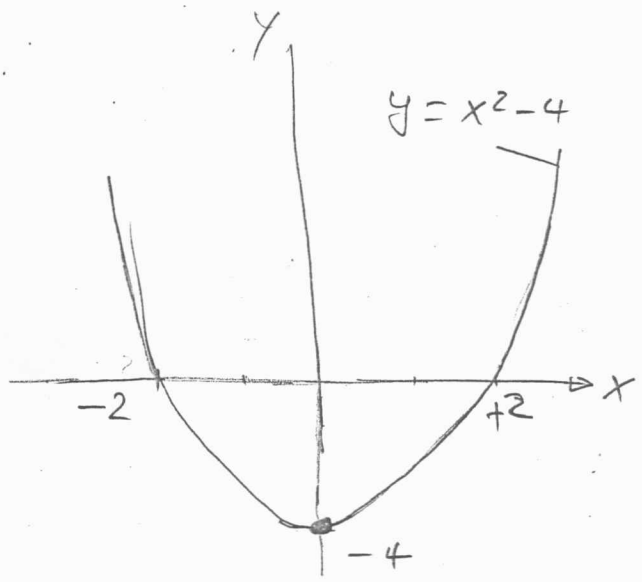
HW3
Spring 2010

12-109



$y = x^2 - 4$

$v = 5\ m/s$

$a_t = 0$, since $v = const$

$\hookrightarrow a = a_n$

$a_n = \frac{v^2}{\rho}$

since $v = const$, a is maximum when ρ is minimum

this is the case when

$x = 0, \quad y = -4m$

$\hookrightarrow$

$\frac{dy}{dx} = 2x \qquad \left.\frac{dy}{dx}\right|_{x=0} = 0$

$\frac{d^2y}{dx^2} = 2$

$\hookrightarrow \rho_{min} = \left.\frac{\left[1+\left(\frac{dy}{dx}\right)^2\right]^{3/2}}{\frac{d^2y}{dx^2}}\right|_{\substack{x=0 \\ y=-4}} = \frac{(1+0)^{3/2}}{2} = 0.5\ m$

$a_{max} = a_{n\,max} = \frac{v^2}{\rho_{min}}$

$a_{max} = \frac{5^2}{0.5} = 50\ m/s$

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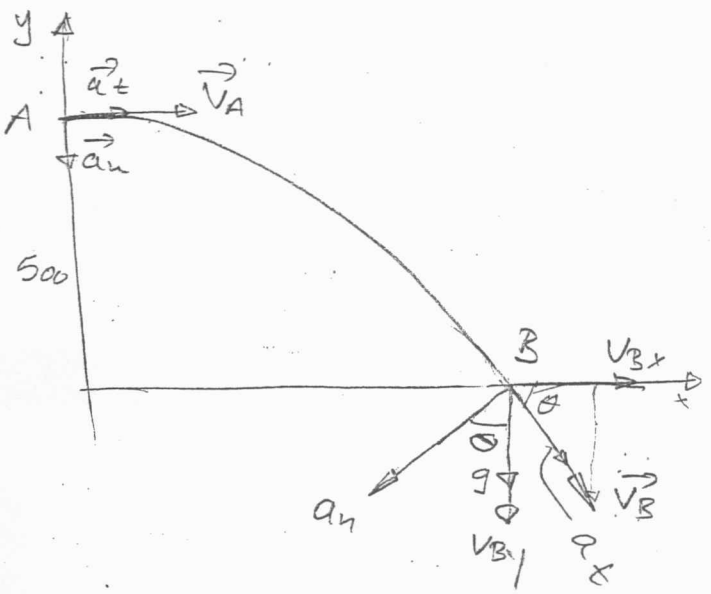

Point A

$a_t = 0$ since V_A = const.

$a_n = g = 9.81$

$V_{xB} = V_{xA} = 50 \text{ m/s}$

$V_{By}^2 = V_{y0}^2 + 2a_y(y - y_0)$

$= 0 + 2(9.81)(0 - 500)$

$\hookrightarrow V_{By} = 99 \text{ m/s}$

$\tan\theta = \frac{V_{By}}{V_{Bx}} = \frac{99}{50} \Rightarrow \theta = 63.21^\circ$

$V_B = \sqrt{V_x^2 + V_y^2} = 110,91 \text{ m/s}$

$a_n = g\cos\theta = 4.42 \text{ m/s}^2$

$a_t = g\sin\theta = 8.76 \text{ m/s}^2$

$a_n = \frac{v^2}{\rho} \Rightarrow \rho = \frac{v^2}{a_n}$

$\rho = 2783 \text{ m}$

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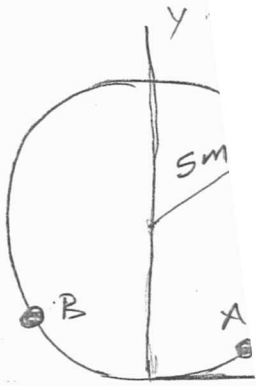
$$s = r\theta$$



$s_A = 0.7(2) = 1.4\,m$

$s_B = 4.5(2) = 3\,m$

$\theta_A = \frac{s_A}{r} = \frac{1.4}{5} = 0.28\,rad = 16.04°$

$\theta_B = \frac{3}{5} = 0.6\,rad = 34.38°$

Particle A:

$x = 5\sin 16.04 = 1.38\,m$

$y = 5(1-\cos 16.04) = 0.195\,m$

$\vec{r}_A = 1.38\vec{i} + 0.195\vec{j}$

Particle B:

$x = -5\sin 34.38° = -2.82\,m$

$y = 5(1-\cos 34.38° = 0.873\,m$

$\vec{r}_B = -2.82\vec{i} + 0.873\vec{j}$

$\Delta\vec{r} = \vec{r}_B - \vec{r}_A$

$= -4.2\vec{i} + 0.678\vec{j}$

$\Delta r = \sqrt{(-4.2)^2 + (0.678)^2}$

$\Delta r = 4.26\,m$

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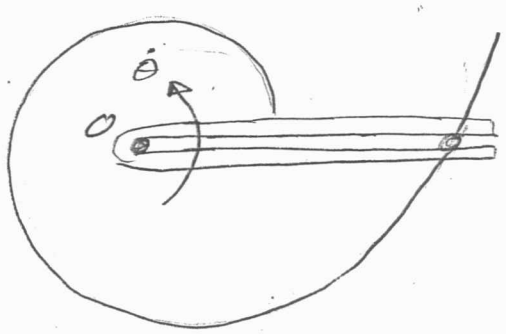
$\dot{\theta} = 3 \text{ rad/s}$

$r(\theta) = 25\left(5 + \frac{\theta}{\pi}\right) \text{ mm}$



$\theta = 360^\circ = 2\pi \quad \dot{\theta} = 3 \quad \ddot{\theta} = 0$

$r = 25\left(5 + \frac{2\pi}{\pi}\right) = 175 \text{ mm}$

$\dot{r} = \frac{25}{\pi}\dot{\theta} = 75/\pi \text{ mm/s} \qquad \ddot{r} = 0, \text{ since } \ddot{\theta} = 0$

$v_r = \dot{r} = 75/\pi = 23.87 \text{ mm/s}$

$v_\theta = r\dot{\theta} = 175(3) = 525 \text{ mm/s}$

$a_r = \ddot{r} - r\dot{\theta}^2 = 0 - (175)(3)^2 = -1.575 \text{ m/s}^2$

$a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta} = 0 + 2(75/\pi)(3) = 0.143 \text{ m/s}^2$

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When $t = 1s$

$\theta = 4t = 4 \qquad \dot{\theta} = 4 \qquad \ddot{\theta} = 0$

$r = 2\sin 2\theta = 1.9787 \text{ m}$

$\dot{r} = 4\cos 2\theta\,\dot{\theta} = -2.328 \text{ m/s}$

$\ddot{r} = -8\sin 2\theta\,\dot{\theta}^2 + 8\cos 2\theta\,\ddot{\theta} = -126.638 \text{ m/s}^2$

$v_r = \dot{r} = -2.33 \text{ m/s}$

$v_\theta = r\dot{\theta} = 7.91 \text{ m/s}$

$a_r = \ddot{r} - r\dot{\theta}^2 = -158 \text{ m/s}^2$

$a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta} = -18.6 \text{ m/s}^2$