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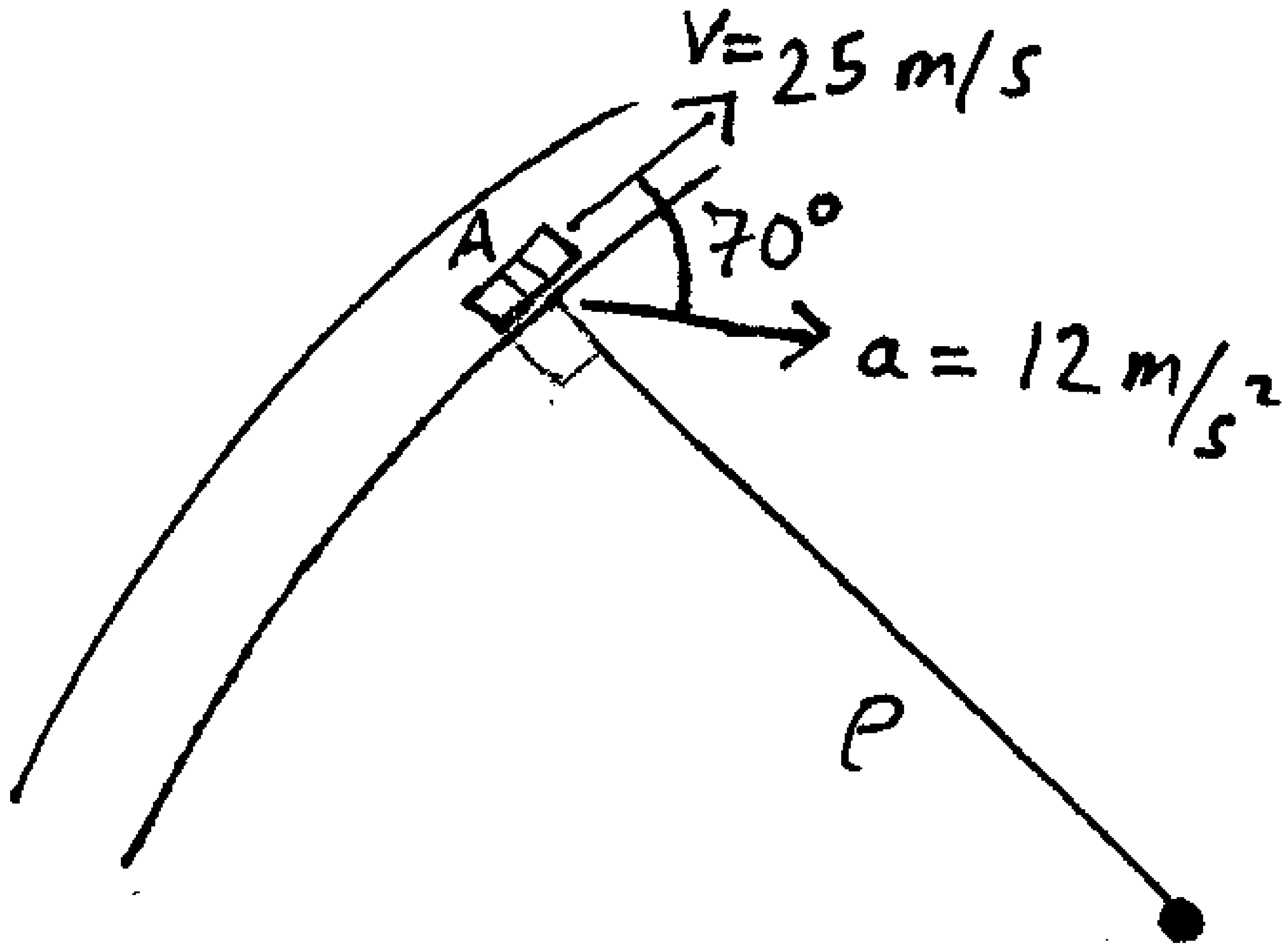
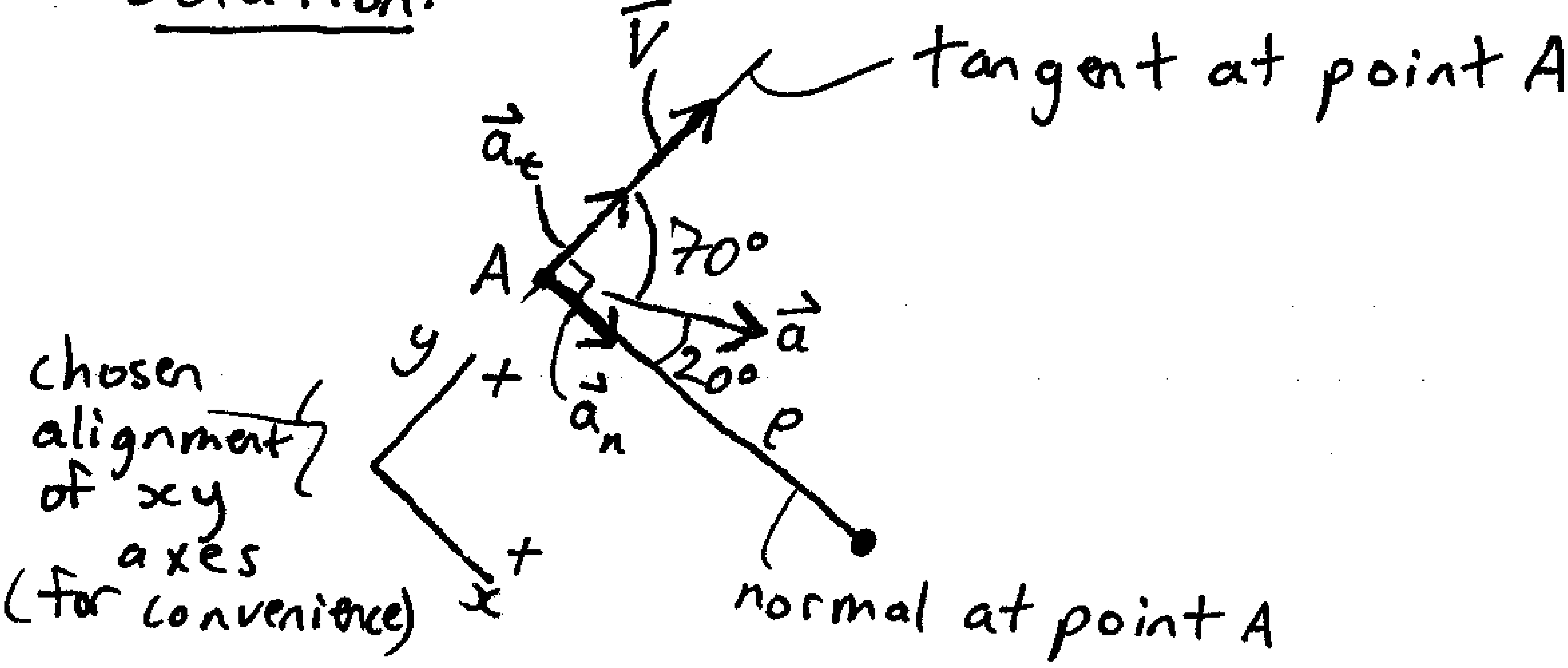
This is a curvilinear motion problem involving normal and tangential components (engineering mechanics)



At a certain instant, a car at A has a speed of 25 m/s and an acceleration of 12 m/s² acting in the direction shown. Calculate radius of curvature ρ of the car's path and the rate of increase in the speed of the car.

<u>Solution:</u>



The magnitude of the normal acceleration is:

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

The magnitude of the tangential acceleration is:

$a_t = \frac{dv}{dt}$ (magnitude of the acceleration vector $\vec{a}_t$, tangent to the path at the instant shown)

$v = 25\, m/s$ (speed of the car, which is the magnitude of the velocity vector $\vec{v}$, tangent to the path at the instant shown)

The vertical component of the resultant acceleration is:

$$a_y = a \sin 20°$$
$$= a_t$$

$$a_t = 12 \sin 20°$$

$$a_t = 4.1\, m/s^2$$

($a = |\vec{a}|$ is the magnitude of the resultant acceleration vector $\vec{a}$)

The horizontal component of the resultant acceleration is:

$$a_x = a \cos 20°$$
$$= a_n$$

$$a_n = 12 \cos 20°$$

$$a_n = 11.28\, m/s^2$$

From before, $a_n = \frac{v^2}{\rho}$

Substitute:

$$11.28 = \frac{(25)^2}{\rho}$$

$\rho = 55.4\,m$ (radius of curvature of car's path)
(answer)

and the rate of increase in the speed of the car is, $a_t = 4.1\,m/s^2$
(answer)