

Q2

$$\underbrace{(4x^3y^2 + 5x^2y + 6xy)dx}_{M(x,y)} + \underbrace{(x^4y + 5y^3 + 3y^2)dy}_{N(x,y)}$$

$$\frac{\partial M}{\partial y} = 8x^3y + 5x^2 + 6x$$

$$\frac{\partial N}{\partial x} = 4x^3y$$

Not equal
not exact

$$\frac{\partial}{\partial y} (\mu(x)M) = \frac{\partial}{\partial x} (\mu(x)N)$$

$$\frac{d\mu}{dy} = \mu \frac{\partial M}{\partial y} - M \frac{\partial \mu}{\partial y} - \mu \frac{\partial N}{\partial x}$$

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$$\frac{1}{M} \frac{\partial M}{\partial y} - \frac{1}{N} \frac{\partial N}{\partial x} = \frac{1}{\mu} \frac{d\mu}{dx}$$

$$\frac{8x^3y + 5x^2 + 6x - 4x^3y}{4x^3y^2 + 5x^2y + 6xy} = \frac{1}{\mu} \frac{d\mu}{dx}$$

$$\frac{5x^2 + 6x + 4x^3y}{4x^3y^2 + 5x^2y + 6xy} = \frac{1}{\mu} \frac{d\mu}{dx}$$

$$\int \frac{4x^2y + 5x + 6}{4x^3y^2 + 5x^2y + 6xy} dx = \int \frac{1}{\mu} \frac{d\mu}{dx} dx = \ln|\mu|$$

(u)

$$\mu = \frac{1}{y}$$

$$(4x^3y + 5x^2 + 6x) dx + (x^4 + 5y^2 + 3y + 1) dy = 0$$

$$4x^3 = M_y$$

$$4x^3 = N_x \rightarrow \text{Exact}$$

$$\int 4x^3y + 5x^2 + 6x dx \rightarrow x^4y + \frac{5x^3}{3} + 3x^2 + h(y)$$

$$\int (x^4 + 5y^2 + 3y + 1) dy$$

$$= x^4 y + \frac{5x^3}{3} + \frac{3y^2}{2} + y + h(x)$$

$$h(y) = \frac{5y^3}{3} + \frac{3y^2}{2} + y$$

$$h(x) = \frac{5x^3}{3} + 3x^2$$

$$x^4 y + \frac{5y^3}{3} + \frac{3y^2}{2} + y + \frac{5x^3}{3} + 3x^2 = C$$
