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17/MHE01/083
Civil Engineering

① $y = \frac{(2x^2+3)}{\ln 2x}$

$\ln y = \ln(2x^2+3) - \ln(\ln 2x)$

$\frac{1}{y}\frac{dy}{dx} = \frac{1}{2x^2+3} \cdot 4x - \frac{1}{x \ln 2x}$

$\frac{dy}{dx} = y\left(\frac{4x}{2x^2+3} - \frac{1}{x \ln 2x}\right)$

At $x = 2.5$

$\frac{dy}{dx} = \frac{2(2.5)^2+3}{\ln(2.5)}\left(\frac{4(2.5)}{2(2.5)^2+3} - \frac{1}{2.5\ln(2+2.5)}\right)$

$\frac{dy}{dx} = 3.82$ to 3 s.f

② gradient of $y = \frac{2x}{x^2-5}$ at $(2, -4)$

let $u = 2x$, $v = x^2 - 5$

$\frac{du}{dx} = 2$, $\frac{dv}{dx} = 2x$

$$\frac{dy}{dx} = \frac{v\frac{du}{dx} - u\frac{dv}{dx}}{v^2}$$

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

$$= \frac{2x^2 - 10 - 4x^2}{(x^2-5)^2}$$

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

At $(2, -4)$

$$\frac{dy}{dx} = -18$$

3) $z = 2x^3 \ln y$

$$\ln z = \ln(2x^3) + \ln(\ln y)$$

$$\frac{1}{z}\frac{dz}{dy} = \frac{1}{2x^3}(6x^2) + \frac{1}{\ln y}\cdot\frac{1}{y}$$

$$\frac{1}{z}\frac{dz}{dy} = \frac{6x^2}{2x^3} + \frac{1}{y(\ln y)}$$

$$\frac{dz}{dy} = z\left[\frac{3}{x} + \frac{1}{y(\ln y)}\right]$$

$$\frac{dz}{dy} = 2x^3 \ln y\left[\frac{3}{x} + \frac{1}{y(\ln y)}\right]$$

4) $\int_0^2 x(2x^2+1)^{1/2}\,dx$

$u = 2x^2 + 1$

$\frac{du}{dx} = 4x$, $dx = \frac{du}{4x}$

$\therefore \int_0^2 x(2x^2+1)^{1/2}\,dx$

$\Rightarrow \int_0^2 x\,u^{1/2} \cdot \frac{du}{4x} = \frac{1}{4}\int_0^2 u^{1/2}\,du$

$= \frac{1}{4}\left[\frac{u^{3/2}}{3/2}\right] = \int_0^2 \frac{3}{8}u^{3/2} + C$

$\Rightarrow \int_0^2 \frac{3}{8}(2x^2+1)^{3/2} + C$

$= \frac{3}{8}(9)^{3/2} - \frac{3}{8}(1)^{3/2} + C$

$= \frac{81}{8} - \frac{3}{8} = \frac{78}{8}$