LIMITS

EXERCISE 2(B)

1. Since the function is conti

$VF|_{x=0} = RHL|_{x=0} = LHL|_{x=0}$

$f(0) = \lim_{x\to 0} f(x)$

$$= \lim_{x\to 0}\left(\frac{\sin 3x + A\sin 2x + B\sin x}{x^5}\right)$$

$$= \lim_{x\to 0}\left(\frac{3\cos 3x + 2A\cos 2x + B\cos x}{5x^4}\right); \left(\frac{3+2A+B}{0}\right) \text{ form}$$

$3 + 2A + B = 0$ ...(1)

$$= \lim_{x\to 0}\left(\frac{-9\sin 3x - 4A\sin 2x - B\sin x}{20x^3}\right); \left(\frac{0}{0}\text{form}\right)$$

$$= \lim_{x\to 0}\left(\frac{-27\cos 3x - 8A\cos 2x - B\cos x}{60x^2}\right); \left(\frac{-27-8A-B}{0}\right) \text{ form}$$

$27 + 8A + B = 0$ ...(2)

$$= \lim_{x\to 0}\left(\frac{81\sin 3x + 16A\sin 2x + B\sin x}{120x}\right); \left(\frac{0}{0}\text{form}\right)$$

$$= \lim_{x\to 0}\left(\frac{243\cos 3x + 32A\cos 2x + B\cos x}{120}\right)$$

$$f(0) = \frac{243+32A+B}{120} \qquad ...(3)$$

using (1) & (2)

$$\boxed{A = -4, B = 5}$$

then

$f(0) = 1$

2. $\therefore$ $$100\, l = \lim_{x\to 0}\frac{x^m - (\sin x)^m}{x^2\cdot(\sin x)^m} = \lim_{x\to 0}\frac{x^m\left[1-\left(\frac{\sin x}{x}\right)^m\right]}{(\sin x)^m x^2} = \lim_{x\to 0}\frac{1-\left(\frac{\sin x}{x}\right)^m}{x^2}$$

$$\left(\text{as } \lim_{x\to 0}\left(\frac{x}{\sin x}\right)^m = 1\right)$$

Using L'Hospital's Rule

$$100l = \lim_{x\to 0}\frac{-D\left(\frac{\sin x}{x}\right)^m}{2x}$$

now let $y = \left(\frac{\sin x}{x}\right)^m$; $\frac{dy}{dx} = m\left(\frac{\sin x}{x}\right)^{m-1}\left[\frac{x\cos x - \sin x}{x^2}\right]$

$$\therefore \quad 100l = -\lim_{x\to 0}\frac{6000\cdot\cos x\cdot(x-\tan x)}{2x^3} = 1000 \qquad \left(\lim_{x\to 0}\left(\frac{\sin x}{x}\right)^{m-1} = 1\right)$$

using expansion of $\tan x$ we get $\boxed{l = 10}$

3. Using L'Hospital's Rule, $\lim_{x\to 0}\frac{\sqrt{x^2+1}-1}{3x^2}$; $\frac{\frac{x}{\sqrt{x^2+1}}}{6x} = \frac{x}{\sqrt{x^2+1}}\cdot\frac{1}{6x} = \frac{1}{6} = \frac{p}{q}$

$\therefore \left|p^2 - q^2\right| = 35$.

Alternate :

Let $x = \tan\theta$, then $L = \lim_{\theta\to 0}\frac{\tan\theta + \ln(\sec\theta - \tan\theta)}{\tan^3\theta}$

$$L = \lim_{\theta\to 0}\frac{\tan\theta + \ln(1-\sin\theta) - \frac{1}{2}\ln(1-\sin^2\theta)}{\tan^3\theta}$$

$$L = \lim_{\theta\to 0}\frac{\sin\theta - \left(\sin\theta + \frac{\sin^2\theta}{2} + \frac{\sin^3\theta}{3} - - -\right)\cos\theta + \frac{1}{2}\left(\sin^2\theta + \frac{\sin^4\theta}{2} + - - -\right)\cos\theta}{\tan^3\theta\cos\theta}$$

$$L = \lim_{\theta\to 0}\left(\frac{\sin\theta(1-\cos\theta)}{\tan^3\theta\cos\theta} - \frac{\sin^3\theta}{3\tan^3\theta\cos\theta}\right) \quad \text{....rest of the terms have degree} > 3$$

$$L = \lim_{\theta\to 0}\left(\left(\frac{\sin\theta}{\tan\theta\cos\theta}\right)\left(\frac{\sin^2\frac{\theta}{2}}{\frac{\tan^2\theta}{4}}\right)\frac{1}{2} - \frac{\sin^3\theta}{3\tan^3\theta\cos\theta}\right) = \frac{1}{2} - \frac{1}{3} = \frac{1}{6}.$$

4. Let radius of circle is r &

$\angle AOB = 2O$

$\angle ACB = \pi - 2\theta$

($\because$ points A, C, B, O are concyclic)

$\therefore \angle AOP = \angle BOP = \theta$

$\angle ACP = \angle BCP = \frac{\pi}{2} - \theta$

In ΔAOP,

$\sin\theta = \frac{AP}{OA} = \frac{AP}{r}$

$\Rightarrow AP = r \sin\theta$

$\cos\theta = \frac{OP}{OA} = \frac{OP}{r}$

$\Rightarrow OP = r \cos\theta$

$AB = 2AP = 2r \sin\theta$

in ΔAOC,

$\sin\left(\frac{\pi}{2} - \theta\right) = \frac{OA}{OC}$

$\Rightarrow \cos\theta = \frac{r}{OC}$

$= \frac{r}{\cos\theta} \; r \cos\theta$

$= r\left(\frac{1}{\cos\theta} - \cos\theta\right)$

$= \frac{r}{\cos\theta} \; (1 - \cos^2\theta)$

$\therefore PC = \frac{r}{\cos\theta}\sin^2\theta$

$\therefore ar(\Delta ABC) = \frac{1}{2} \; AB. PC$

$= \frac{1}{2} 2r \sin\theta \; . \; \frac{r}{\cos\theta}.\sin^2\theta$

$= r^2 \tan\theta \; . \; \sin^2\theta$

$\because OC = \frac{r}{\cos\theta} \; OR = r$

$RC = OC - OR$

$$= \frac{r}{\cos\theta} - r$$

$$= \frac{r}{\cos\theta}(1 - \cos\theta)$$

In ΔDRC,

$$\tan\left(\frac{\pi}{2} - \theta\right) = \frac{DR}{RC}$$

$$\Rightarrow \cot\theta = \frac{DR}{RC} \Rightarrow DR = RC \cos\theta$$

$$= \frac{r}{\cos\theta} (1 - \cos\theta).\cot\theta$$

$$= \frac{r}{\cos\theta}(1 - \cos\theta).\frac{\cos\theta}{\sin\theta} = \frac{r(1 - \cos\theta)}{\sin\theta}$$

DR + RE = DE $\Rightarrow$ DE = 2DR

$$\Rightarrow OC = \frac{r}{\cos\theta}$$

PC = OC – OP $\Rightarrow$ DE = 2DR

$$= \frac{2r}{\sin\theta}(1 - \cos\theta)$$

$$\text{are }(\Delta DEC) = \frac{1}{2} \times DE \times RC$$

$$= \frac{1}{2}\frac{2r(1 - \cos\theta)}{\sin\theta}.\frac{r(1 - \cos\theta)}{\cos\theta}$$

$$= \frac{r^2(1 - \cos\theta)(1 - \cos\theta)}{\sin\theta.\cos\theta}$$

$$= \frac{r^2.2\sin^2\frac{\theta}{2} \cdot 2\sin^2\frac{\theta}{2}}{\sin\theta.\cos\theta}$$

$$= \frac{4r^2\sin^2\frac{\theta}{2}\sin^2\frac{\theta}{2}}{\sin\theta.\cos\theta} = \frac{4r^2\sin^4\frac{\theta}{2}}{\sin\theta\cos\theta}$$

AB = 2r $\sin\theta$

If AB $\to$ 0 i.e. $2\sin\theta \to 0 \Rightarrow \theta \to 0$

$$\therefore \lim_{AB\to 0}\frac{ar(\Delta ABC)}{ar(\Delta CDE)}$$

$$= \lim_{\theta\to 0}\frac{r^2\tan\theta.\sin^2\theta}{\dfrac{4r^2\sin\theta/2}{\sin\theta.\cos\theta}}$$

$$= \lim_{\theta\to 0}\frac{\tan\theta.\sin^3\theta.\cos\theta}{4\sin^4\theta/2}$$

$$= \lim_{\theta\to 0}\frac{\dfrac{\tan\theta.\sin^3\theta.\cos\theta}{\theta^4}}{4\dfrac{\sin^4\theta/2}{\theta^4}}$$

$$= \lim_{\theta\to 0}\frac{\left(\dfrac{\tan\theta}{\theta}\right)\cdot\left(\dfrac{\sin\theta}{\theta}\right)^3\cdot\cos\theta}{4\left(\dfrac{\sin\theta/2}{\theta/2}\right)^4\cdot\dfrac{1}{2^4}}$$

$$= \frac{1.1.1}{4.1.1/16} = 4$$

5. $\displaystyle \underset{x\to 0}{\mathrm{Lim}}\frac{ae^x - b\cos x + ce^{-x}}{x\sin x} = 2$

$$\underset{x\to 0}{\mathrm{Lim}}\frac{a\left[1+\dfrac{x}{1!}+\dfrac{x^2}{2!}+.....\right]-b\left[1-\dfrac{x^2}{2!}+\dfrac{x^4}{4!}-.....\right]+c\left[1-\dfrac{x}{1!}+\dfrac{x^2}{2!}-.....\right]}{x^2\left[\dfrac{\sin x}{x}\right]}$$

(i) $a - b + c = 0$ = constant

coeff. of x = (ii) $a - c = 0 \Rightarrow a = c$

coeff. of x^2 = (iii) $\dfrac{a}{2}+\dfrac{b}{2}+\dfrac{c}{2} = 2 \Rightarrow a + b + c = 4$

$2(a + c) = 4 \Rightarrow a - c = 2$

$\boxed{a = 1 = c}$ $\boxed{b = 2}$

6. $L = \left(1-\dfrac{4}{3^2}\right)\left(1-\dfrac{4}{4^2}\right)\left(1-\dfrac{4}{5^2}\right)...........$

$\left(1-\dfrac{2}{3}\right)\left(1-\dfrac{2}{4}\right)\left(1-\dfrac{2}{5}\right)\left(1-\dfrac{2}{6}\right)$ $\qquad$ $\left(1+\dfrac{2}{3}\right)\left(1+\dfrac{2}{4}\right)-\left(1+\dfrac{2}{5}\right)$

$$\frac{1}{3}\times\frac{2}{4}\times\frac{3}{5}\times\frac{4}{6}\ldots\ldots\ldots \qquad \left(\frac{5}{3}\right)\left(\frac{6}{4}\right)\left(\frac{7}{5}\right)$$

$$=\frac{1}{3}\times\frac{2}{4}=\left(\frac{1}{6}\right)$$

$$M=\frac{2^3-1}{2^3+1}\cdot\frac{3^3-1}{3^3+1}\cdot\frac{4^3-1}{4^3+1}\ldots\ldots\ldots$$

$$\frac{(n-1)(n^2+n+1)}{(n+1)(n^2-n+1)}=\left(\frac{2-1}{2+1}\cdot\frac{3-1}{3+1}\cdot\frac{4-1}{4+1}\cdot\frac{5-1}{5+1}\ldots\ldots\right)$$

$$\left(\frac{2^2+2+1}{2^2-2+1}\cdot\frac{3^2+3+1}{3^2-3+1}\right)\ldots\ldots$$

$$\Rightarrow \frac{102}{(n+1)_n}\cdot\frac{n^2+n+1}{3}=\frac{2}{3}$$

7. $$\frac{1}{1+n^2}\le\frac{1}{1+n^2}\le\frac{1}{1+n^2}$$

$$\frac{2}{n+n^2}\le\frac{2}{2+n^2}\le\frac{2}{1+n^2}$$

$$\frac{3}{n+n^2}\le\frac{3}{n+n^2}\le\frac{3}{1+n^2}$$

$$\frac{n(n+1)}{2(n+n^2)}\le Sn\le\frac{n(n+1)}{2(1+n^2)}$$

(a) $$\frac{1}{\sqrt{n^2+2n}}\le\frac{1}{\sqrt{n^2}}\le\frac{1}{\sqrt{n^2}}$$

$$\frac{1}{\sqrt{n^2+2n}}\le\frac{1}{\sqrt{n^2+1}}\le\frac{1}{\sqrt{n^2}}$$

$$\frac{2n}{\sqrt{n^2+2n}}\le Sn\le\frac{2n}{\sqrt{n^2}}$$

$t=2$.

8. $$l=\lim_{x\to0^+} x^{(x^x-1)} \qquad (0^0 \text{ form})$$

$$\ln l=\lim_{x\to0}(x^x-1).\ln x = \operatorname{Limit}_{x\to0}\frac{(e^{x\ln x}-1)}{x\ln x}\ \operatorname{Limit}_{x\to0}\ x\ln x\ .\ln x$$

$$=\operatorname{Limit}_{x\to0}\ x(\ln x)^2 \qquad (\text{ as } x\to0\ x\ln x\to0)$$

$$= \underset{x\to 0}{\text{Limit}} \frac{(\ln x)^2}{1/x} = \underset{x\to 0}{\text{Limit}} -\frac{2\ln x}{x}.x^2 \quad \text{(use Lopital's rule)}$$

$$= \underset{x\to 0}{\text{Limit}} -2\ln x.x = 0 \qquad \Rightarrow \qquad l = e^0 = 1$$

9. Let $U_n = \underset{x\to 0}{\text{Lim}} \dfrac{1-\cos 3x\cdot\cos 3^2x\cdot\cos 3^3x.........\cos 3^n x}{x^2}$

and $V_n = \underset{x\to 0}{\text{Lim}} \dfrac{1-\cos\frac{x}{3}\cdot\cos\frac{x}{3^2}\cdot\cos\frac{x}{3^3}.........\cos\frac{x}{3^n}}{x^2}$

$$U_n = \underset{x\to 0}{\text{Lim}} \frac{-D(\cos 3x\cdot\cos 3^2x\cdot\cos 3^3x.........\cos 3^n x)}{2x}$$

now let $y = \cos 3x \cdot \cos 3^2x \cdot \cos^3 x .... \cos 3^n x$

$l\text{n } y = l\text{n} \cos 3x + l\text{n} \cos 3^2x + ... + l\text{n} \cos 3^n x$

$$\frac{1}{y}\frac{dy}{dx} = -[3 \tan 3x + 3^2 \tan 3^2x + ... + 3^n \tan 3^n x]$$

$$\frac{dy}{dx} = -\prod_{r=1}^{n} \cos 3^r x[3\tan 3x + 3^2 \tan 3^2 x + ... + 3^n \tan 3^n x]$$

$$\therefore \quad U_n = \underset{x\to 0}{\text{Lim}} \frac{3\tan 3x + 3^2\tan 3^2x + ... + 3^n \tan 3^n x}{2x} = \frac{3^2 + (3^2)^2 + (3^3)^2 + ... + (3^n)^2}{2}$$

$$U_n = \frac{3^2[3^{2n}-1]}{(3^2-1)\cdot 2} \qquad ....(1)$$

|||ly replacing 3^r by $\dfrac{1}{3^r}$ we get

$$V_n = \frac{\frac{1}{3^2}\left[1-\frac{1}{3^{2n}}\right]}{\left(1-\frac{1}{3^2}\right)\cdot 2} = \frac{(3^{2n}-1)}{3^{2n}(3^2-1)\cdot 2} \qquad ....(2)$$

$$\therefore \quad \frac{U_n}{V_n} = 3^{2n+2} = 3^{10} \text{ (given)}$$

$$\therefore \quad 2n + 2 = 10 \quad \Rightarrow \quad \boxed{n = 4}$$

10. $\underset{x\to 0}{\lim} \dfrac{1}{x^3}\left[\dfrac{1}{\sqrt{1+x}} - \dfrac{1+ax}{1+bx}\right]$

$$= \lim_{x\to 0}\frac{1}{x^3}\left[\frac{1+bx-(1+ax)\sqrt{1+x}}{\sqrt{1+x}\ \ (1+bx)}\right]$$

$$= \lim_{x\to 0}\frac{1+bx-(1+ax)\ (1+x)^{1/2}}{x^3(1+x)^{1/2}(1+bx)}$$

We know that

$$(1+x)^n = 1+nx+\frac{n(n-1)}{2!}x^2+\frac{n(n-1)\ (n-2)}{3!}x^3+....$$

where, $n \in Q$ & $|x|<1$

$$= \lim_{x\to 0}\frac{1+bx-(1+ax)\left[1+\frac{1}{2}x+\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)}{2!}x^2+\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)\left(\frac{1}{2}-2\right)}{3!}x^3+.......\right]}{x^3(1+x)^{1/2}\ \ (1+bx)}$$

$$\lim_{x\to 0}\frac{1+bx-1-\frac{1}{2}x-\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)}{2!}x^2-\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)\left(\frac{1}{2}-2\right)}{3!}x^3-...-ax\left(1+\frac{1}{2}x+\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)}{2!}x^2+\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)\left(\frac{1}{2}-2\right)}{3!}x^3+......\right)}{x^3(1+x)^{1/2}(1+bx)}$$

$$=\lim_{x\to 0}\frac{bx-\frac{1}{2}x-\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)}{2!}x^2-\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)\left(\frac{1}{2}-2\right)}{3!}x^3-...-ax\left(1+\frac{1}{2}x+\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)}{2!}x^2+\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)\left(\frac{1}{2}-2\right)}{3!}x^3+.....\right)}{x^3(1+x)^{1/2}(1+bx)}$$

$$=\lim_{x\to 0}\frac{b-\frac{1}{2}-\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)}{2!}x-\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)\left(\frac{1}{2}-x\right)x^2}{3!}-.....-a\left(1+\frac{1}{2}x+\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)}{2!}x^2+\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)\left(\frac{1}{2}-2\right)}{3!}x^3+...\right)}{x^2(+x)^{1/2}(1+bx)}$$

$$= \lim_{x\to 0}\frac{\left(b-a-\frac{1}{2}\right)-\left(\frac{a}{2}+\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)}{2!}\right)x-\left(\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)\left(\frac{1}{2}-2\right)}{3!}+a.\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)}{2!}\right)x^2-(\ )x^3-(\ )x^4-.......}{x^2.1.1}$$

Limit exists finitaly if

$$\text{(i) } b-a-\frac{1}{2}=0$$

$$\text{(ii) } \frac{a}{2}+\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)}{2!}=0$$

$$\Rightarrow \frac{a}{2}-\frac{\frac{1}{2}.\frac{1}{2}}{2}=0$$

$$\Rightarrow a-\frac{1}{4}=0$$

$$\Rightarrow a=\frac{1}{4}$$

$$\because b-a=\frac{1}{2}$$

$$\Rightarrow b=a+\frac{1}{2}$$

$$=\frac{3}{4}$$

$$a=\frac{1}{4} \; \& \; b=\frac{3}{4}$$

$$=\lim_{x\to 0}\frac{\left(-\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)}{2!}a-\frac{\frac{1}{2}\left(\frac{1}{2}-1\right)\left(\frac{1}{2}-2\right)}{3!}\right)x^2-(\;)x^3-(\;)x^4-......}{x^2}$$

$$=\lim_{x\to 0}\left[\left(\frac{a}{8}-\frac{\frac{1}{2}.\frac{1}{2}.\frac{3}{2}}{2.3}\right)-(\;)x-(\;)x^2-......\right]$$

$$=\frac{1}{32}-\frac{1}{2}.\frac{1}{2}.\frac{1}{2}.\frac{1}{2}=-\frac{1}{16}+\frac{1}{32}=-\frac{1}{32}$$

$$\Rightarrow \lim_{x\to 0}\frac{1}{x^3}\left(\frac{1}{\sqrt{1+x}}-\frac{1+ax}{1+bx}\right)=-\frac{1}{32}$$

$$\therefore \ell=-\frac{1}{32}$$

$$\therefore\ \frac{1}{a}-\frac{2}{\ell}+\frac{3}{b}$$

$$=\frac{1}{\frac{1}{4}}-\frac{2}{\frac{-1}{32}}+\frac{3}{\frac{3}{4}}$$

$= 4 + 2.32 + 4$

$= 4 + 64 + 4$

$= 72$

11. Clearly from $x^2 + ax + 12 = 0$, $x^2 + bx + 15 = 0$ & $x^2 + (a+b)x + 36 = 0$, the roots are (3 & 4), (3 & 5) and (3 & 12) respectively.
Hence the common root is 3.

12. $$\lim_{x\to\frac{\pi}{3}}\frac{3\tan x-\tan^3 x}{3\cos\left(x+\frac{\pi}{6}\right)}=\lim_{x\to\frac{\pi}{3}}\frac{\left(3\cos^2 x-\sin^2 x\right)\sin x}{3\cos\left(x+\frac{\pi}{6}\right)\cos^3 x}$$

$$=\lim_{x\to\frac{\pi}{3}}\frac{\left(3-4\sin^2 x\right)\sin x}{3\cos\left(x+\frac{\pi}{6}\right)\cos^3 x}=\lim_{x\to\frac{\pi}{3}}\frac{\sin 3x}{3\cos\left(x+\frac{\pi}{6}\right)\cos^3 x}$$

Now let $x=y+\frac{\pi}{3}$, then $L=\lim_{y\to 0}\frac{\sin 3y}{3\sin y\cos^3\left(y+\frac{\pi}{3}\right)}$

$$L=\lim_{y\to 0}\frac{\frac{\sin 3y}{3y}}{\frac{\sin y}{y}\cos^3\left(y+\frac{\pi}{3}\right)}=8.$$

13. $$\left[\frac{4}{x^3-x^{-1}}-\frac{1-3x+x^2}{1-x^3}\right]^{-1}+\frac{3.\left(x^4-1\right)}{x^3-x^{-1}}$$

$$=\lim_{x\to 1}\left[\left[\frac{4x}{x^3-1}+\frac{1-3x+x^2}{x^3-1}\right]^{-1}+\frac{3x\left(x^4-1\right)}{x^4-1}\right]$$

$$=\lim_{x\to 1}\left[\left[\frac{1+x+x^2}{x^3-1}\right]^{-1}+3x\right]=\lim_{x\to 1}\left[x-1+3x\right]=3.$$

14. $$\lim_{x\to 0}\frac{x\left(1-m\cos x\right)+n\sin x}{x^3}=\lim_{x\to 0}\frac{x\left(1-m\left(1-\frac{x^2}{2}+\frac{x^4}{4!}-...\right)\right)+n\left(x-\frac{x^3}{6}+\frac{x^5}{5!}-...\right)}{x^3}=1$$

Now $n-m+1=0$ & $\frac{m}{2}-\frac{n}{6}=1$

$\Rightarrow m=\frac{5}{2}$ & $n=\frac{3}{2}$

Hence m + n = 4.

15. $$x+\cfrac{x^{1/3}}{x+\cfrac{x^{1/3}}{x+....\infty \text{ terms}}}=y\Rightarrow x+\frac{x^{1/3}}{y}$$

$$\Rightarrow y^2-xy-x^{1/3}=0\Rightarrow y=\frac{x+\sqrt{x^2+4x^{1/3}}}{2}$$

$$\Rightarrow \lim_{x\to\infty}\cfrac{x}{x+\cfrac{x^{1/3}}{x+\cfrac{x^{1/3}}{x+....\infty \text{ terms}}}}=\lim_{x\to\infty}\frac{2x}{x+\sqrt{x^2+4x^{1/3}}}=2$$

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