3.6 Day 1

1. $y = \sqrt[3]{x} = x^{\frac{1}{3}}$

$\frac{dy}{dx} = \frac{1}{3}x^{-\frac{2}{3}} = \frac{1}{3x^{2/3}} = \frac{1}{3\sqrt[3]{x^2}}$

2. $y = \sqrt{x} = x^{\frac{1}{2}}$

$\frac{dy}{dx} = \frac{1}{2}x^{-\frac{1}{2}} = \frac{1}{2\sqrt{x}}$

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3. $y = \sqrt[4]{x^3} = x^{\frac{3}{4}}$

$y' = \frac{3}{4}x^{-\frac{1}{4}} = \frac{3}{4\sqrt[4]{x}}$

4. $y = \frac{1}{\sqrt{x}} = x^{-\frac{1}{2}}$

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

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5. $y = x^2\sqrt{x} = x^2 \cdot x^{\frac{1}{2}} = x^{\frac{5}{2}}$

$y' = \frac{5}{2}x^{\frac{3}{2}}$

OR : Product Rule

$y' = 2x \cdot x^{\frac{1}{2}} + x^2 \cdot \frac{1}{2\sqrt{x}}$

$= 2x^{\frac{3}{2}} + \frac{x^2}{2x^{\frac{1}{2}}} = 2x^{\frac{3}{2}} + \frac{1}{2}x^{\frac{3}{2}} = \frac{5}{2}x^{\frac{3}{2}}$

6. $y = \frac{x^4}{\sqrt[3]{x^2}} = \frac{x^4}{x^{2/3}} = x^{\frac{10}{3}}$

$\frac{dy}{dx} = \frac{10}{3}x^{\frac{7}{3}}$

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$y = \sin(3x)$

outside $y = \sin(x)$

inside $y = 3x$

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1. $y = (x-3)^2$

outside: $f(x) = (x)^2$
inside: $g(x) = x-3$

$y' = 2(x-3) \cdot 1 = 2x-6$

2. $y = \sin(x^2+3)$

$f(x) = \sin(x)$
$g(x) = x^2+3$

$\frac{dy}{dx} = \cos(x^2+3) \cdot 2x = 2x\cos(x^2+3)$

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3. $y = \cos(\tan x)$

$f(x) = \cos(x)$
$g(x) = \tan x$

$y' = -\sin(\tan x) \cdot \sec^2 x$

4. $y = \frac{1}{(x^2-5)}$

$f(x) = \frac{1}{(x)}$ or $(x)^{-1}$
$g(x) = x^2-5$

$\frac{dy}{dx} = -(x^2-5)^{-2} \cdot 2x = \frac{-2x}{(x^2-5)^2}$

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5. $y = \tan^2 x = (\tan x)^2$

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

$g(x) = \tan x$

$\frac{dy}{dx} = 2(\tan x) \cdot \sec^2 x$

6. $y = \frac{1}{(2x^2+1)^2}$

$f(x) = \frac{1}{(x)^2}$ or $(x)^{-2}$

$g(x) = 2x^2+1$

$y' = -2\underline{(2x^2+1)}^{-3} \cdot 4x \qquad = \frac{-8x}{(2x^2+1)^3}$

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7. $y = \left(\frac{\cos x}{\sin x + 1}\right)^2$

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

$g(x) = \frac{\cos x}{\sin x + 1}$

$y' = 2\left(\frac{\cos x}{\sin x+1}\right) \cdot \left(\frac{(\sin x+1)(-\sin x) - \cos x(\cos x)}{(\sin x+1)^2}\right)$

$\vdots$

8. $y = 3\sin\left(\frac{2}{x}\right)$

$f(x) = 3\sin(x)$

$g(x) = \frac{2}{x}$ or $2x^{-1}$

$\frac{dy}{dx} = 3\cos\left(\frac{2}{x}\right) \cdot (-2x^{-2}) = \frac{-6\cos\left(\frac{2}{x}\right)}{x^2}$

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9. $y = (1+\sin(2x))^2$

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

$g(x) = 1+\sin(x)$

$h(x) = 2x$

$y' = 2(1+\sin 2x) \cdot \cos(2x) \cdot 2$

$= 4\cos 2x(1+\sin 2x)$

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10. $y = \sqrt{\sin(3x)}$

$f(x) = \sqrt{(x)}$

$g(x) = \sin(x)$

$h(x) = 3x$

$y' = \frac{1}{2\sqrt{\sin 3x}} \cdot \cos 3x \cdot 3$

$= \frac{3\cos 3x}{2\sqrt{\sin 3x}}$

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RS #60 The Chain Rule

$$\frac{d}{dx}\left(f(g(x))\right) = f'(g(x)) \cdot g'(x)$$

$$\frac{d}{dx}\left(\sin 3x\right) = \cos(3x) \cdot 3 = 3\cos 3x$$

$f(x) = \sin(x)$
$g(x) = 3x$

$$\frac{d}{dx}\left(\sqrt{x^2+3}\right) = \frac{1}{\cancel{2}\sqrt{(x^2+3)}} \cdot \frac{\cancel{2}x}{1} = \frac{x}{\sqrt{x^2+3}}$$

$f(x) = \sqrt{(x)}$
$g(x) = x^2+3$

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11. $y = \sin\left(\frac{3}{x}\right)$

$f(x) = \sin(x)$
$g(x) = \frac{3}{x} = 3x^{-1}$

$$\frac{dy}{dx} = \cos\left(\frac{3}{x}\right) \cdot \left(-3x^{-2}\right) = \frac{-3\cos\left(\frac{3}{x}\right)}{x^2}$$

12. $y = \frac{1}{(\sin x)}$

$f(x) = \frac{1}{x} = (x)^{-1}$
$g(x) = \sin x$

$$y' = -(\sin x)^{-2} \cdot \cos x$$
$$= \frac{-\cos x}{\sin^2 x}$$

13. $y = \sqrt{x + \cos x}$

$f(x) = \sqrt{(x)}$
$g(x) = x + \cos x$

$$y' = \frac{1}{2\sqrt{(x+\cos x)}} \cdot (1 - \sin x)$$
$$= \frac{1 - \sin x}{2\sqrt{x+\cos x}}$$

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