2(a)	$\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{\mathrm{d}y}{\mathrm{d}t}\times\frac{\mathrm{d}t}{\mathrm{d}x}=\frac{1+\sinh t}{\cosh t}$
2(b)	$\frac{\mathrm{d}}{\mathrm{d}t}\left(\frac{1+\sinh t}{\cosh t}\right)=\frac{\cosh t\left(\cosh t\right)-\left(1+\sinh t\right)\sinh t}{\cosh^2 t}=\frac{1-\sinh t}{\cosh^2 t}$
	$\frac{\mathrm{d}^2 y}{\mathrm{d}x^2}=\frac{\mathrm{d}}{\mathrm{d}t}\left(\frac{\mathrm{d}y}{\mathrm{d}x}\right)\times\frac{\mathrm{d}t}{\mathrm{d}x}=\frac{1-\sinh t}{\cosh^3 t}$
2(c)	$y=y(0)+xy'(0)+\frac{x^2}{2!}y''(0)=1+x+\frac{1}{2}x^2$
	$2^n=(2n+1)I_n-2nI_{n-1}\Rightarrow(2n+1)I_n=2^n+2nI_{n-1}$

3(a)	$\frac{\mathrm{d}}{\mathrm{d}x}\left(x^2y\right)=x^2y'+2xy$
	$\frac{\mathrm{d}}{\mathrm{d}x}\left(\left(x+y\right)^3\right)=3\left(x+y\right)^2\left(1+y'\right)$
	$y'-4+3(1+y')=0\Rightarrow y'=\frac{1}{4}$
3(b)	$x^2y''+2xy'+2xy'+2y$
	$+3\left(x+y\right)^2y''+6\left(1+y'\right)^2\left(x+y\right)\left[=0\right]$
	$(-1)^2y''+4(-1)(\frac{1}{4})+2(2)+3y''+6\left(\frac{5}{4}\right)^2\left[=0\right]$
	$y''=-\frac{99}{32}$

7(a)	$\frac{\mathrm{d}}{\mathrm{d}x}\left(\frac{1}{2}x\sqrt{4-x^2}+2\sin^{-1}\left(\frac{1}{2}x\right)\right)=-\frac{1}{2}x^2\left(4-x^2\right)^{-\frac{1}{2}}+\frac{1}{2}\left(4-x^2\right)^{\frac{1}{2}}+2\left(4-x^2\right)^{-\frac{1}{2}}$
	$=\frac{1}{2}\left(4-x^2\right)\left(4-x^2\right)^{-\frac{1}{2}}+\frac{1}{2}\left(4-x^2\right)^{\frac{1}{2}}=\left(4-x^2\right)^{\frac{1}{2}}$
7(b)	$\mathrm{e}^{\frac{1}{2}\int(2+x)^{-1}\,\mathrm{d}x}=\sqrt{2+x}$
	$\frac{\mathrm{d}}{\mathrm{d}x}\left(y\sqrt{2+x}\right)=\sqrt{2+x}\sqrt{2-x}=\sqrt{4-x^2}$
	$y\sqrt{2+x}=\frac{1}{2}x\sqrt{4-x^2}+2\sin^{-1}\left(\frac{1}{2}x\right)[+C]$
	$\frac{1}{2}\sqrt{3}=\frac{1}{2}\sqrt{3}+\frac{1}{3}\pi+C$
	$y\sqrt{2+x}=\frac{1}{2}x\sqrt{4-x^2}+2\sin^{-1}\left(\frac{1}{2}x\right)-\frac{1}{3}\pi$

7(a)(i)	$\dot{x}=4\frac{\sec^2\frac{1}{2}t}{\tan\frac{1}{2}t}+3\operatorname{cosec}^2 t-3$ $\dot{x}=8\operatorname{cosec}t+3\operatorname{cosec}^2 t-3=8\operatorname{cosec}t+3\cot^2 t$
7(a)(ii)	$\dot{y}=6\operatorname{cosec}t-4\cot^2 t$
7(a)(iii)	$\dot{x}^2+\dot{y}^2=\left(8\operatorname{cosec}t+3\cot^2 t\right)^2+\left(6\operatorname{cosec}t-4\cot^2 t\right)^2$ $=100\operatorname{cosec}^2 t+25\cot^4 t=100\operatorname{cosec}^2 t+25\left(\operatorname{cosec}^2 t-1\right)^2$ $=25\operatorname{cosec}^4 t+50\operatorname{cosec}^2 t+25$
	$=25\left(\operatorname{cosec}^2 t+1\right)^2$
	$5\int_{\frac{1}{6}\pi}^{\frac{1}{3}\pi}\operatorname{cosec}^2 t+1\,\mathrm{d}t=5\left[-\cot t+t\right]_{\frac{1}{6}\pi}^{\frac{1}{3}\pi}=5\left(-\frac{1}{\sqrt{3}}+\frac{1}{3}\pi+\sqrt{3}-\frac{1}{6}\pi\right)=\frac{5}{6}\pi+\frac{10}{3}\sqrt{3}$

7(b)	$\frac{\dot{y}}{\dot{x}} = \frac{6\,\mathrm{cosec}\,t - 4\cot^2 t}{8\,\mathrm{cosec}\,t + 3\cot^2 t} = \frac{6\sin t - 4\cos^2 t}{8\sin t + 3\cos^2 t} = \frac{6\sec t - 4\cot t}{8\sec t + 3\cot t}$
	$\frac{\mathrm{d}}{\mathrm{d}t}\left(\frac{6\,\mathrm{cosec}\,t - 4\cot^2 t}{8\,\mathrm{cosec}\,t + 3\cot^2 t}\right)$ $= \frac{\left(8\csc t + 3\cot^2 t\right)\left(-6\cot t\csc t + 8\cot t\csc^2 t\right) + \left(6\csc t - 4\cot^2 t\right)\left(6\csc^2 t\cot t + 8\cot t\csc t\right)}{\left(8\,\mathrm{cosec}\,t + 3\cot^2 t\right)^2}$ or $\frac{\mathrm{d}}{\mathrm{d}t}\left(\frac{6\sin t - 4\cos^2 t}{8\sin t + 3\cos^2 t}\right)$ $= \frac{\left(8\sin t + 3\cos^2 t\right)\left(6\cos t + 8\cos t\sin t\right) - \left(6\sin t - 4\cos^2 t\right)\left(8\cos t - 6\cos t\sin t\right)}{\left(8\sin t + 3\cos^2 t\right)^2}$
	$\frac{100\cos t\sin^2 t + 50\cos^3 t}{\left(8\sin t + 3\cos^2 t\right)^2} = \frac{50\cos t\left(\sin^2 t + 1\right)}{\left(8\sin t + 3\cos^2 t\right)^2} = \frac{50\cot t\,\mathrm{cosec}\,t\left(\mathrm{cosec}^2 t + 1\right)}{\left(8\,\mathrm{cosec}\,t + 3\cot^2 t\right)^2}$
	$\frac{\mathrm{d}^2 y}{\mathrm{d}x^2} = \frac{\mathrm{d}}{\mathrm{d}t}\left(\frac{6\sin t - 4\cos^2 t}{8\sin t + 3\cos^2 t}\right)\times\frac{\mathrm{d}t}{\mathrm{d}x} = \frac{50\sin^2 t\cos t\left(\sin^2 t + 1\right)}{\left(8\sin t + 3\cos^2 t\right)^3}$ $= \frac{50\cot t\,\mathrm{cosec}\,t\left(\mathrm{cosec}^2 t + 1\right)}{\left(8\,\mathrm{cosec}\,t + 3\cot^2 t\right)^3}$

1	$f'(x) = -(x+2)^{-2}\mathrm{e}^{(x+2)^{-1}}$
	$f''(x) = (x+2)^{-4}\mathrm{e}^{(x+2)^{-1}} + 2\left(x+2\right)^{-3}\mathrm{e}^{(x+2)^{-1}} = \frac{2x+5}{\left(x+2\right)^4}\mathrm{e}^{(x+2)^{-1}}$
	$f(0) = \mathrm{e}^{\frac{1}{2}}\quad f'(0) = -\frac{1}{4}\mathrm{e}^{\frac{1}{2}}\quad f''(0) = \frac{5}{16}\mathrm{e}^{\frac{1}{2}}$
	$\mathrm{e}^{(x+2)^{-1}} = \mathrm{e}^{\frac{1}{2}} - \frac{1}{4}\mathrm{e}^{\frac{1}{2}}x + \frac{5}{32}\mathrm{e}^{\frac{1}{2}}x^2$