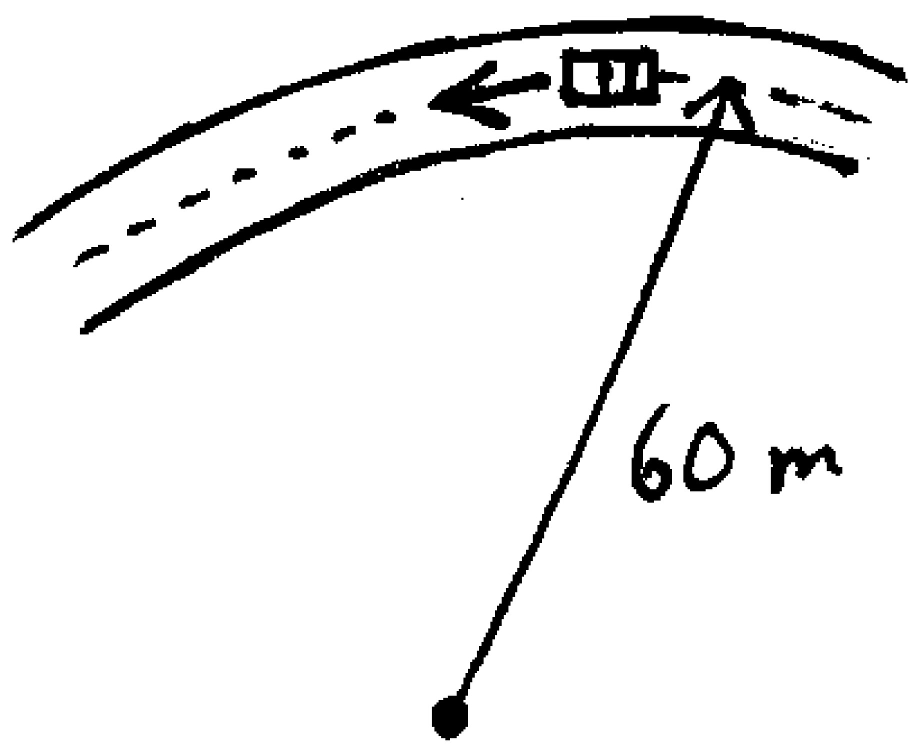
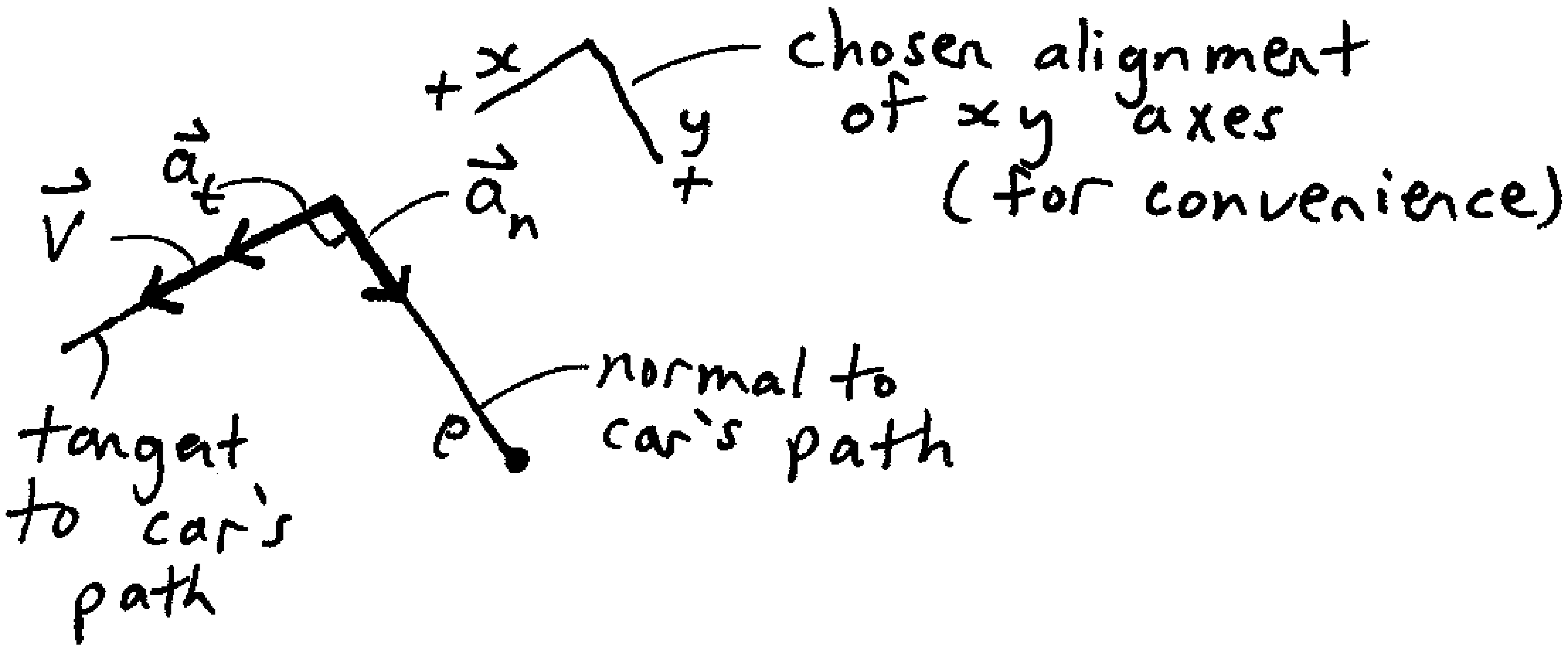
This is a curvilinear motion problem involving normal and tangential components (engineering mechanics).



A car travels at a speed of 8 m/s along a circular road which has a radius of 60 m. Starting from a time of $t=0$, in seconds, the car increases its speed by $\dot{v} = (0.6t)\ m/s^2$. Calculate the speed of the car and the magnitude of its acceleration when $t = 5$ s.

<u>Solution:</u>



The magnitude of the normal acceleration is:

$$a_n = \frac{v^2}{\rho}$$ (a_n is the magnitude of the acceleration vector $\vec{a}_n$, normal to the path at any given instant)

The magnitude of the tangential acceleration is:

$a_t = \frac{dv}{dt} = \dot{v} = 0.6t$ (magnitude of the acceleration vector $\vec{a}_t$, tangent to the path at any given instant)

We need to find an expression for the speed, v, as a function of t. Note that v is the speed of the car, which is the magnitude of the velocity vector $\vec{v}$, tangent to the path at any given instant.

Given, $\frac{dv}{dt} = 0.6t$

Integrate:

$v = 0.3t^2 + C$, where C is the constant of integration

At $t = 0$, $v = 8\ m/s$

Substitute:

$8 = 0.3(0)^2 + C$
$C = 8$

Then, $v = 0.3t^2 + 8$

(speed of the car)

When $t = 5s$, $v = 0.3(5)^2 + 8 = 15.5\ m/s$ (answer)

and $a_t = 0.6(5) = 3\ m/s^2$

The horizontal component of the resultant acceleration is:

$$a_x = a_t = 3\ m/s^2 \quad (at\ t = 5\ s)$$

The vertical component of the resultant acceleration is:

$$a_y = a_n = \frac{v^2}{\rho} = \frac{(15.5)^2}{60} = 4.0\ m/s^2 \quad (at\ t = 5s)$$

The magnitude of the resultant acceleration is: $\sqrt{(3)^2 + (4)^2} = 5.0\ m/s^2$

(answer)