## EXERCISE 30.2

**1. Differentiate each of the following from first principles:**
**(i) 2/x**
**(ii) 1/√x**
**(iii) $1/x^3$**
**(iv) $[x^2 + 1]/ x$**
**(v) $[x^2 - 1] / x$**
**Solution:**
**(i)** 2/x
Given:
f (x) = 2/x
By using the formula,

$$\frac{d}{dx}(f(x)) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$

By substituting the values we get,

$$= \lim_{h \to 0} \frac{\frac{2}{x+h} - \frac{2}{x}}{h}$$

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

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

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

When h= 0, we get

$$= \frac{-2}{x^2}$$

$= -2x^{-2}$

∴ Derivative of f(x) = 2/x is $-2x^{-2}$

**(ii)** 1/√x
Given:
f (x) = 1/√x
By using the formula,

$$\frac{d}{dx}(f(x)) = \lim_{h\to 0} \frac{f(x+h) - f(x)}{h}$$

By substituting the values we get,

$$= \lim_{h\to 0} \frac{\frac{1}{\sqrt{x+h}} - \frac{1}{\sqrt{x}}}{h}$$

By using algebra of limits, we get

$$= \lim_{h\to 0} \frac{\sqrt{x} - \sqrt{x+h}}{h\sqrt{x}\sqrt{x+h}} \times \frac{\sqrt{x} + \sqrt{x+h}}{\sqrt{x} + \sqrt{x+h}}$$

$$= \lim_{h\to 0} \frac{x - x - h}{h\sqrt{x}\sqrt{x+h}\left(\sqrt{x} + \sqrt{x+h}\right)}$$

$$= \lim_{h\to 0} \frac{-h}{h\sqrt{x}\sqrt{x+h}\left(\sqrt{x} + \sqrt{x+h}\right)}$$

$$= \lim_{h\to 0} \frac{-1}{\sqrt{x}\sqrt{x+h}\left(\sqrt{x} + \sqrt{x+h}\right)}$$

When h = 0, we get

$$= \frac{-1}{\sqrt{x}\sqrt{x}\left(\sqrt{x} + \sqrt{x}\right)}$$

$$= \frac{-1}{x \times 2\sqrt{x}}$$

$$= \frac{-1}{2x^{\frac{3}{2}}}$$

$$= -\frac{1}{2}x^{\frac{-3}{2}}$$

∴ Derivative of $f(x) = 1/\sqrt{x}$ is $-1/2\ x^{-3/2}$

**(iii) $1/x^3$**

Given:

$f(x) = 1/x^3$

By using the formula,

$$\frac{d}{dx}(f(x))=\lim_{h\to 0}\frac{f(x+h)-f(x)}{h}$$

By substituting the values we get,

$$=\lim_{h\to 0}\frac{\frac{1}{(x+h)^3}-\frac{1}{x^3}}{h}$$

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

By using the formula $[a^3-b^3=(a-b)(a^2+ab+b^2)]$

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

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

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

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

When h = 0, we get

$$=\frac{-3x^2}{x^6}$$

$$=\frac{-3}{x^4}$$

$$=-3x^{-4}$$

∴ Derivative of $f(x) = 1/x^3$ is $-3x^{-4}$

**(iv)** $[x^2 + 1]/ x$

Given:

$f(x) = [x^2 + 1]/ x$

By using the formula,

$$\frac{d}{dx}(f(x))=\lim_{h\to 0}\frac{f(x+h)-f(x)}{h}$$

By substituting the values we get,

$$= \lim_{h \to 0} \frac{\frac{(x+h)^2+1}{x+h} - \frac{x^2+1}{x}}{h}$$

Upon expansion,

$$= \lim_{h \to 0} \frac{\frac{x^2+2xh+h^2+1}{x+h} - \frac{x^2+1}{x}}{h}$$

By using algebra of limits, we get

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

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

$$= \lim_{h \to 0} \frac{h(x^2 + hx - 1)}{xh(x+h)}$$

$$= \lim_{h \to 0} \frac{x^2 + hx - 1}{x(x+h)}$$

When h = 0, we get

$$= \frac{x^2 - 1}{x^2}$$

$= 1 – 1/x^2$

∴ Derivative of f(x) = $1 – 1/x^2$

**(v)** $[x^2 - 1] / x$

Given:

f (x) = $[x^2 - 1]/ x$

By using the formula,

$$\frac{d}{dx}(f(x)) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$

By substituting the values we get,

$$= \lim_{h \to 0} \frac{\frac{(x+h)^2-1}{x+h} - \frac{x^2-1}{x}}{h}$$

Upon expansion,

$$= \lim_{h\to 0} \frac{\frac{x^2+2xh+h^2-1}{x+h} - \frac{x^2-1}{x}}{h}$$

By using algebra of limits, we get

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

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

$$= \lim_{h\to 0} \frac{h(x^2 + hx + 1)}{xh(x+h)}$$

$$= \lim_{h\to 0} \frac{x^2 + hx + 1}{x(x+h)}$$

When h = 0, we get

$$= \frac{x^2+1}{x^2}$$

$= 1 + 1/x^2$

∴ Derivative of f(x) = $1 + 1/x^2$



**2. Differentiate each of the following from first principles:**

**(i)** $e^{-x}$

**(ii)** $e^{3x}$

**(iii)** $e^{ax+b}$

**Solution:**

**(i)** $e^{-x}$

Given:

f (x) = $e^{-x}$

By using the formula,

$$\frac{d}{dx}(f(x)) = \lim_{h\to 0} \frac{f(x+h) - f(x)}{h}$$

By substituting the values we get,

$$\frac{d}{dx}(e^x) = \lim_{h\to 0} \frac{e^{-(x+h)} - e^{-x}}{h}$$

$$= \lim_{h \to 0} \frac{e^{-x}e^{-h} - e^{-x}}{h}$$

Taking $e^{-x}$ common, we have

$$= \lim_{h \to 0} \frac{e^{-x}\left(e^{-h} - 1\right)}{h}$$

$$= \lim_{h \to 0} e^{-x} \times \lim_{h \to 0} \frac{e^{-h}-1}{-h} \times (-1)$$

We know that, $\lim_{x \to 0} \frac{e^{x}-1}{x} = \log_e e = 1$

$$= -e^{-x} \lim_{h \to 0} \frac{e^{-h} - 1}{-h}$$

So,

$$= -e^{-x}(1)$$

$$= -e^{-x}$$

∴ Derivative of f (x) = $-e^{-x}$



**(ii)** $e^{3x}$

Given:

f (x) = $e^{3x}$

By using the formula,

$$\frac{d}{dx}(f(x)) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$

By substituting the values we get,

$$\frac{d}{dx}\left(e^{3x}\right) = \lim_{h \to 0} \frac{e^{3(x+h)} - e^{3x}}{h}$$

$$= \lim_{h \to 0} \frac{e^{3x}e^{3h} - e^{3x}}{h}$$

Taking $e^{-x}$ common, we have

$$= \lim_{h \to 0} \frac{e^{3x}\left(e^{3h} - 1\right)}{3h}$$

By using algebra of limits,

$$= \lim_{h \to 0} e^{3x} \times \lim_{h \to 0} \frac{e^{3h}-1}{h}$$

Since we cannot substitute the value of h directly, we take

$$= \lim_{h \to 0} e^{3x} \times \lim_{h \to 0} \frac{e^{3h}-1}{3h} \times 3$$

We know that, $\lim_{x \to 0} \frac{e^{x}-1}{x} = \log_e e = 1$

$$= 3e^{3x} \lim_{h \to 0} \frac{e^{3h}-1}{3h}$$

$$= 3e^{3x}(1)$$

$$= 3e^{3x}$$

∴ Derivative of f (x) = $3e^{3x}$

**(iii)** $e^{ax+b}$

Given:

f (x) = $e^{ax+b}$

By using the formula,

$$\frac{d}{dx}(f(x)) = \lim_{h \to 0} \frac{f(x+h)-f(x)}{h}$$



By substituting the values we get,

$$\frac{d}{dx}\left(e^{ax+b}\right) = \lim_{h \to 0} \frac{e^{a(x+h)+b}-e^{ax+b}}{h}$$

$$= \lim_{h \to 0} \frac{e^{ax+b}e^{ah}-e^{ax+b}}{h}$$

Taking $e^{ax+b}$ common, we have

$$= \lim_{h \to 0} \frac{e^{ax+b}\left(e^{ah}-1\right)}{h}$$

By using algebra of limits,

$$= \lim_{h \to 0} e^{ax+b} \times \lim_{h \to 0} \frac{e^{ah}-1}{h}$$

Since we cannot substitute the value of h directly, we take

$$= \lim_{h \to 0} e^{ax+b} \times \lim_{h \to 0} \frac{e^{ah}-1}{ah} \times a$$

We know that, $\lim_{x \to 0} \frac{e^{x}-1}{x} = \log_e e = 1$

$$= ae^{ax+b}\lim_{h\to 0}\frac{e^{ah}-1}{ah}$$

$$= ae^{ax+b}(1)$$

$$= ae^{ax+b}$$

∴ Derivative of f (x) = $ae^{ax+b}$

**3. Differentiate each of the following from first principles:**
**(i) √(sin 2x)**
**(ii) sin x/x**
**Solution:**
**(i)** √(sin 2x)
Given:
f (x) = √(sin 2x)
By using the formula,

$$\frac{d}{dx}(f(x)) = \lim_{h\to 0}\frac{f(x+h)-f(x)}{h}$$

By substituting the values we get,

$$= \lim_{h\to 0}\frac{\sqrt{\sin(2x+2h)}-\sqrt{\sin 2x}}{h}$$

Multiply numerator and denominator by √(sin 2(x + h)) + √(sin 2x), we have

$$= \lim_{h\to 0}\frac{\sqrt{\sin(2x+2h)}-\sqrt{\sin 2x}}{h}\times\frac{\sqrt{\sin(2x+2h)}+\sqrt{\sin 2x}}{\sqrt{\sin(2x+2h)}+\sqrt{\sin 2x}}$$

By using $a^2 - b^2 = (a + b)(a - b)$, we get

$$= \lim_{h\to 0}\frac{\sin(2x+2h)-\sin 2x}{h\left(\sqrt{\sin(2x+2h)}+\sqrt{\sin 2x}\right)}$$

By using the formula,

$$sinC - sinD = 2cos\left(\frac{C+D}{2}\right)\sin\left(\frac{C-D}{2}\right)$$

$$= \lim_{h \to 0} \frac{2\cos\left(\frac{2x+2h+2x}{2}\right)\sin\left(\frac{2x+2h-2x}{2}\right)}{h\left(\sqrt{\sin(2x+2h)}+\sqrt{\sin 2x}\right)}$$

$$= \lim_{h \to 0} \frac{2\cos(2x+h)\sin h}{h\left(\sqrt{\sin(2x+2h)}+\sqrt{\sin 2x}\right)}$$

By applying limits to each term, we get

$$= \lim_{h \to 0} 2\cos(2x+h) \lim_{h \to 0} \frac{\sin h}{h} \lim_{h \to 0} \frac{1}{\left(\sqrt{\sin(2x+2h)}+\sqrt{\sin 2x}\right)}$$

$$= 2\cos 2x\,(1)\,\frac{1}{\sqrt{\sin 2x}+\sqrt{\sin 2x}}$$

$$= \frac{2\cos 2x}{2\sqrt{\sin 2x}}$$

$$= \frac{\cos 2x}{\sqrt{\sin 2x}}$$

∴ Derivative of f (x) = cos 2x / √(sin 2x)



**(ii)** sin x/x

Given:

f (x) = sin x/x

By using the formula,

$$\frac{d}{dx}(f(x)) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$

By substituting the values we get,

$$= \lim_{h \to 0} \frac{\frac{\sin(x+h)}{x+h} - \frac{\sin x}{x}}{h}$$

$$= \lim_{h \to 0} \frac{x\sin(x+h) - (x+h)\sin x}{hx(x+h)}$$

By using algebra of limits,

$$= \lim_{h\to 0} \frac{x\left(\sin x\cos h + \cos x\sin h\right) - x\sin x - h\sin x}{hx\left(x+h\right)}$$

$$= \lim_{h\to 0} \frac{x\sin x\cos h + x\cos x\sin h - x\sin x - h\sin x}{hx\left(x+h\right)}$$

$$= \lim_{h\to 0} \frac{x\sin x\cos h - x\sin x + x\cos x\sin h - h\sin x}{hx\left(x+h\right)}$$

By applying limits to each term, we get

$$= x\sin x \lim_{h\to 0}\frac{\cos h - 1}{h} + \frac{x\cos x}{x}\lim_{h\to 0}\frac{\sin h}{h}\lim_{h\to 0}\frac{1}{x+h} - \frac{\sin x}{x}\lim_{h\to 0}\frac{1}{x+h}$$

$$= x\sin x \lim_{h\to 0}\frac{-2\sin^2\frac{h}{2}}{h} + \frac{x\cos x}{x}\lim_{h\to 0}\frac{\sin h}{h}\lim_{h\to 0}\frac{1}{x+h} - \frac{\sin x}{x}\lim_{h\to 0}\frac{1}{x+h}$$

$$= x\sin x \lim_{h\to 0}\frac{-2\sin^2\frac{h}{2}}{\frac{h^2}{4}} \times \frac{h}{4} + \frac{x\cos x}{x}\lim_{h\to 0}\frac{\sin h}{h}\lim_{h\to 0}\frac{1}{x+h} - \frac{\sin x}{x}\lim_{h\to 0}\frac{1}{x+h}$$

$$= -x\sin x \times \lim_{h\to 0}\frac{h}{2} + \frac{x\cos x}{x}\lim_{h\to 0}\frac{\sin h}{h}\lim_{h\to 0}\frac{1}{x+h} - \frac{\sin x}{x}\lim_{h\to 0}\frac{1}{x+h}$$



When h = 0, we get

$$= -x\sin x\left(\frac{1}{2}\right)(0) + \frac{cosx}{x} - \frac{sinx}{x^2}$$

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

By taking LCM, we get

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

∴ Derivative of f (x) = [x cos x – sin x]/$x^2$

**4. Differentiate the following from first principles:**

**(i) $\tan^2 x$**

**(ii) tan (2x + 1)**

**Solution:**

**(i)** $\tan^2 x$

Given:

f (x) = $\tan^2 x$

By using the formula,

$$\frac{d}{dx}(f(x)) = \lim_{h\to0}\frac{f(x+h)-f(x)}{h}$$

By substituting the values we get,

$$= \lim_{h\to0}\frac{\tan^2(x+h)-\tan^2 x}{h}$$

By using (a + b) (a – b) = $a^2 - b^2$, we have

$$= \lim_{h\to0}\frac{[\tan(x+h)+\tan x]\,[\tan(x+h)-\tan x]}{h}$$

Replacing tan with sin/cos,

$$= \lim_{h\to0}\frac{\left[\frac{\sin(x+h)}{\cos(x+h)}+\frac{\sin x}{\cos x}\right]\left[\frac{\sin(x+h)}{\cos(x+h)}-\frac{\sin x}{\cos x}\right]}{h}$$

By taking LCM,

$$= \lim_{h\to0}\frac{[\sin(x+h)\cos x+\cos(x+h)\sin x]\,[\sin(x+h)\cos x-\cos(x+h)\sin x]}{h\cos^2 x\cos^2(x+h)}$$

$$= \lim_{h\to0}\frac{[\sin(2x+h)]\,[\sin h]}{h\cos^2 x\cos^2(x+h)}$$

By applying limits to each term, we get

$$= \frac{1}{\cos^2 x}\lim_{h\to0}\sin(2x+h)\lim_{h\to0}\frac{\sin h}{h}\lim_{h\to0}\frac{1}{\cos^2(x+h)}$$

When h = 0, we get

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

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

$$= 2\times\frac{\sin x}{\cos x}\times\frac{1}{\cos^2 x}$$

$$= 2\tan x\sec^2 x$$

∴ Derivative of f (x) = 2 tan x $\sec^2$ x

**(ii)** tan (2x + 1)

Given:

f (x) = tan (2x + 1)
By using the formula,

$$\frac{d}{dx}(f(x)) = \lim_{h\to0}\frac{f(x+h)-f(x)}{h}$$

By substituting the values we get,

$$= \lim_{h\to0}\frac{\tan(2x+2h+1)-\tan(2x+1)}{h}$$

Replacing tan with sin/cos,

$$= \lim_{h\to0}\frac{\frac{\sin(2x+2h+1)}{\cos(2x+2h+1)}-\frac{\sin(2x+1)}{\cos(2x+1)}}{h}$$

By taking LCM,

$$= \lim_{h\to0}\frac{\sin(2x+2h+1)\cos(2x+1)-\cos(2x+2h+1)\sin(2x+1)}{h\cos(2x+2h+1)\cos(2x+1)}$$

$$= \lim_{h\to0}\frac{\sin(2x+2h+1-2x-1)}{h\cos(2x+2h+1)\cos(2x+1)}$$

By applying limits to each term, we get

$$= \frac{1}{\cos(2x+1)}\lim_{h\to0}\frac{\sin(2h)}{2h}\times 2\lim_{h\to0}\frac{1}{\cos(2x+2h+1)}$$

When h = 0, we get

$$= \frac{1}{\cos(2x+1)}\times 2\times\frac{1}{\cos(2x+1)}$$

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

$$= 2\sec^2(2x+1)$$

∴ Derivative of f (x) = 2 $\sec^2$ (2x + 1)

**5. Differentiate the following from first principles:**
**(i) sin √2x**
**(ii) cos √x**
**Solution:**
**(i)** sin √2x
Given:
f (x) = sin √2x

f (x + h) = sin √2(x+h)

By using the formula,

$$\frac{d}{dx}(f(x)) = \lim_{h\to 0} \frac{f(x+h) - f(x)}{h}$$

By substituting the values we get,

$$= \lim_{h\to 0} \frac{\sin\sqrt{2x+2h} - \sin\sqrt{2x}}{h}$$

By using the formula,

$$sinC - sinD = 2sin\left(\frac{C-D}{2}\right)\cos\left(\frac{C+D}{2}\right)$$

$$= \lim_{h\to 0} \frac{2\sin\left(\sqrt{2x+2h} - \sqrt{2x}\right)\cos\left(\sqrt{2x+2h} - \sqrt{2x}\right)}{h}$$

By using algebra of limits,

$$= \lim_{h\to 0} \frac{2\times 2\sin\left(\frac{\sqrt{2x+2h}-\sqrt{2x}}{2}\right)\cos\left(\frac{\sqrt{2x+2h}+\sqrt{2x}}{2}\right)}{2h+2x-2x}$$

To use the sandwich theorem to evaluate the limit, we need $\frac{\sqrt{2x+2h}-\sqrt{2x}}{2}$ in denominator.

$$= \lim_{h\to 0} \frac{2\times 2\sin\left(\frac{\sqrt{2x+2h}-\sqrt{2x}}{2}\right)\cos\left(\frac{\sqrt{2x+2h}-\sqrt{2x}}{2}\right)}{\left(\sqrt{2x+2h}-\sqrt{2x}\right)\sqrt{2x+2h}+\sqrt{2x}}$$

$$= \lim_{h\to 0} \frac{2\times 2\sin\left(\frac{\sqrt{2x+2h}-\sqrt{2x}}{2}\right)\cos\left(\frac{\sqrt{2x+2h}-\sqrt{2x}}{2}\right)}{2\times\left(\frac{\sqrt{2x+2h}-\sqrt{2x}}{2}\right)\left(\sqrt{2x+2h}+\sqrt{2x}\right)}$$

By applying limits to each term, we get

$$= \lim_{h\to 0} \frac{\sin\left(\frac{\sqrt{2x+2h}-\sqrt{2x}}{2}\right)}{\left(\frac{\sqrt{2x+2h}-\sqrt{2x}}{2}\right)} \lim_{h\to 0} \frac{2\cos\left(\frac{\sqrt{2x+2h}-\sqrt{2x}}{2}\right)}{\sqrt{2x+2h}+\sqrt{2x}}$$

When h = 0, we get

$$= 1 \times \frac{2\cos\sqrt{2x}}{2\sqrt{2x}}\left[\because \lim_{h\to 0} \frac{\sin\left(\frac{\sqrt{2x+2h}-\sqrt{2x}}{2}\right)}{\left(\frac{\sqrt{2x+2h}-\sqrt{2x}}{2}\right)} = 1\right]$$

$$= \frac{\cos\sqrt{2x}}{\sqrt{2x}}$$

∴ Derivative of f (x) = cos √2x / √2x

**(ii)** cos √x

Given:

f (x) = cos √x

f (x + h) = cos √(x+h)

By using the formula,

$$\frac{d}{dx}(f(x)) = \lim_{h\to0}\frac{f(x+h)-f(x)}{h}$$

By substituting the values we get,

$$= \lim_{h\to0}\frac{\cos\sqrt{x+h}-\cos\sqrt{x}}{h}$$

By using the formula,

$$\cos C - \cos D = -2\sin\left(\frac{C+D}{2}\right)\sin\left(\frac{C-D}{2}\right)$$

$$= \lim_{h\to0}\frac{-2\sin\left(\frac{\sqrt{x+h}+\sqrt{x}}{2}\right)\sin\left(\frac{\sqrt{x+h}-\sqrt{x}}{2}\right)}{h}$$

By using algebra of limits, we get

$$= \lim_{h\to0}\frac{-2\sin\left(\frac{\sqrt{x+h}+\sqrt{x}}{2}\right)\sin\left(\frac{\sqrt{x+h}-\sqrt{x}}{2}\right)}{x+h-x}$$

To use the sandwich theorem to evaluate the limit, we need $\frac{\sqrt{x+h}-\sqrt{x}}{2}$ in denominator.

$$= \lim_{h\to0}\frac{-2\sin\left(\frac{\sqrt{x+h}+\sqrt{x}}{2}\right)\sin\left(\frac{\sqrt{x+h}-\sqrt{x}}{2}\right)}{2\times\left(\sqrt{x+h}+\sqrt{x}\right)\frac{(\sqrt{x+h}-\sqrt{x})}{2}}$$

By applying limits to each term, we get

$$= \lim_{h\to0}\frac{\sin\left(\frac{\sqrt{x+h}-\sqrt{x}}{2}\right)}{\frac{\sqrt{x+h}-\sqrt{x}}{2}}\lim_{h\to0}\frac{-\sin\left(\frac{\sqrt{x+h}+\sqrt{x}}{2}\right)}{\sqrt{x+h}+\sqrt{x}}$$

When h = 0, we get

$$= 1 \times \frac{-\sin\sqrt{x}}{2\sqrt{x}} \left[ \because \lim_{h \to 0} \frac{\sin\left(\frac{\sqrt{x+h}-\sqrt{x}}{2}\right)}{\frac{\sqrt{x+h}-\sqrt{x}}{2}} = 1 \right]$$

$$= \frac{-\sin\sqrt{x}}{2\sqrt{x}}$$

∴ Derivative of f (x) = - sin √x / 2√x