

Variables Separable

Put y with dy and x with dx

$$\frac{dy}{dx} = h(y) \cdot g(x)$$

Y SIDE

$$dy \quad 1/h(y)$$

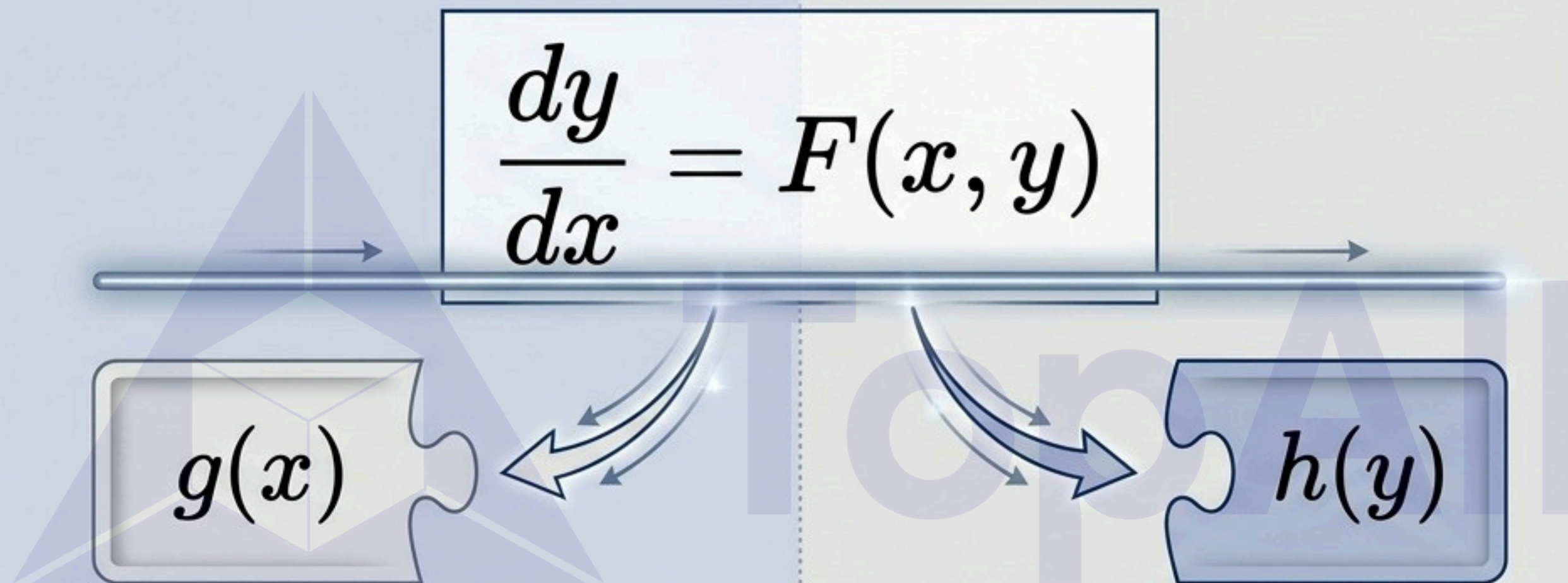
$$\int \frac{1}{h(y)} dy$$

X SIDE

$$dx \quad g(x)$$

$$\int g(x) dx$$

When Can You Separate?



If: $F(x, y) = g(x) \odot h(y)$

Must be a product structure—not addition.

Then: $\frac{dy}{dx} = h(y) \cdot g(x)$

Move Each Variable to Its Side

$$\frac{dy}{dx} = \mathbf{h(y)} \cdot g(x)$$

Provided:
 $h(y) \neq 0$

$$\frac{1}{h(y)}$$

$$\frac{1}{h(y)} dy = g(x) dx$$



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$$E=mc^2$$



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Now It Becomes Two Integrals

$$\int \frac{1}{h(y)} dy = \int g(x) dx$$

$$H(y) + C_1 = G(x) + C_2$$

$$H(y) = G(x) + C$$

✓
+C appears only once in the final combined relation. It absorbs all intermediate constants.

Example: Separate First

Mixed Equation

$$\frac{dy}{dx} = \frac{1 + y^2}{1 + x^2}$$

Since $1 + y^2 \neq 0$

Separated Form

$$\frac{dy}{1 + y^2} = \frac{dx}{1 + x^2}$$

Integrated Result

$$\int \frac{dy}{1 + y^2} = \int \frac{dx}{1 + x^2}$$
$$\tan^{-1} y = \tan^{-1} x + C$$

Use the Given Condition Last

General Solution

$$y = \frac{-1}{2x^2 + C}$$

Initial Condition

Substitute $x_0 = 0, y_0 = 1$

Find C

$$1 = \frac{-1}{0 + C}$$

$$C = -1$$

Particular Solution

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

Variable Separation in 5 Steps

1. Recognise product form:

$$F(x, y) = g(x)h(y)$$

2. Move y terms with dy :

Group on the left.

3. Move x terms with dx :

Group on the right.

4. Integrate both sides:

Add $+C$ to one side only.

5. Apply condition:

Substitute (x_0, y_0) if a particular solution is required.

Core Mechanism



$$\frac{dy}{dx} = h(y)g(x)$$



$$\int \frac{1}{h(y)} dy = \int g(x) dx$$



$$H(y) = G(x) + C$$

⚠ TRAP: Check $h(y) \neq 0$ before dividing. Do not divide by zero.



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