f - \vec{V}_i$$

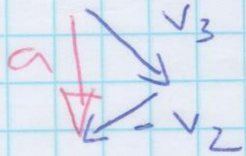
1:



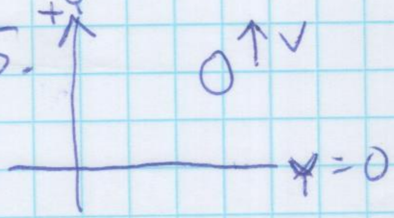


2:

3:



5.



Disp.	~+
Vel.	+
Accel.	−

6.

a	D
b	A
c	C
d	A

Total velocities. Not x or y components.

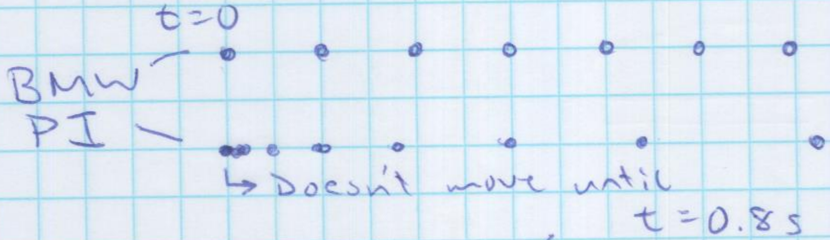
7. A.

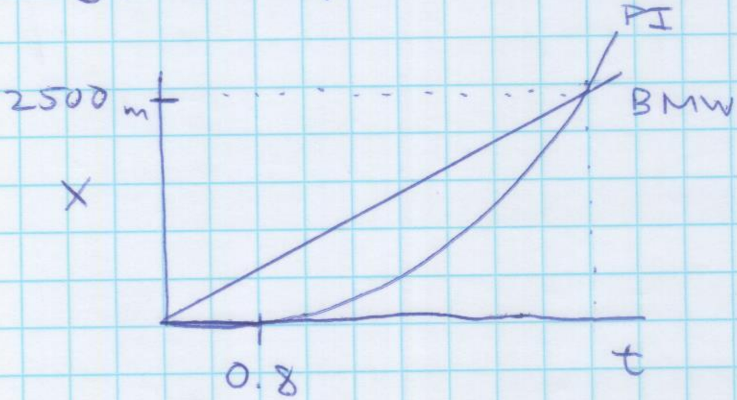
Ball 1 has $v_0 \neq 0$. You threw it, giving it velocity!

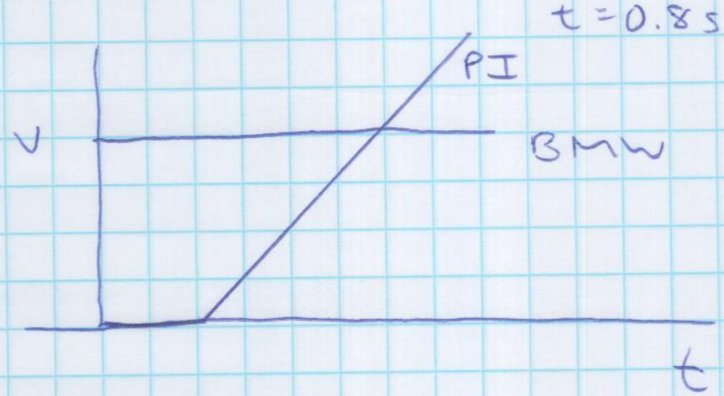
And Ball 1 goes Up, then Down. Its velocity <u>Must</u> change sign.

Ball 2 has $v_0 = 0$ and its vel. stays in same direction while increasing.

8. Rough sketches:







BMW: $\Delta x = v_0 \Delta t + \frac{1}{2} a \Delta t^2$

$2500\ m = (33\ m/s)\ \Delta t + 0$

$\Delta t = 75.7\ s$ for BMW to reach exit

PI: $0 \rightarrow 0.8\ s$ $\quad \Delta x = 0$

$0.8 \rightarrow 75.7\ s$ $\quad \Delta x = 2500$

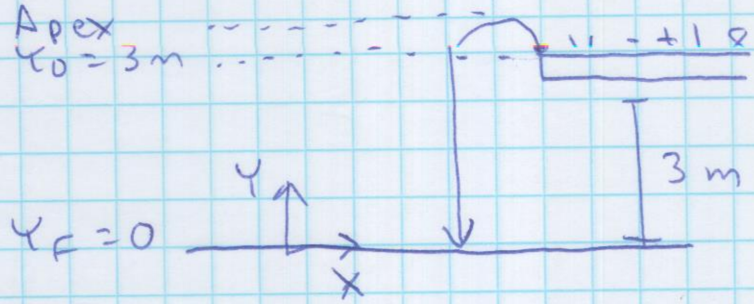
Covers same distance in $\Delta t = 75.7 - 0.8 = 74.9\ s$ as BMW covers in 75.7 s.

PI: $\Delta x = v_0 \Delta t + \frac{1}{2} a \Delta t^2$

$2500 = 0 + \frac{1}{2} a (74.9)^2$

$a = 0.89\ m/s^2$

1. One Dimensional Problem.



Work from board → Apex → Water, or

$$\Delta Y = V_{oy}\Delta t + \frac{1}{2} g \Delta t^2$$

$$(0 - 3\ m) = (+1.8\ \tfrac{m}{s})\Delta t + \tfrac{1}{2}(-9.8\ m/s^2)\Delta t^2$$

$$+4.9\Delta t^2 + -1.8\Delta t + -3 = 0$$

$$\Delta t = \frac{1.8 \pm \sqrt{(-1.8)^2 - 4(4.9)(-3)}}{2(4.9)}$$

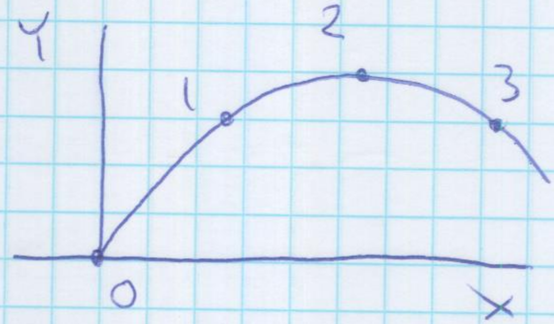
$$\Delta t = 0.98\ s \text{ or } -0.62\ s$$

b. c. $V_F = V_0 + a\Delta t$

$$V_F = +1.8\ m/s + (-9.8\ m/s^2)(0.98\ s)$$

$$V_F = -7.8\ m/s \text{ as hits water}$$

10. At $t = 1\,s$, given v_x, v_y.



t	0 s	1 s	2 s	3 s
v_x	2 m/s	2 m/s	2 m/s	2 m/s
v_y		2 m/s	0 : Apex	− 2 m/s
v_{TOTAL}		$\sqrt{8}$ m/s	2 m/s	$-\sqrt{8}$ m/s

→ No horiz. accel.

→ Symmetry

$$v_{TOTAL} = \sqrt{v_x^2 + v_y^2}$$

Need kinematics to find values at 0 s.

$$v_f = v_0 + a\Delta t$$

Find a now by using a* v_0, v_f you know. (Y direction!)

1 s → 2 s:

$$v_{2y} = v_{1y} + a_y \Delta t$$

$$0 = 2 + a_y(2 - 1\,s)$$

$$a_y = -2\,m/s^2 = \text{gravity}$$

at t = 0:

$$v_{y1} = v_{y0} + a_y \Delta t$$

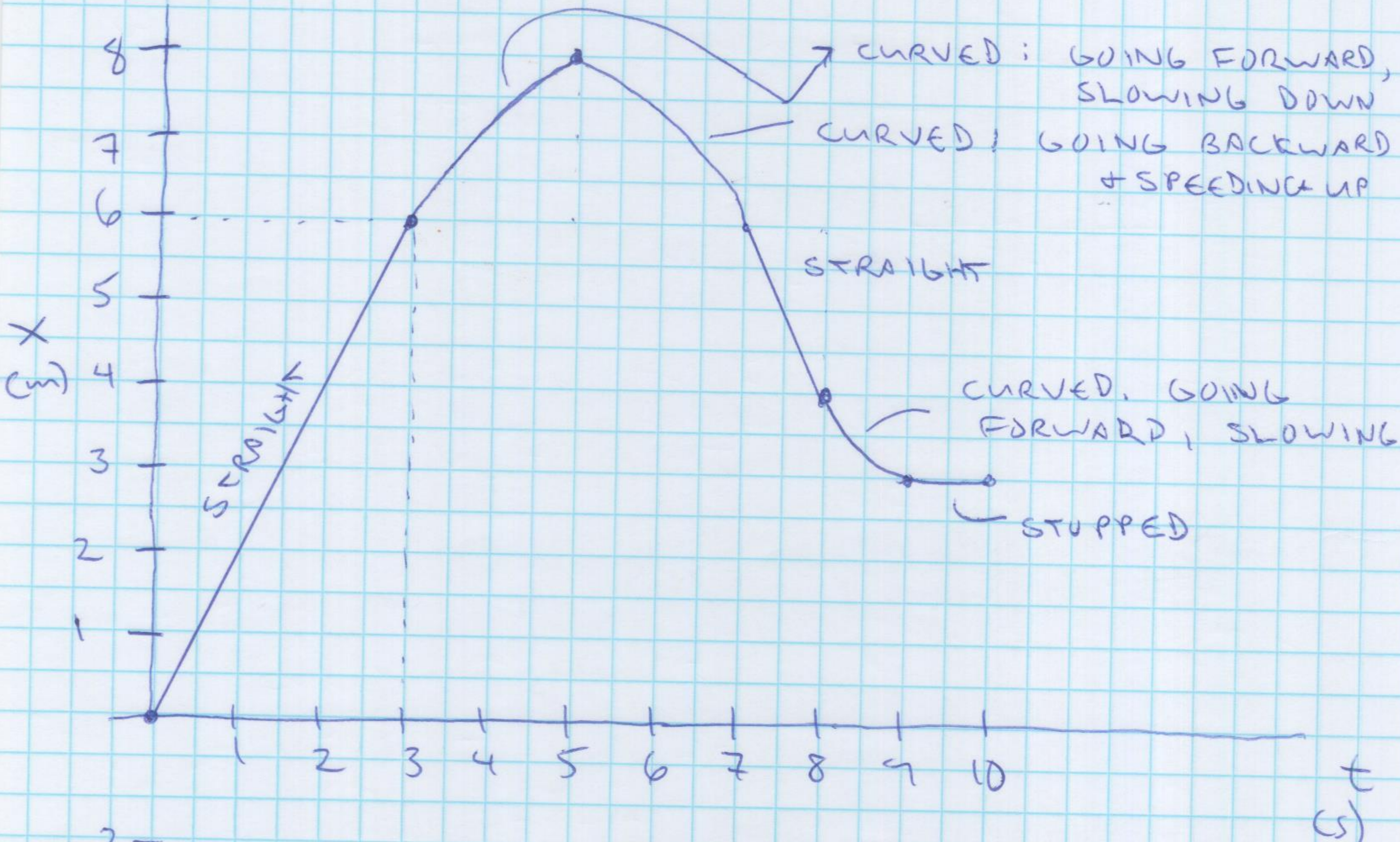
$$2\,m/s = v_{y0} + (-2\,m/s^2)(1 - 0\,s)$$

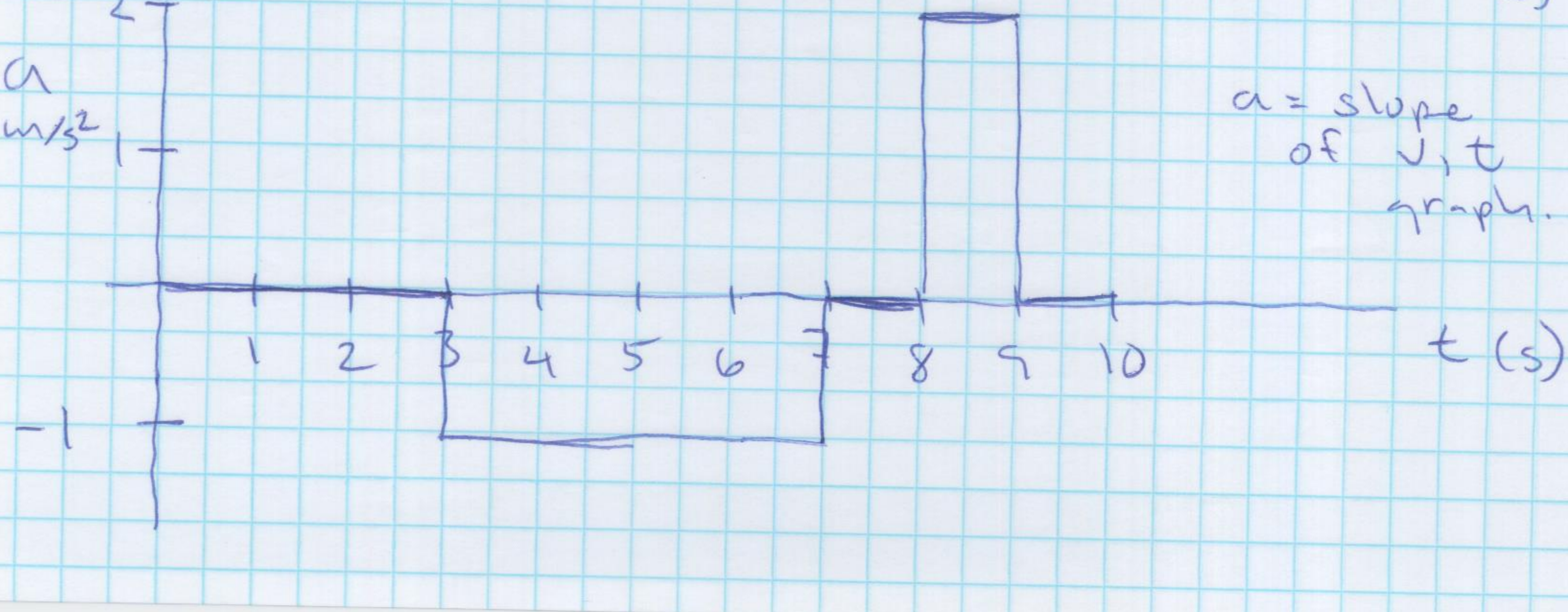
$$v_{y0} = 4\,m/s$$

v_{TOTAL} at t = 0 s is $= \sqrt{2^2 + 4^2} = \sqrt{20}$ m/s

11. Area under v,t = Δx during that time

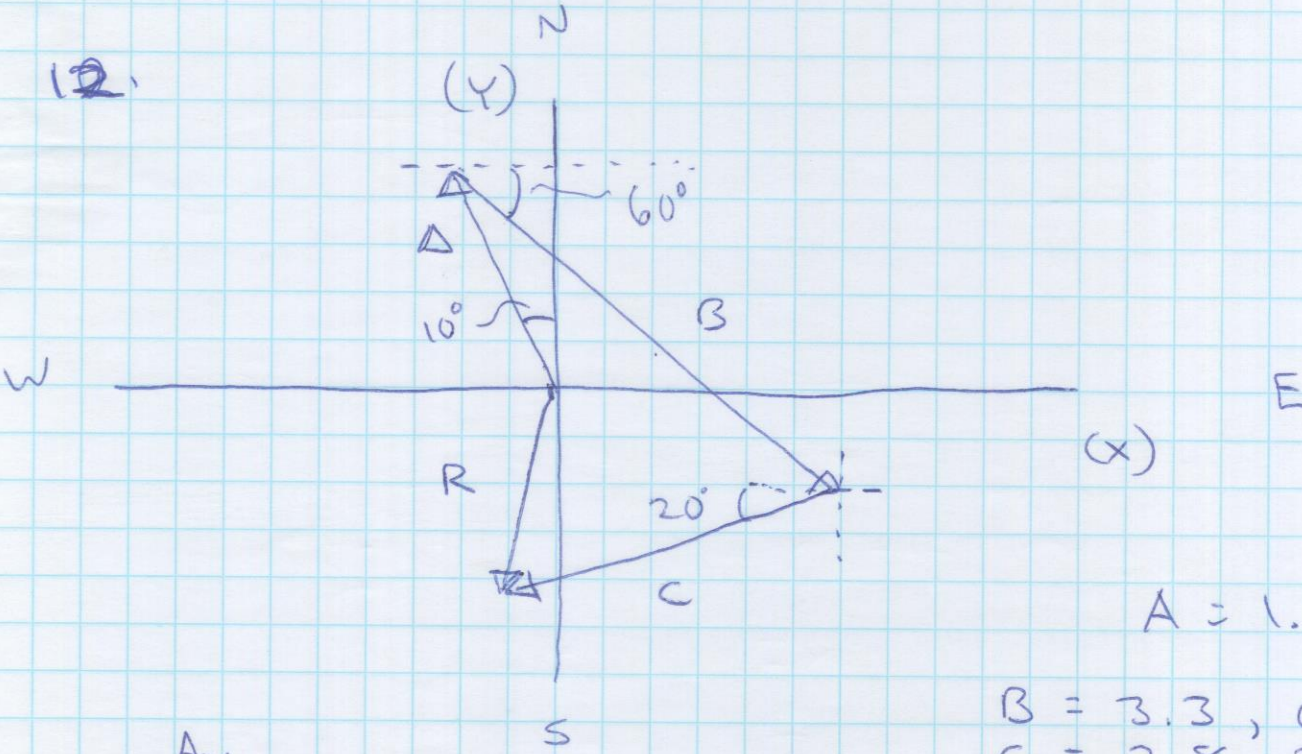
A : $\Delta x = (2\ m/s)(3-0\ s) = 6\ m$
B : $\Delta x = \frac{1}{2}(2\ m/s)(5-3\ s) = 2\ m$
C : $\Delta x = \frac{1}{2}(-2\ m/s)(7-5\ s) = -2\ m$
D : $\Delta x = (-2\ m/s)(8-7\ s) = -2\ m$
E : $\Delta x = \frac{1}{2}(-2\ m/s)(9-8\ s) = -1\ m$
F : $\Delta x = 0$



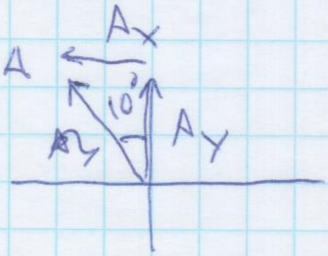


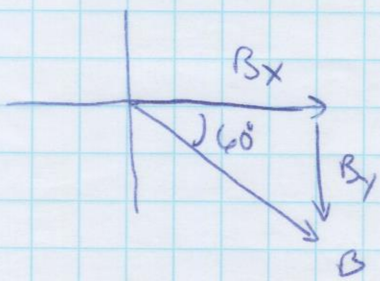
a = slope of v,t graph.

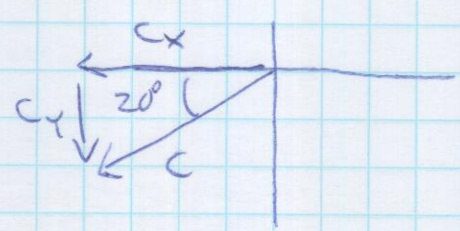
12.



A = 1.6, 10° W of N
B = 3.3, 60° S of E
C = 2.8, 20° S of W



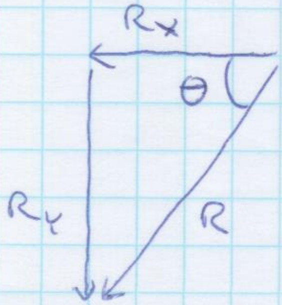




	A	B	C
x	$-1.6 \sin 10°$	$+3.3 \cos 60°$	$-2.8 \cos 20°$
y	$+1.6 \cos 10°$	$-3.3 \sin 60°$	$-2.8 \sin 20°$

$$R_x = A_x + B_x + C_x = -1.26 \text{ km}$$

$$R_y = A_y + B_y + C_y = -2.24 \text{ km}$$



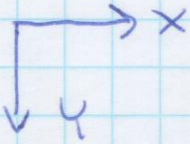
$$R = \sqrt{R_x^2 + R_y^2} = \sqrt{(-1.26)^2 + (-2.24)^2}$$

$$R = 2.6 \text{ km}$$

$$\tan\theta = \frac{R_y}{R_x}$$

$$\theta = \tan^{-1}\left(\frac{2.24}{1.26}\right) = 61° \text{ S of W}$$

13  $V_0 = 6.0$ m/s Horizontal



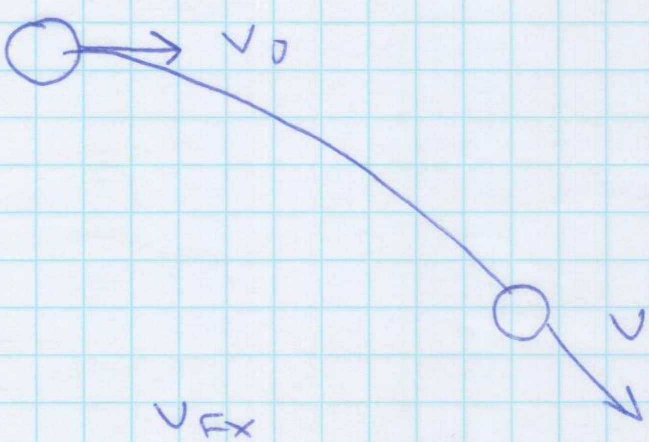
My coordinate system

So $V_{0x} = 6.0$ m/s

$V_{0y} = 0$

(and V_{TOTAL} is 6.0 m/s)

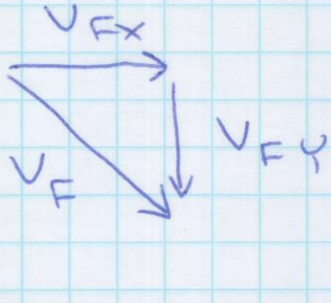
Want $V_{Final} = 12.0$ m/s



Acceleration is only in y - direction.

$V_{Fx} = 6.0$

$V_{Fy} = ?$ to make $V_{TOTAL} = 12$



$$V_{Fx}^2 + V_{Fy}^2 = V_F^2$$

$$(6.0 \text{ m/s})^2 + V_{Fy}^2 = (12 \text{ m/s})^2$$

$$V_{Fy} = 10.4 \text{ m/s}$$

What time is needed to go from $V_{0y} = 0$ to $V_{Fy} = 10.4$?

$$V_{Fy} = V_{0y} + g\Delta t$$

$$10.4 \text{ m/s} = 0 + (+9.8 \text{ m/s}^2)\Delta t$$

$$\Delta t = 1.06 \text{ s}$$

→

13. The story so far: Coconut has been falling for 1.06 s. It's speed now has components

$$v_y = 10.4 \text{ m/s}$$

$$v_x = 6.0 \text{ m/s}$$

Dropped: $\Delta y = v_{0y} \Delta t + \frac{1}{2} g \Delta t^2$

$$\Delta y = 0 + \frac{1}{2}(-9.8 \text{ m/s}^2)(1.06 \text{ s})^2$$

$$\Delta y = -5.5 \text{ m}$$ Has fallen this far.

Travelled Horiz: $\Delta x = v_{0x} \Delta t + \frac{1}{2} a_x \Delta t^2$

$$\Delta x = (6.0 \text{ m/s})(1.06 \text{ s}) + 0$$

$$\Delta x = 6.36 \text{ m}$$