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$(2y^2+3x)dx + 2xy\,dy = 0$

$M = 2y^2 + 3x$ $\qquad$ $N = 2xy$

$\frac{\partial M}{\partial y} = 4y$ $\qquad$ $\frac{\partial N}{\partial x} = 2y$

Here, $\frac{\partial M}{\partial y} \neq \frac{\partial N}{\partial x}$

Not exact

$\therefore \frac{\partial M}{\partial y} - \frac{\partial N}{\partial x} = 4y - 2y$

$\left(\frac{\partial M}{\partial y} - \frac{\partial N}{\partial x}\right) = 2y$

$\therefore$ Condition ① $\frac{1}{N}\left(\frac{\partial M}{\partial y} - \frac{\partial N}{\partial x}\right) = \frac{1}{\cancel{2xy}}(\cancel{2y})$

$= \boxed{\frac{1}{x} = f(x)}$

Thus, the integrating factor will be

$If = e^{\int f(x)dx}$

$= e^{\int \frac{1}{x}dx}$

$= e^{\ln|x|}$ $\cancel{+c}$

$I.f = x$

$\therefore$ 'x' by If on both sides of main eq^n.

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$(2xy^2 + 3x^2)dx + 2x^2 y\,dy = 0$

Thus, $\dfrac{\partial M}{\partial y} = \dfrac{\partial N}{\partial x}$ and the eqⁿ will be exact

$\therefore M(x, y)\,dx + N(x, y)\,dy = 0$

~~f(x) dx + f~~

$F_x\,dx + F_y\,dy = 0$

$F_x = 2xy^2 + 3x^2$

$\displaystyle\int \frac{\partial F}{\partial x} = \int 2xy^2 + 3x^2$

Integrating both sides

$F = \dfrac{x^2 y^2}{2} + x^3 + f(y)$ —— (1)

$F_y = 2x^2 y$

$\displaystyle\int \frac{\partial F}{\partial y} = \int 2x^2 y$

$F = \dfrac{x^2 y^2}{2} + f(x)$ —— (2)

Hence, comparing both eqⁿs

$F = \dfrac{x^2 y^2}{2} + x^3$

Solution will be obtained by comparing $F = C$.

$\therefore \dfrac{x^2 y^2}{2} + x^3 = 2C$

$x^2 y^2 + 2x^3 = C$

$\boxed{x^2(y^2 + 2x) = C}$

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