1) $x = e^{2t}$ $y = \sin(3t)$

$\frac{dx}{dt} = 2e^{2t}$ $\frac{dy}{dt} = 3\cos(3t)$

$\frac{dy}{dx} = \frac{3\cos(3t)}{2e^{2t}}$

2) $x = \cos^3 t$ $y = \sin^2 t$

$\frac{dx}{dt} = -3\cos^2 t \sin t$

$\frac{dy}{dt} = 2\sin t \cos t$

$L = \int_0^{\pi/2} \sqrt{\left(\frac{dx}{dt}\right)^2 + \left(\frac{dy}{dt}\right)^2}\, dt$

3) $x = t^3 - t^2 - 1$ $y = t^4 + 2t^2 - 8t$

vertical tangent $\rightarrow x'(t) = 0$

$x'(t) = 3t^2 - 2t = 0$

$= t(3t-2) = 0$

$t = 0$ $t = \frac{2}{3}$

4) $x(t) = 3t^2 - 4t + 2$ $y(t) = t^3 - 4t$

$x(1) = 1$ $y(1) = -3$

point: $(1, -3)$

$x'(t) = 6t - 4$ $y'(t) = 3t^2 - 4$

$\frac{dy}{dx} = \frac{3t^2 - 4}{6t - 4}$ $\left.\frac{dy}{dx}\right|_{t=1} = -\frac{1}{2}$

Tangent: $y + 3 = -\frac{1}{2}(x - 1)$

5) $x(t) = 6 - 2t$ $y(t) = t^3 + 3$

$x'(t) = -2$ $y'(t) = 3t^2$

$6 - 2t = 4$ $t^3 + 3 = 4$

$-2t = -2$ $t^3 = 1$

$t = 1$ $t = 1$

$x'(1) = -2$ $y'(1) = 3$

The particle is moving up and to the left

6) $x = \cos(5t)$ $y = t^3$

$x'(t) = -5\sin(5t)$ $y'(t) = 3t^2$

$\|\vec{v}(2)\| = \sqrt{(x'(2))^2 + (y'(2))^2}$

$= 12.304$

7) $s(t) = \left\langle \frac{(t-2)^3}{3} + 4,\ t^2 - 4t + 4 \right\rangle$

a) $v(t) = \left\langle (t-2)^2,\ 2t - 4 \right\rangle$

$\|v(1)\| = \sqrt{1 + 4} = 2.236$

b) $\int_0^1 \sqrt{\left[(t-3)^2\right]^2 + (2t-4)^2}\, dt = 3.816$

c) At rest: $x'(t) = y'(t) = 0$

@ $t = 2$.

8) $\frac{dx}{dt} = 1 + \tan(t^2)$ $\frac{dy}{dt} = 3e^{\sqrt{t}}$

$\vec{a}(5) = \left\langle 10.178,\ 6.276 \right\rangle$

$\|\vec{v}(5)\| = \sqrt{(1 + \tan 25)^2 + \left(3e^{\sqrt{5}}\right)^2}$

$= 28.083$

9) $x(t) = t + \cot t \quad y(t) = 3t + 2\sin t$

$3t + 2\sin t = 5 \quad @ \quad t = 1.079$

$v(1.079) = \langle 0.1185, 3.944 \rangle$

10) $\frac{dx}{dt} = 2\sin(t^3) \quad \frac{dy}{dt} = \cos(t^2)$

a) $\left.\frac{dy}{dx}\right|_{t=1} = -0.519$

$y - 4 = -0.519(x - 3)$

b) $\|\vec{v}(2)\| = 2.084$

c) $\int_0^1 \sqrt{\left(\frac{dx}{dt}\right)^2 + \left(\frac{dy}{dt}\right)^2}\, dt = 1.126$

d) $x(2) = 3 + \int_1^2 2\sin(t^3)\, dt = 3.436$

$y(2) = 4 + \int_1^2 \cos(t^2)\, dt = 3.557$

$\vec{s}(2) = \langle 3.436, 3.557 \rangle$

11) $\frac{dx}{dt} = \cos(t^2) \quad \frac{dy}{dt} = \sin(t^3)$

$x(2) = 4 + \int_0^2 \cos(t^2)\, dt = 4.461$

$y(2) = 7 + \int_0^2 \sin(t^3)\, dt = 4.452$

$\vec{s}(2) = \langle 4.461, 4.452 \rangle$

12) $x = \sin 2t \quad y = \cos 5t$

$x'(t) = 2\cos 2t$

$y'(t) = -5\sin 5t$

$\|\vec{v}(2)\| = \sqrt{(x'(2))^2 + (y'(2))^2} = 3.018$

13) $s(t) = \langle t^2 + 1, \frac{4}{3}t^3 \rangle$

$v(t) = \langle 2t, 4t^2 \rangle$

$L = \int_0^3 \sqrt{(2t)^2 + (4t^2)^2}\, dt$

$= 37.3437$