A motorcycle traveling at a constant speed of 10 m/s in a 15 mph zone passes a stationary police car. The cop immediately pursues the cyclist with a constant acceleration of 1.5 m/s^2.

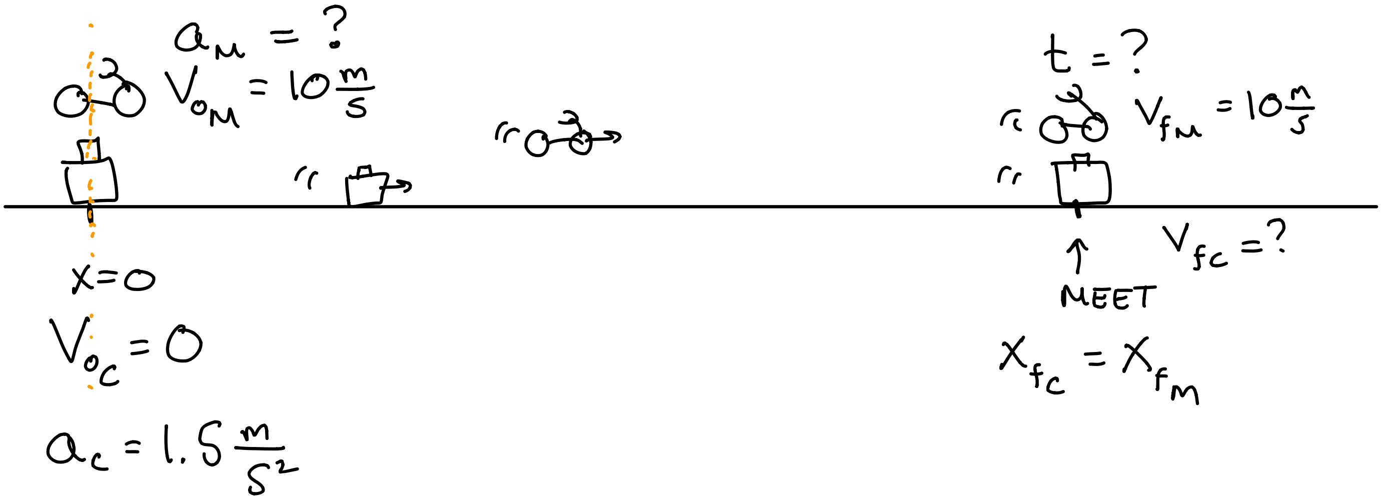
a) At what time does the cop catch up and pass along side the motorcycle?

— SEE VIDEO —

b) What is the cop's speed at this time?

c) Make a qualitative graph of position vs. time. Include both vehicles on the graph.

$$* \ a_c = 1.5 \frac{m}{s^2} = \frac{1.5 \frac{m}{s}}{s} \simeq \frac{3.3 \text{ mph}}{s} = \frac{\Delta V}{\Delta t}$$



When they meet (SIDE by SIDE), what do they have in common? V, t, x?

$* \therefore X_{fc} = X_{fM}$ Need $x(t)$: That's #2

$$X_{fc} = X_{oc} + V_{oc}t + \frac{1}{2}a_c t^2$$

$$X_{fc} = 0 + 0 + \frac{1}{2}a_c t^2$$

$$\therefore \boxed{X_{fc} = \frac{1}{2}a_c t^2}$$

Now Repeat for Motorc.

$$X_{fM} = X_{oM} + V_{om}t + \frac{1}{2}a_M t^2$$

$$X_{fM} = 0 + V_{oM}t + 0$$

$$\therefore \boxed{X_{fM} = V_{oM}t}$$

Now set $X_{fc} = X_{fM}$

$$\frac{1}{2}a_c t^2 = V_{oM}\, t$$ ÷ both sides by t.

$$\frac{\frac{1}{2}a_c t^2}{t} = \frac{V_{oM}\, t}{t} \qquad \frac{1}{2}a_c t = V_{oM}$$

$$\frac{(\cancel{2})\frac{1}{\cancel{2}}\cancel{a_c}\, t}{\cancel{a_c}} = \frac{V_{oM}\,(2)}{a_c} \Rightarrow \boxed{t_{MEET} = \frac{2V_{oM}}{a_c}}$$

$$t = \frac{2V_{oM}}{a_c}$$

PART (a):

$$t = \frac{2(10\,\frac{m}{s})}{1.5\,\frac{m}{s^2}} = 13.3\,s$$ (put on Diagram!)

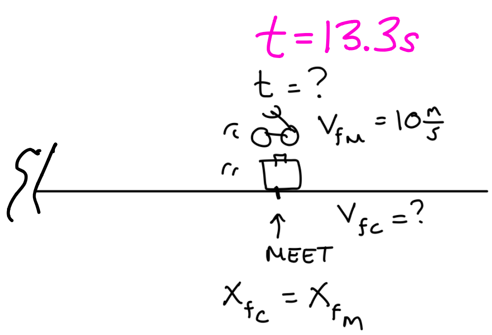
b) What is the cop's speed at this time?

#1 $V_{fc} = V_{oc} + a_c t$

$V_{fc} = 0 + a_c t$

$V_{fc} = a_c t$, Note: $t =$

$t = \frac{2V_{oM}}{a_c}$, subs into here

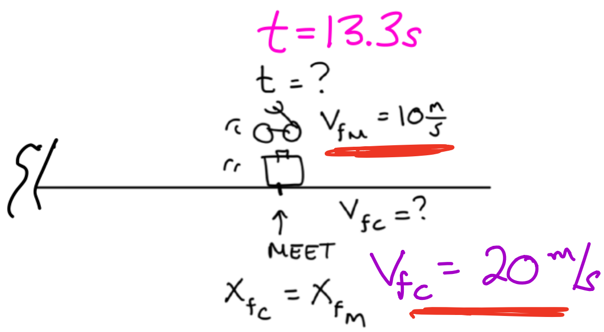


$V_{fc} = a_c t$ becomes

$$V_{fc} = \cancel{a_c}\left(\frac{2V_{oM}}{\cancel{a_c}}\right), \quad \therefore V_{fc} = 2V_{oM} \; !$$

$V_{fc} = 2V_{oM}$, this means that the cop is moving at twice the motorcycle's speed when the meet up. SEE VIDEO

$$V_{fc} = 2\left(10\tfrac{m}{s}\right) = 20\ m/s$$



Part c:

↓

No #s.

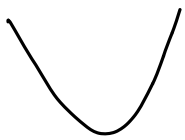
c) Make a qualitative graph of position vs. time. Include both vehicles on the graph.

$* \quad x_{f_c} = \frac{1}{2} a_c t^2$

This has the form from Algebra class:

$x_{f_c} = \# t^2$

Parabolic

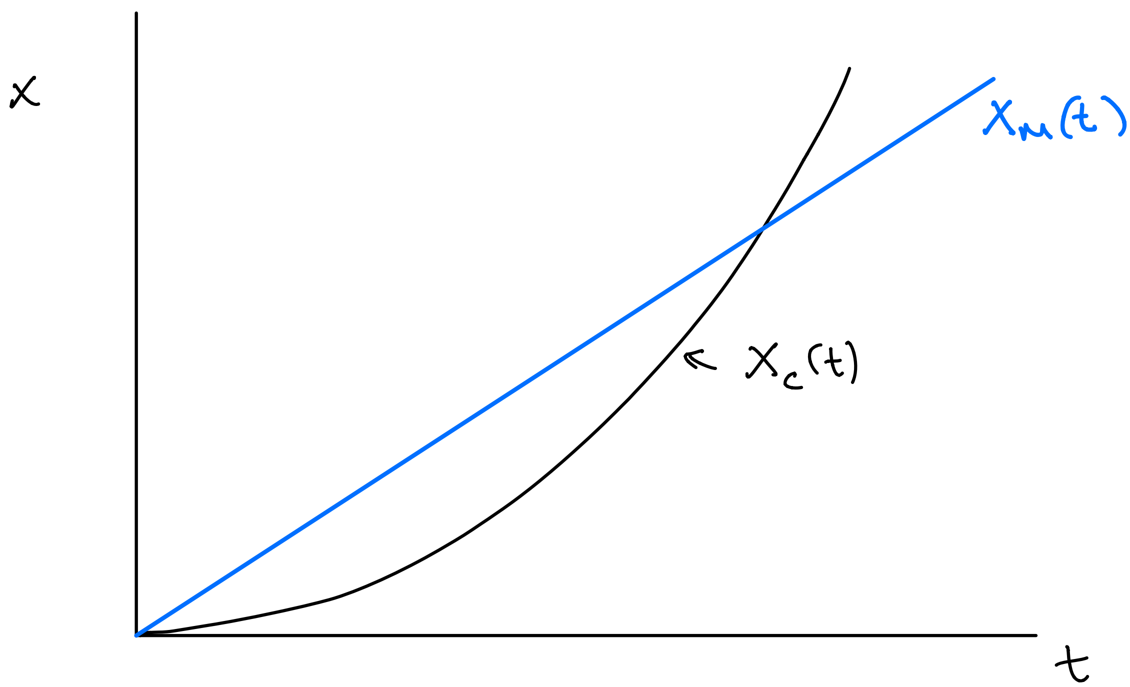


$* \quad x_{f_M} = V_{o_M} t$

Form:

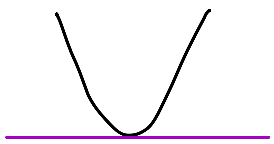
$x_{f_m} = \# t$

Straight Line

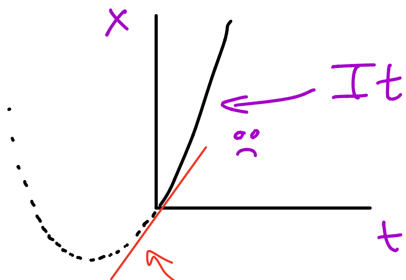


* Since $V_{cop_0} = 0$, that information must be correctly represented on the graph.

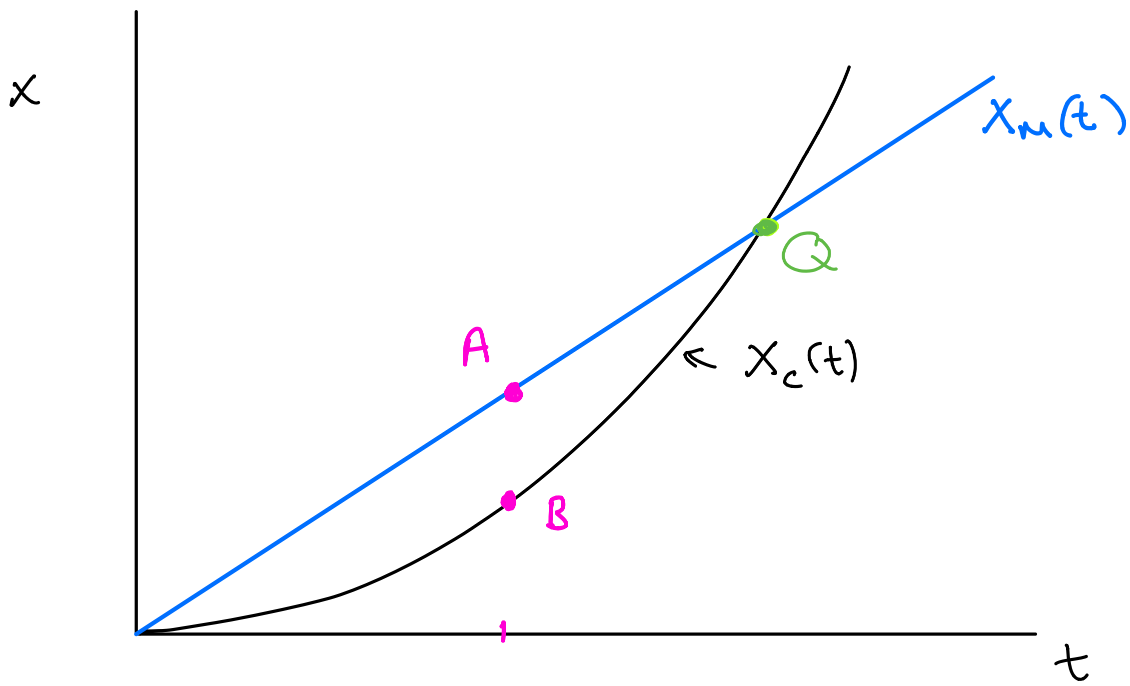
But the velocity at any instant is just the slope of the tangent line at that instant, so if the initial velocity of the cop car is zero, then the tangent line to the curve at $t=0$ must have a zero slope (a horizontal tangent line)!!



$\therefore$ At $t=0$, there must be a vertex of a parabola.



It can't be like this, because @ $t=0$, the slope of the tangent line (which is the instantaneous velocity) is NOT zero (see tangent line).



* What can you say is happening at points A & B?

* The cop & Motorcycle have the same speed!! Why?

* what is happening at point Q? Why?

hint: When they meet, we found that $V_{f_c} = 2V_{fm}$.

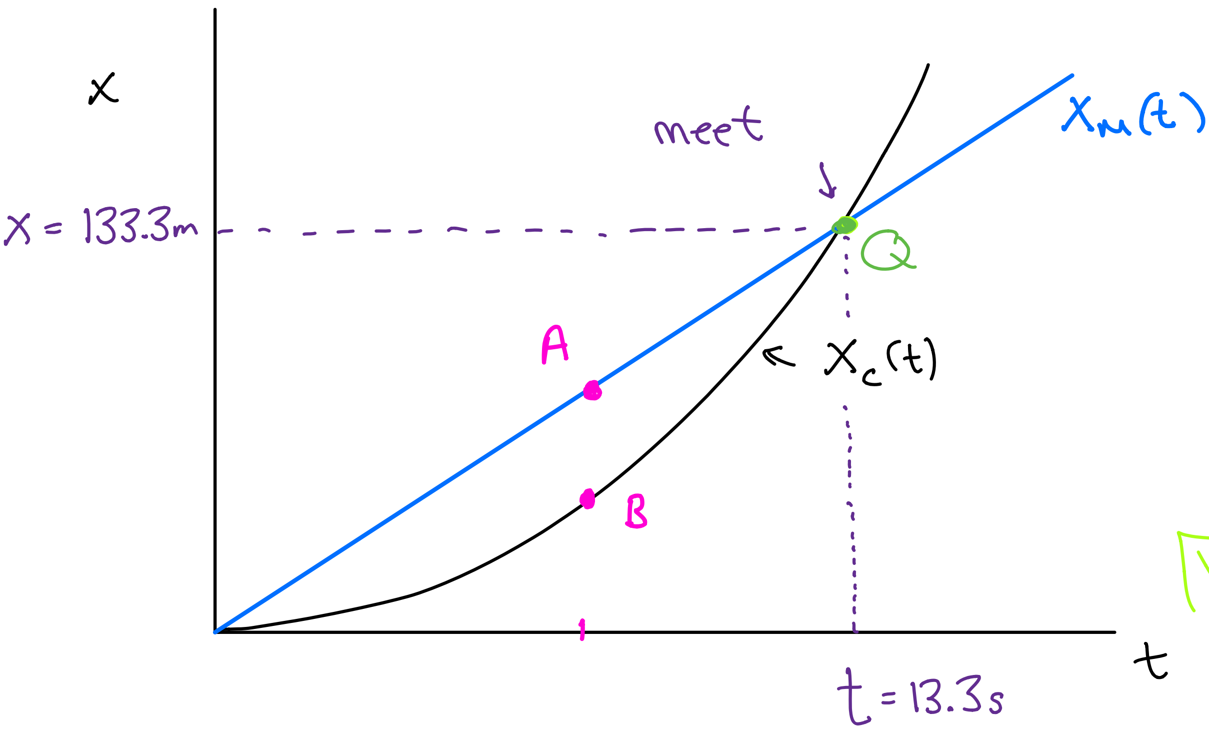
Part d) Where Do they meet? $X_f = ?$

$X_{f_c} = \frac{1}{2}a_c t^2$ or $X_{f_M} = V_{oM} t$

USE Either!

Meet here.

$$X_{fM} = 10\tfrac{m}{s}(13.3s) = 133.3m$$



$*\quad X_{fc} = \frac{1}{2}a_c t^2$

$X_{fc} = \frac{1}{2}(1.5\tfrac{m}{s^2})t^2$

$*\quad X_{fM} = V_{oM}t$

$X_{fM} = 10\tfrac{m}{s}t$

If you plotted $X = 3t^2$ & $X = 10t$

(on your calculator or online), it would look like this.