2.3

16. $f(t)=\dfrac{2t^2-3t^{3/2}}{5t^{1/2}}=\frac{2}{5}t^{3/2}-\frac{3}{5}t\Rightarrow f'(t)=\frac{2}{5}\cdot\frac{3}{2}t^{1/2}-\frac{3}{5}=\frac{3}{5}\left(\sqrt{t}-1\right).$

Using the Quotient Rule, we have

$$f'(t)=\frac{5t^{1/2}\dfrac{d}{dt}\left(2t^2-3t^{3/2}\right)-\left(2t^2-3t^{3/2}\right)\dfrac{d}{dt}\left(5t^{1/2}\right)}{\left(5t^{1/2}\right)^2}=\frac{5t^{1/2}\left(4t-\frac{9}{2}t^{1/2}\right)-\left(2t^2-3t^{3/2}\right)\left(\frac{5}{2}t^{-1/2}\right)}{25t}$$

$$=\frac{20t^{3/2}-\frac{45}{2}t-5t^{3/2}+\frac{15}{2}t}{25t}=\frac{15t^{3/2}-15t}{25t}=\frac{3}{5}t^{1/2}-\frac{3}{5}=\frac{3}{5}\left(\sqrt{t}-1\right)$$

35. $$f'(x)=\left(x^{1/2}+2x\right)\frac{d}{dx}\left(x^{3/2}-x\right)+\left(x^{3/2}-x\right)\frac{d}{dx}\left(x^{1/2}+2x\right)$$

$$=\left(x^{1/2}+2x\right)\left(\tfrac{3}{2}x^{1/2}-1\right)+\left(x^{3/2}-x\right)\left(\tfrac{1}{2}x^{-1/2}+2\right)\quad\Rightarrow$$

$$f'(4)=\left[(4)^{1/2}+2(4)\right]\left[\tfrac{3}{2}(4)^{1/2}-1\right]+\left[(4)^{3/2}-(4)\right]\left[\tfrac{1}{2}(4)^{-1/2}+2\right]=(2+8)(3-1)+(8-4)\left(\tfrac{1}{4}+2\right)$$

$$=(10)(2)+(4)\left(\tfrac{9}{4}\right)=29$$

49. $$h'(x)=\frac{[x+g(x)]\dfrac{d}{dx}[xf(x)]-xf(x)\dfrac{d}{dx}[x+g(x)]}{[x+g(x)]^2}=\frac{[x+g(x)][f(x)+xf'(x)]-xf(x)[1+g'(x)]}{[x+g(x)]^2}\Rightarrow$$

$$h'(1)=\frac{[1+(-2)][2+(1)(-1)]-(1)(2)(1+3)}{(1-2)^2}=-9$$

58. $y=x^2\left(x+\dfrac{1}{x}\right)=x^3+x\Rightarrow y'=3x^2+1\Rightarrow y''=6x$

62. a. $f(x)=8x^7-6x^5+4x^3-x\Rightarrow f'(x)=56x^6-30x^4+12x^2-1\quad\Rightarrow\quad f''(x)=336x^5-120x^3+24x\Rightarrow$ $f'''(x)=1680x^4-360x^2+24$, so $f'''(0)=24$.

b. $y=x^{-1}\Rightarrow y'=-x^{-2}\quad\Rightarrow\quad y''=2x^{-3}\Rightarrow y'''=-6x^{-4}$, so $y'''\big|_{x=1}=-6(1)^{-4}=-6$.

2. 5

3. $h'(t) = \frac{d}{dt}(3\tan t - 4\sec t) = 3\sec^2 t - 4\sec t\tan t = \sec t\,(3\sec t - 4\tan t)$

17. $f'(x) = \frac{d}{dx}\left(\frac{1+\sin x}{1-\cos x}\right) = \frac{(1-\cos x)(\cos x) - (1+\sin x)(\sin x)}{(1-\cos x)^2} = \frac{\cos x - \cos^2 x - \sin x - \sin^2 x}{(1-\cos x)^2}$

$= \frac{\cos x - \sin x - 1}{(1-\cos x)^2}$

33. $y' = \frac{d}{dx}\left(x^2 \sec x\right) = x^2 \sec x\tan x + 2x\sec x \Rightarrow y'|_{x=\pi/4} = \frac{\pi^2}{16}\cdot\frac{2}{\sqrt{2}}\cdot 1 + 2\left(\frac{\pi}{4}\right)\left(\frac{2}{\sqrt{2}}\right) = \frac{\sqrt{2}\pi\,(8+\pi)}{16}$

38. $g'(x) = \frac{d}{dx}(x + \sin x) = 1 + \cos x$. Setting $1 + \cos x = 1$ gives $\cos x = 0 \Rightarrow x = \frac{(2k+1)\pi}{2}$, $k = 0, \pm1, \pm2, \ldots$.

45. $\lim_{h\to 0}\frac{\frac{1}{\sin(x+h)} - \frac{1}{\sin x}}{h} = \lim_{h\to 0}\frac{\csc(x+h) - \csc x}{h} = \frac{d}{dx}(\csc x)$ by definition, and this is equal to $-\csc x\cot x$.