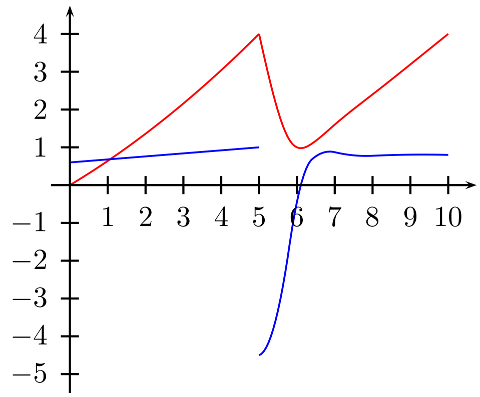
1. The size of the tumor is a continuous function of time (it wouldn't have been, if the treatment were surgical). The rate of growth is not continuous everywhere. It is continuous, except at the time of treatment. Before treatment the tumor grows, so the rate is positive, whereas right after treatment the tumor shrinks, so the rate immediately becomes negative — this is a jump discontinuity at $t = 5$.



Red — size of tumor
Blue — rate of growth

2. (a) $(x^{-2})' = \lim_{h\to 0} \dfrac{(x+h)^{-2} - x^{-2}}{h} = \lim_{h\to 0} \dfrac{1}{h}\left[\dfrac{1}{(x+h)^2} - \dfrac{1}{x^2}\right] = \lim_{h\to 0} \dfrac{x^2 - (x+h)^2}{h(x+h)^2x^2}$

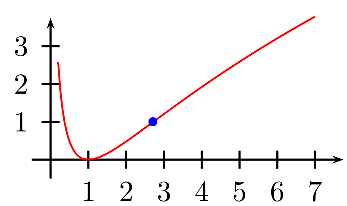
$$= \lim_{h\to 0} \frac{x^2 - x^2 - 2xh - h^2}{h(x+h)^2x^2} = \lim_{h\to 0} \frac{-2xh - h^2}{h(x+h)^2x^2} = \lim_{h\to 0} \frac{-2x - h}{(x+h)^2x^2} = \frac{-2x}{x^2x^2} = -\frac{2}{x^3}$$

(b) $(\pi^{x\cosh x})' = \ln\pi\ \pi^{x\cosh x}\,(x\cosh x)' = \ln\pi\ \pi^{x\cosh x}\,(\cosh x + x\sinh x)$

(c) $[\arctan(x^e)]' = \dfrac{1}{1+(x^e)^2}(x^e)' = \dfrac{ex^{e-1}}{1+x^{2e}}$

3. $y' = 2\ln x\,(\ln x)' = 2\ln x\,\dfrac{1}{x} = 2\dfrac{\ln x}{x}$ $\qquad y'' = 2\dfrac{\frac{1}{x}x - \ln x}{x^2} = \dfrac{2}{x^2}(1-\ln x)$

$y'' < 0$ when $1 - \ln x < 0$, i.e. $\ln x > 1$, i.e. $x > e$, so y is concave down on (e, ∞).



4. In general, the tangent line to $y = f(x)$ at $x = a$ is given by $y = f(a) + f'(a)(x-a)$. If $a = 0$, the tangent line is given by $y = f(0) + f'(0)x$.

   If $f(x) = x^2g(x)$, then $f(0) = 0$. Since $f'(x) = 2xg(x) + x^2g'(x)$, we have $f'(0) = 0$, so the tangent line is $y = 0$.

   If $f(x) = g(x^2)$, then $f(0) = g(0) = 1$. Since $f'(x) = g'(x^2)2x$, we have $f'(0) = 0$, so the tangent line is $y = 1$.

5. Suppose $p(t) = 10 + t\sin(1/t)$. Let $u = 1/t$. Then $t = 1/u$ and $u \to 0$ as $t \to \infty$, so

   $\lim_{t\to\infty} t\sin(1/t) = \lim_{u\to 0} \dfrac{\sin u}{u} = 1$, so $\lim_{t\to\infty} p(t) = 10 + 1 = 11$.

   Thus, in the long run, the deer population approaches 11 thousand.

   If $p(t) = 10 + \sin t/t$, then since $-1 \le \sin t \le 1$, we have $10 - 1/t \le p(t) \le 10 + 1/t$. By the squeeze law (a.k.a. sandwich rule) $p(t) \to 10$ as $t \to \infty$, so in the long run the deer population approaches 10 thousand.