

Opener

$\int \sec^2 x \, dx =$

(A) $\tan x + C$ (B) $\csc^2 x + C$ (C) $\cos^2 x + C$

(D) $\frac{\sec^3 x}{3} + C$ (E) $2\sec^2 x \tan x + C$

$\int \frac{5}{1+x^2} \, dx =$

(A) $\frac{-10x}{(1+x^2)^2} + C$ (B) $\frac{5}{2x} \ln(1+x^2) + C$ (C) $5x - \frac{5}{x} + C$

(D) $5 \arctan x + C$ (E) $5 \ln(1+x^2) + C$

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Which of the following is equal to $\int \frac{1}{\sqrt{25-x^2}} \, dx$?

(A) $\arcsin \frac{x}{5} + C$ ~~(B) $\arcsin x + C$~~ (C) $\frac{1}{5} \arcsin \frac{x}{5} + C$

~~(D) $\sqrt{25-x^2} + C$~~ ~~(E) $2\sqrt{25-x^2} + C$~~

$\frac{d}{dx} \sin^{-1} x = \frac{1}{\sqrt{1-x^2}}$ $\sqrt{1-\frac{x^2}{25}}$
 $\frac{1}{\sqrt{25-x^2}} = \frac{1}{\sqrt{25-x^2}} \cdot \frac{1}{\sqrt{1-(\frac{x}{5})^2}}$ $\sqrt{\frac{25-x^2}{25}}$

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6-1 day 1 Differential Equations

Learning Objectives:

Diffy Q

I can Solve a Differential Equation

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A differential equation is an equation involving a derivative like:

$$\frac{dy}{dx} = 3xy^2$$

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Ex1. Solve the differential equation

1.) $\frac{dy}{dx} = x^3 - 2x^2$ given the initial condition $(2, 1)$

$\int dy = \int (x^3 - 2x^2) \, dx$
 $y = \frac{1}{4}x^4 - \frac{2}{3}x^3 + C$
 $1 = \frac{1}{4} \cdot 2^4 - \frac{2}{3} \cdot 2^3 + C$
 $1 = 4 - \frac{16}{3} + C$
 $-3 + \frac{16}{3} = C$
 $-\frac{9}{3} + \frac{16}{3} = \frac{7}{3} = C$

$y = \frac{1}{4}x^4 - \frac{2}{3}x^3 + \frac{7}{3}$

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Steps to Solving a DiffyQ

- 1.) Separate the variables
- 2.) Integrate both sides
- 3.) Solve for y (if possible)
- 4.) Use the initial condition to find C

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2.) $\frac{dy}{dx} = 4x^3 - \frac{2}{x}$ given the initial condition (2,5)

$$\int 1 dy = \int (4x^3 - \frac{2}{x}) dx$$

$$y = x^4 - 2 \ln x + C$$

$$5 = 16 - 2 \ln 2 + C$$

$$-11 + 2 \ln 2 = C$$

$$y = x^4 - 2 \ln x + -11 + 2 \ln 2$$

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3.) $\frac{dy}{dx} = 3xy^2$ given the initial condition (2,1)

$$\int \frac{y^{-2} dy}{y^2} = \int 3x dx$$

$$-1y^{-1} = \frac{3}{2}x^2 + C$$

$$-\frac{1}{y} = \frac{3}{2}x^2 + C$$

$$-1 = 6 + C$$

$$-7 = C$$

$$y = \frac{-1}{\frac{3}{2}x^2 - 7}$$

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Ex2. Find the general solution to the differential equation

$$\frac{dy}{dx} = -\frac{x}{y}$$

$$y = \pm \sqrt{-x^2 + C}$$

$$\int y dy = -\int x dx$$

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

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

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Homework

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