13.3

3. $r'(t) = \left(2, \frac{1}{t}, 2t\right)$

$\int_1^4 |r'(t)| dt = (t^2 + \ln t)_1^4 = 15 + \ln 4$

9. $r'(t) = (2t, 4t, 3t^2)$

$s(t) = \int_0^t |r'(u)|\, du = \frac{(9t^2+20)^{\frac{3}{2}} - 20^{\frac{3}{2}}}{27}$

11. $r'(t) = (2, 4, -1)$

$s(t) = \sqrt{2^2 + 4^2 + 1^2} = \sqrt{21}$

13. $r'(t) = \left(1, \frac{1}{t}, \frac{\ln t}{2t}\right)$

$s(1) = \sqrt{2}$

15. $r'(t) = (3\cos 3t\,, -4\sin 4t\,, -5\sin 5t)$

$s\left(\frac{\pi}{2}\right) = 5$

13.4

1. $r'(t) = (8t, 9)$

$T(t) = \frac{1}{\sqrt{64t^2+81}}(8t, 9)\ T(1) = \left(\frac{8}{\sqrt{145}}, \frac{9}{\sqrt{145}}\right)$

5. $r'(t) = (-\pi\sin\pi t\,, \pi\cos\pi t\,, 1)$

$T(t) = \left(\frac{-\pi\sin\pi t}{\sqrt{\pi^2+1}}, \frac{\pi\cos\pi t}{\sqrt{\pi^2+1}}, \frac{1}{\sqrt{\pi^2+1}}\right)\ T(1) = \left(0, \frac{-\pi}{\sqrt{\pi^2+1}}, \frac{1}{\sqrt{\pi^2+1}}\right)$

7. $r'(t) = (0, e^t, 1)\ r''(t) = (0, e^t, 0)$

$k(t) = \frac{e^t}{(e^{2t}+1)^{\frac{3}{2}}}$

11. $r'(t) = \left(\frac{-1}{t^2}, \frac{-2}{t^3}, 2t\right)\ r''(t) = \left(\frac{2}{t^3}, \frac{6}{t^4}, 2\right)$

$k(1) = \frac{2\sqrt{74}}{27}$

17. $r(t) = (t, t^4)\ r'(t) = (1, 4t^3)\ r''(t) = (0, 12t^2)$

$k(2) = \frac{48}{(\sqrt{1+32^2})^3}$

21. $r(t) = (t - tanht, secht)\ r'(t) = \left(1 - \frac{4}{(e^t+e^{-t})^2}, \frac{-2(e^t-e^{-t})}{(e^t+e^{-t})^2}\right)$

$r''(t) = \left(\frac{8(e^t-e^{-t})}{(e^t+e^{-t})^3}, \frac{4(e^t-e^{-t})^2 - 2(e^t+e^{-t})^3}{(e^t+e^{-t})^4}\right)$

$k(t) = \frac{2}{(e^t + e^{-t})} = sech t$

13.5

3. $r'(t) = (3t^2, -1, 8t)\ a(t) = (6t, 0, 8)$
   $v(1) = (3, -1, 8)\ a(1) = (6, 0, 8)\ s(1) = \sqrt{74}$
5. $v(\theta) = (\cos\theta, -\sin\theta, -3\sin 3\theta)\ a(\theta) = (-\sin\theta, -\cos\theta, -9\cos 3\theta)$
   $v\left(\frac{\pi}{3}\right) = \left(\frac{1}{2}, \frac{-\sqrt{3}}{2}, 0\right)\ a\left(\frac{\pi}{3}\right) = \left(\frac{-\sqrt{3}}{2}, \frac{-1}{2}, 9\right)\ v\left(\frac{\pi}{3}\right) = 1$
15. $v(t) = \left(\frac{t^2}{2} + 3, 4t - 2\right)\ r(t) = \left(\frac{t^3}{6} + 3t, 2t^2 - 2t\right)$
17. $v(t) = i + \frac{t^2}{2}k\ r(t) = ti + j + \frac{t^3}{6}k$
31. *The dot product of 2 vectors are minus, which means the $v(t)$ is slowing down.*
33. $v(t) = (1, -\sin t, \cos t)\ a(t) = (0, -\cos t, -\sin t)$

$T = \frac{(1, -\sin t, \cos t)}{\sqrt{2}}\ T' = (0, -\cos t, -\sin t)$

$a_T = 0, a_N = 1$