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Section : 2B

Roll no: 20P-0750

Question no 1:

$x = 10t^2$: By substitution, for

$t(s) = 2.0 \quad 2.1 \quad 3.0$

$x(m) = 40 \quad 44.1 \quad 90$

(a) $V_{avg} = ?$

$$V_{avg} = \frac{\Delta x}{\Delta t} = \frac{50}{1} = 50\,ms^{-1}$$

(b) $V_{avg} = ?$

$$V_{avg} = \frac{\Delta x}{\Delta t} = \frac{4.1}{0.1} = 41\,ms^{-1}$$

Question no: 2

(a) at $t_i = 1.5s$, $x_i = 8.0m$ (point A)

at $t_f = 4.0s$, $x_f = 2.0m$ (point B)

$$V_{avg} = \frac{x_f - x_i}{t_f - t_i} = \frac{(2.0 - 8.0)m}{(4 - 1.5)s}$$

$$= \frac{-6m}{2.5s} = -2.4ms^{-1}$$

(b) The slope of the tangent can found from point C and D.

$t_c = 1s$, $x_c = 9.5m$

$t_d = 3.5s$, $x_D = 0$

$v \approx -3.8ms^{-1}$

(c) The velocity is zero when x is a minimum.

This is at $t \approx 4s$

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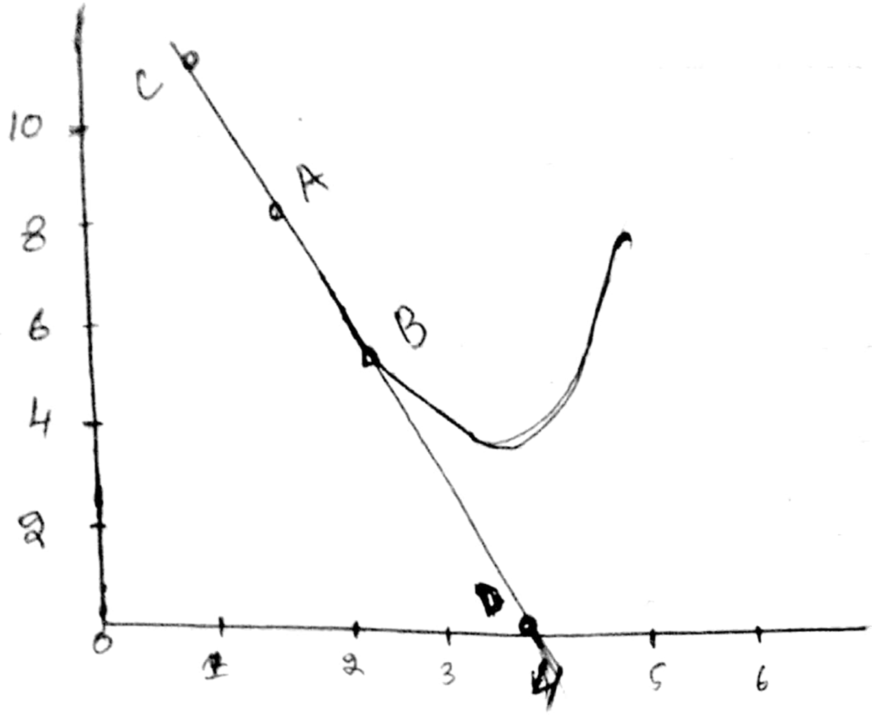

Question no:3

(a)

$$V = \frac{(5.0)\,m}{(1-0)\,s} = 5\,ms^{-1}$$

(b) $$v = \frac{(5-10)\,m}{(4-2)\,s} = -2.5\,ms^{-1}$$

(c) $$V = \frac{(5m - 5m)}{(5s - 4s)} = 0$$

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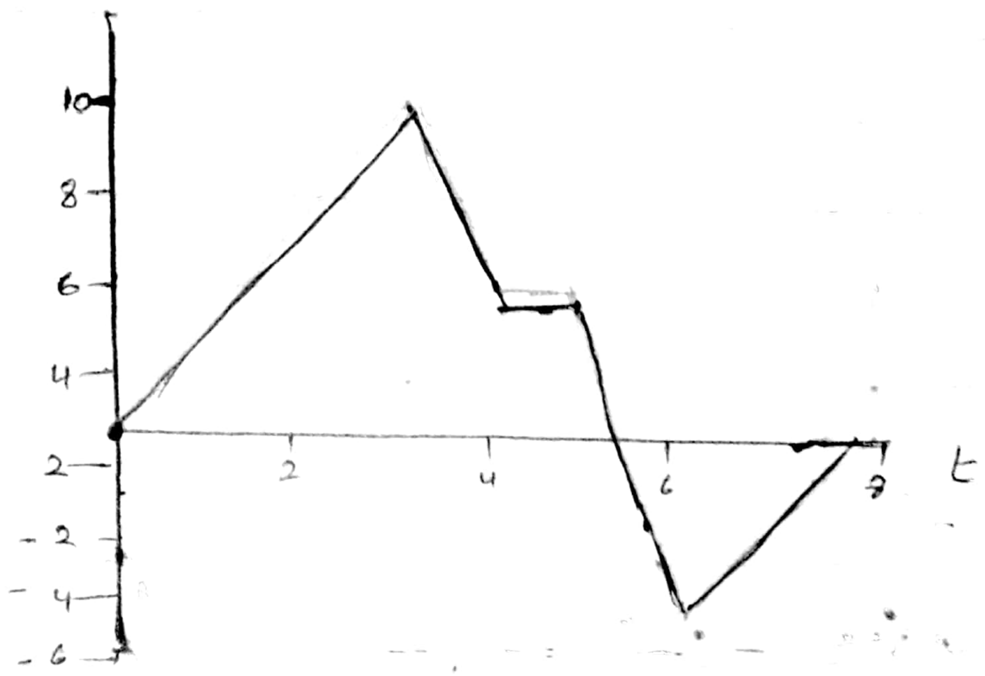
$$d = v = \frac{0-(-5m)}{(8s-7s)} = \underline{\underline{5ms^{-1}}}$$



Question no:4

$$x = 2.00 + 3t - t^2, \text{ so } v = \frac{dx}{dt} = 3-2t$$

$$\text{and } a = \frac{dv}{dt} = -2.00$$

At $t = 3.00s$

(a $x = (2+a-a)m = 2m$

(b) $v = (3.00 - 6.00) m/s = -3ms^{-1}$

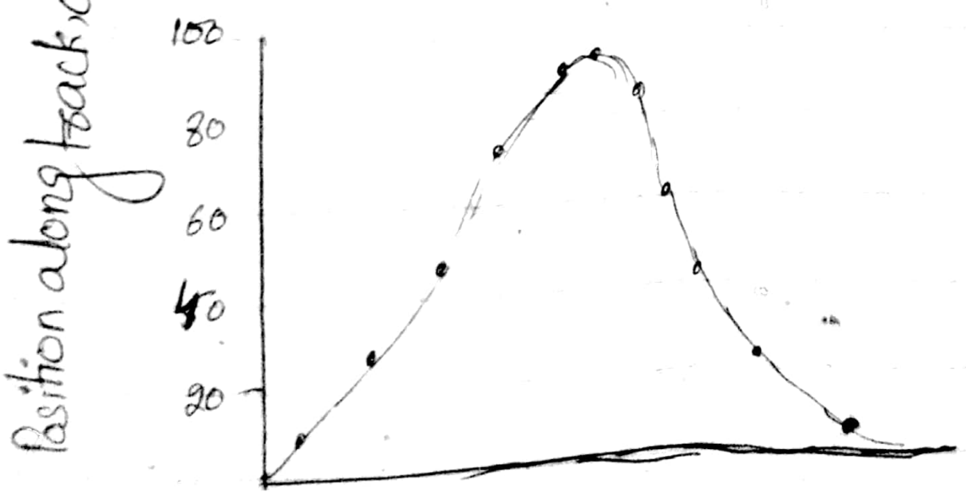
c= $a = -2.00 ms^{-2}$

Question no: 5

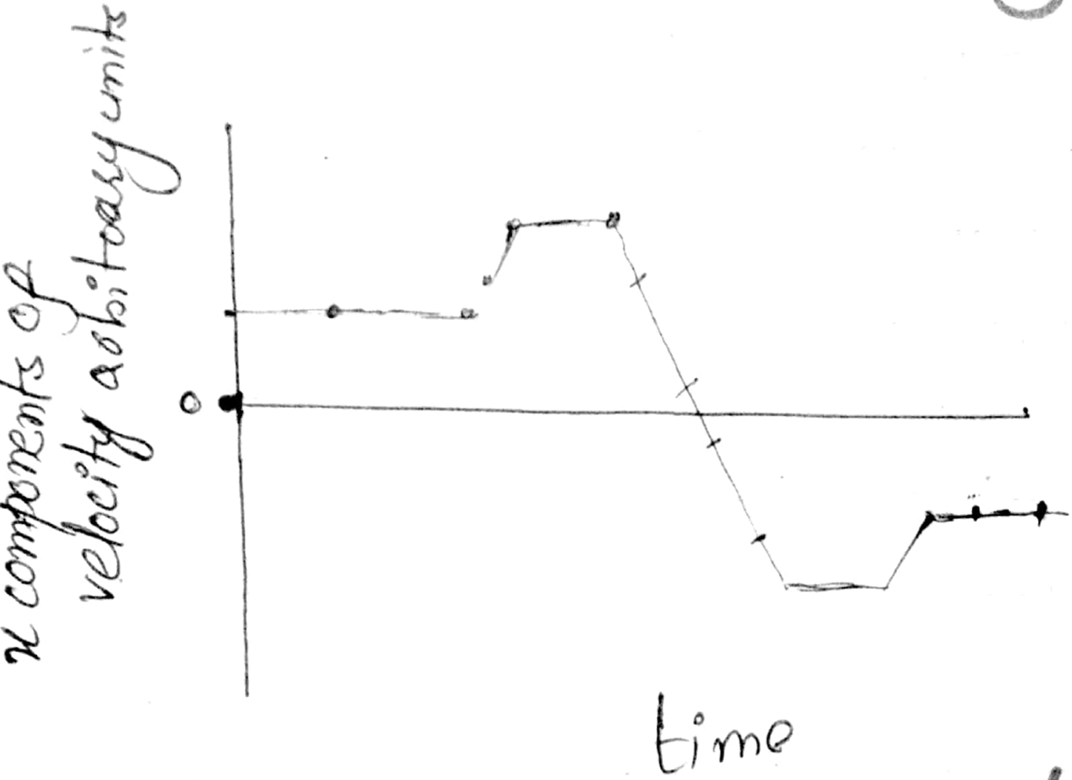
The acceleration is zero whenever the marble is on a horizontal section.

The acceleration has a costant positive value when the marble is rolling on the 20 10 40 cm, section - and has a constant negative value when it is rolling on the second sloping section. The position graph is a straight sloping line whenever the speed is constant and a section of a parabola when the speed changes

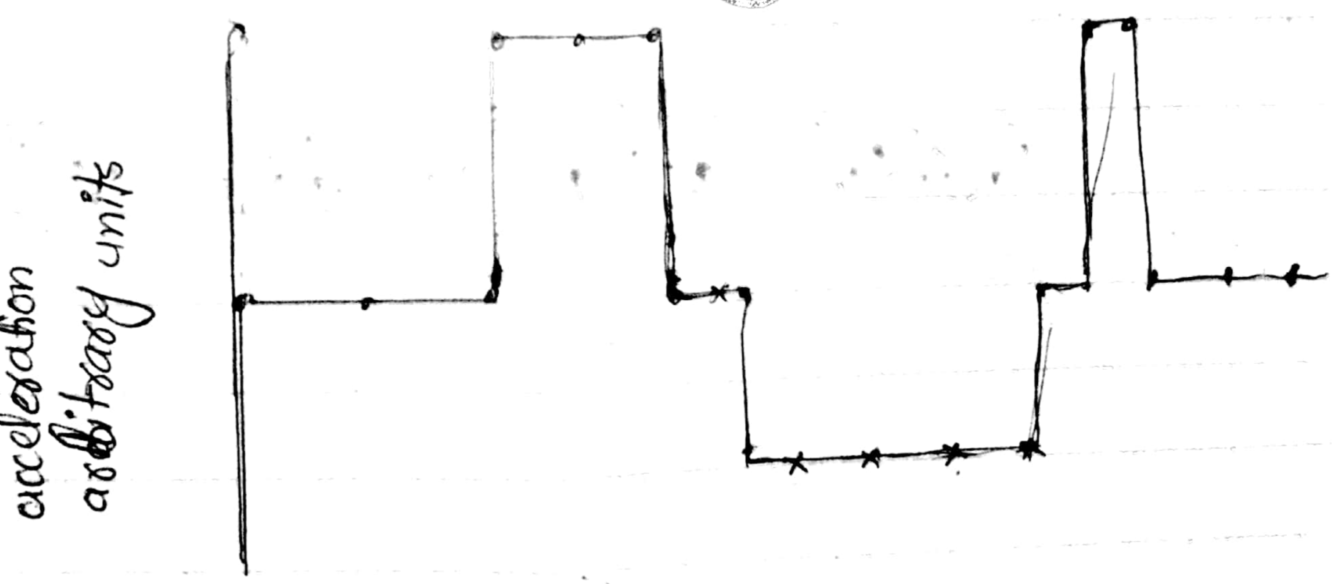
Position as a function of Time



Velocity as a Function of Time



Acceleration as a function of Time



Question no:6

(a) For the First car the speed as a function of time is.

$v = v_i + at = -3.5\,cms^{-1} + 2.4\,cm^{-2}t$

for the second car, the speed is $5.5\,cms^{-1} + 0$

Setting the two expressions equal

$-3.5\,cms^{-1} + 2.4\,cms^{-2}a = 5.5\,cms^{-1}$

$t = (9\,cms^{-1})\,(2.4\,cms^{-2}) = 3.75\,s$

(b) The first car then has speed

$-3.5\,cms^{-1} + (2.4\,cm/s^2)(3.75\,s)$

$= 5.50\,cms^{-1}$, and this is the constant speed of the second car.

(c) for the first car the position as a function of time is

$x_i + v_i t + (1/2)at^2 = 15\,cm -$

$(3.5\,cm^{-1})(1.2\,cms^{-2})t^2 - (9\,cm^{-1}) + 5\,cm = 0$

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Using Quadratic formula

$$t = \frac{9 \pm \sqrt{9^2 - 4(1.2)(5)}}{2(1.2)}$$

$$= \frac{9 \pm \sqrt{57}}{2.4}$$

$$= \frac{9 + \sqrt{57}}{2.4}$$

$$= \frac{9 - \sqrt{57}}{2.4}$$

$= 6.90s$ and $0.604s$

d, At $0.604s$ the second and also the first cars position is $10\,cm + (5.5 m/s)0.604$
$= 13.3\,cm$

At $6.90s$ Both are at position $10\,cm + (5.5\,cm/s)\,6.90 = 47.9\,cm$

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Q no 7:

(a) Compare the position equation $x = 2 + 3t - 4t^2$ to the general form

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

to recognize that $x_i = 2m$

$v_i = 3m/s$

$a = 8ms^{-2}$

velocity equation

$v_f = v_i + at$, is then

$v_f = 3m/s - (8\,m/s^2)$

The particle changes direction when $v_f = 0$ which occurs at $t = \frac{3}{8}$.

The position at this time is

$$x = 2m + (3m/s)(\frac{3}{8}ms) - (4m/s^2)(\frac{3}{8}s)^2$$

$= 2.56m$

(b) from $x_f = x_i + v_i t + \frac{1}{2} a t^2$

observe that when $x_f = x_i$, the time is given by $t = -\frac{2v_i}{a}$ this, when the particle returns to its initial position, the time is

$$a = \frac{-2(3ms^{-1})}{-8ms^{-2}}\left(\frac{3}{4}s\right) = -3ms^{-1}$$

Qno8:

Take the original point to be when sue poticies the van. choose the origin of the x-axis of Sue's car. for her we have $x_{is} = 0$, $v_{is} = 30m/s$

$a_s = -2m/s^2$ so her position is given by

$$x_s(t) = x_{is} + v_{is}t + \frac{1}{2}at^2$$
$$= (30m/s)t + \frac{1}{2}(-2m/s^2)t^2$$

for the van, $x_{iv} = +v_{iv}t + \frac{1}{2}a_vt^2$

$$= 155 + (5.00m/s)t + 0$$

b) ~~th~~ test for a collision, we took for an instant t_c when both are the same place:

$$30t_c - t_c = 155 + 5t_c$$
$$0 = t_c^2 - 25t_c + 155$$

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From the quadratic formula

$$t_c = \frac{25 \pm \sqrt{(25)^2 - 4(155)}}{2} = 13.6s \text{ or } 11.4.$$

The roots are real, not imiganary, so there is a collision. the smaller value is the collision time, the wreck happens at position

$$155m + (5.00m/s)(11.4s) = 212m.$$

Question : 9

=> Starting from rest at $a = 13$ mi/h's, the bicycle reaches its maximum speed

$V_{bmax} = 20 mi h^{-1}$ in a time

$$t_{b,1} = \frac{V_{bmax} - 0}{a_b} = \frac{20 mi/h}{13 mi/h}$$

Since the acceleration a_c of the car is less that of bicycle car cannot be catch the bicycle until some time y the total displacement of the bicycle at t_1s.

$$\Delta x b = \frac{1}{2} \, d b t b^2 + V_{bman} \, (t - t b')$$

$$\left[\frac{1.47}{1}\right] \left[\frac{1}{2}\left(13 \frac{mi/h}{s}\right)(1.54)^2 + (20)(1.1.54)\right]$$

the total displacement of the car at the point is

$$\Delta x c = \frac{1}{2} a c t^2 = \left(\frac{1.47}{1}\right) \left[\frac{1}{2}\left(9.00 \frac{mi/h}{s}\right)\right]$$

$$= (6.62 \, (t/s))t^2$$

∴ At the time car catches the bicycle

$\Delta x c = \Delta x_{10}$ = this give

$$(6.62 ft/s^2)t^2 = (29.4 ft)t - 22.6 ft \text{ or } t^2 - (4.443)t + 3.42 s^2 = 0$$

(b)

$$t = \frac{V_{bman}}{a c} = \frac{20}{9} = 2.22 s$$

At this time the lead is

$$(\Delta x b - \Delta x c) = (\Delta x b - \Delta x c) \text{ is } 2.22 s^2$$

$$\left[(29.4)(2.22) - 22.6 ft\right] - \left[(6.62 ft/s^2)(2.22 s)^2\right]$$

or $(\Delta x_b - \Delta x_c)_{max} = 10.0 ft$:

Q no:10

(a) $= v_f = v_i - gt = 0$ when

$t = 3.00 s$

$g = 9.80 m/s$

$v_i = gt = (9.80)(3) = 29.4 m/s$

(b) $y_f - y_i = \frac{1}{2}(v_f - v_i)t$

$y_f - y_i = \frac{1}{2}(29.4 m/s)(3.00)$

$= 44.1 m$:

Q no:11

$y = 3t^2$: At $t = 2 s$

$y = 3(2)^2 = 24 m$

and

$V_y = \frac{dy}{dt} = 9.00t^2 = 36.0 m/s$

If the helicopter releases a small mailbag at this time, the mailbag starts its free fall with velocity 36 m/s upward

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Equations of motion of mailbag is

$$y_6 = y_{12}^{-1} \, vit - \frac{1}{2}gt^2$$

$$= 24 + 36t - \frac{1}{2}(9.80)t^2$$

Setting $y_6 = 0$

$$0 = 24 + 36t - 4.90t^2$$

Solving for t. (only positive value)

$$\boxed{t = 7.96s}$$

Question no: 12

$a_1 = 0.100 m/s^2$

$$n = 1000m = \frac{1}{2}a_1t_1^2 + vit_2 + \frac{1}{2}a_2t_2^2$$

$$1000 = \frac{1}{2}a_1t_1^2 + a_1t_1\left(-\frac{a_1t_1}{a_2}\right) + \frac{1}{2}a^2\left(\frac{a_1t_1}{a_2}\right)^2$$

$$1000 = 0.5(0.1)\left[1 - (0.105)\right]t^2 \quad 2000 = 1.20t_1^2$$

$$t^2 = \frac{a_1t_1}{-a^2} \approx 26s$$

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$a_2 = -0.500\, m/s^2$

$t = t_1 + t_2$ and $v_1 = a_1 t_1 = -at^2$

$1000 = \frac{1}{2} a_1 \left(1 - \frac{a_1}{a_2}\right) t_1^2$

$81 = \sqrt{\frac{2000}{1.20}} = 129.8$

Total time = 155 s

Question no: 13

(a) $d = \frac{1}{2}(9.80)t_1^2$ $\quad d = 36t_2$

$t_1 + t_2 = 2.40$ $\quad 336t_2 = 4.90(2.40 - t_2)^2$

$4.90t_2^2 - 359.5t_2 + 28.22 = 0$

$t_2 = \frac{359.5 \pm \sqrt{359.5^2 - 4(4.90)(28.22)}}{9.80}$

$t_2 = \frac{359.5 \pm 358.75}{9.80} = 0.0765\, s$

So

$d = 336t_2 = 26.4\, m$

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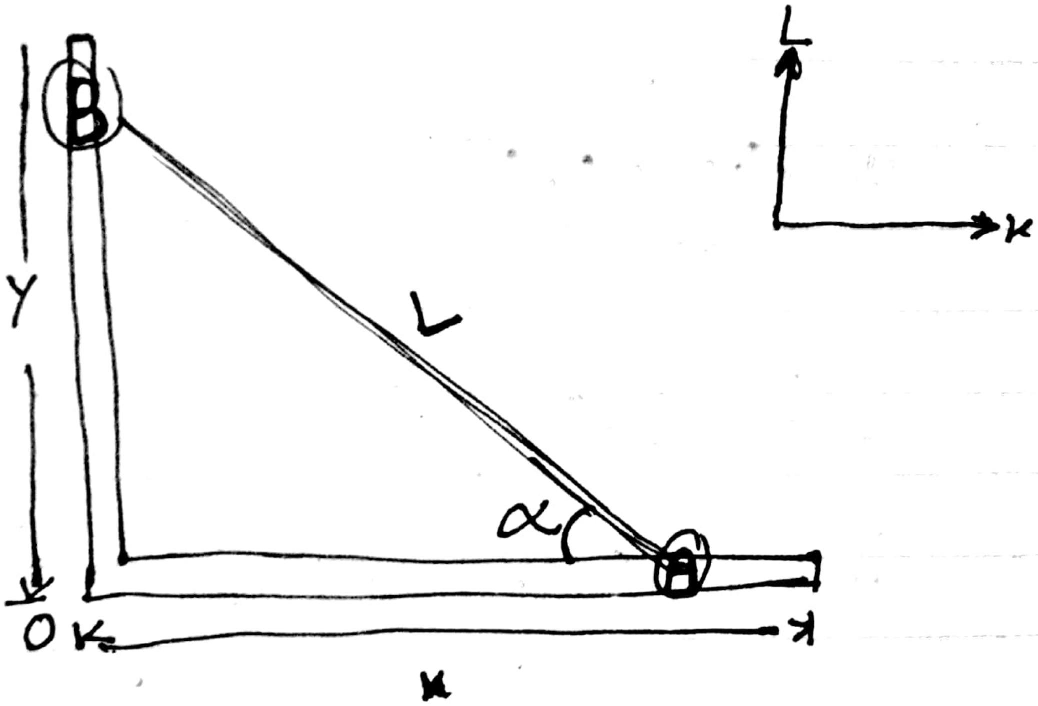
(b) Ignoring the sound travel time

$d = \frac{1}{2}(9.80)(2.90)^2$

$= 28.2m$ on error of $6.82 \cdot 10$

Question no: 14



The distance x and y the always related by $x^2 + y^2 = L^2$
Differentiate through this equation with respect to time, we have

$$\frac{2x\,dx}{dt} + 2y\frac{dy}{dt} = 0$$

now $\frac{dy}{dt}$ is v_B, the unknown velocity of B

and $\frac{dx}{dt} = -v$.

From the equation, resulting from differentiate we have

$$\frac{dy}{dt} = \frac{-x}{y}\left(\frac{dx}{dt}\right) = \frac{-x}{y}(-v)$$

but $\frac{y}{x} = \tan\alpha$ so

$$v_B = \left(\frac{1}{\tan\alpha}\right)v$$

when $\alpha = 60^\circ$

$$v_B = \frac{v}{\tan 60^\circ} = \frac{v\sqrt{3}}{3}$$

$$v_B = 0.577v$$

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