

AB Calculus Diff Eq. All the Things Practice

Name: Key



1. Evaluate each of the following integrals.

a) $\int (5x^2 + 2x - \sqrt[3]{x^4} + \frac{1}{x}) dx$

b) $\int_1^4 (\frac{1}{x^3} - \sqrt{x}) dx$

c) $\int \sqrt{2x-3} dx$

d) $\int \cos^3 x \sin x dx$

e) $\int \tan x dx$

f) $\int_1^2 \frac{2 \ln x}{x} dx$

g) $\int \frac{1}{16+9x^2} dx$

h) $\int \frac{7}{\sqrt{25-4x^2}} dx$

2. Find the general and particular solutions for the following differential equations with the given initial condition.

a) $\frac{dy}{dx} = \frac{4x}{y}$ and $y(0) = 5$

b) $\frac{dy}{dx} = 3x^2y$ and $y(0) = 2$

c) $\frac{dy}{dx} = 4xy^2$ and $y(0) = 1$

d) $\frac{dy}{dx} = \frac{y^2}{x}$ and $y(1) = \frac{1}{3}$

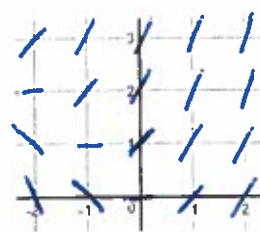
3. Find the equations for the velocity and position of a particle if the acceleration of a particle is given by $a(t) = -32 \text{ ft/sec}^2$, and, at time $t = 0$, the velocity of a particle is 64 ft/sec and the position is 32 ft .

4. On the axes provided, sketch a slope field for each differential equation.

a) $\frac{dy}{dx} = y - 2x$



b) $\frac{dy}{dx} = x + y$



5. Given the differential equation $\frac{dy}{dx} = x + 2$ and $y(0) = 3$, find an approximation for $y(1)$ by using Euler's method with two equal steps.

$y(1) \approx 5.25$

6. Suppose a continuous function f and its derivative f' have values that are given in the following table. Given that $f(2) = 5$, use Euler's method with two steps of size $\Delta x = 0.5$ to approximate the value of $f(3)$.

x	2.0	2.5	3.0
$f'(x)$	0.4	0.6	0.8
$f(x)$	5	5.2	5.5

$f(3) \approx 5.5$

1.) $\int (5x^2 + 2^x - \sqrt[3]{x^4} + \frac{1}{x}) dx$
 $\int (5x^2 + 2^x - x^{4/3} + x^{-1}) dx$
 $= \frac{5x^3}{3} + \frac{2^x}{\ln 2} - \frac{3x^{7/3}}{7} + \ln|x| + C$

c) $\frac{1}{2} \int \sqrt{u} du$ $u = 2x - 3$
 $\frac{1}{2} \int u^{1/2} du$ $\frac{du}{dx} = 2$
 $\frac{1}{2} \cdot \frac{2}{3} u^{3/2} + C$ $\frac{1}{2} du = dx$
 $\frac{1}{3} u^{3/2} + C \rightarrow \frac{1}{3} (2x - 3)^{3/2} + C$

e) $\int \tan x dx \rightarrow \int \frac{\sin x}{\cos x} dx$
 $u = \cos x$ $\rightarrow \frac{1}{-1} \int \frac{du}{u}$
 $\frac{du}{dx} = -\sin x$
 $\frac{du}{-1} = \sin x dx$ $\rightarrow -\ln|u| + C$
 $\rightarrow -\ln|\cos x| + C$

g) $\int \frac{1}{16 + 9x^2} dx \rightarrow \int \frac{1}{16(1 + \frac{9}{16}x^2)} dx$
 $\rightarrow \frac{1}{16} \int \frac{1}{1 + (\frac{3}{4}x)^2} dx$ $\rightarrow u = \frac{3}{4}x$
 $\frac{du}{dx} = \frac{3}{4}$
 $\frac{4}{3} du = dx$
 $\Rightarrow \frac{1}{16} \cdot \frac{4}{3} \int \frac{1}{1 + u^2} du$
 $\rightarrow \frac{1}{12} \tan^{-1} u + C \rightarrow \frac{1}{12} \tan^{-1}(\frac{3}{4}x) + C$

b) $\int_1^4 (x^{-3} - x^{3/2}) dx$
 $= \frac{x^{-2}}{-2} - \frac{2x^{5/2}}{5} \Big|_1^4$
 $(\frac{-1}{2}(4)^{-2} - \frac{2}{3}(4)^{3/2}) - (\frac{-1}{2}(1)^{-2} - \frac{2}{3}(1)^{3/2})$
 $= ((\frac{-1}{2})(\frac{1}{16}) - \frac{2}{3}(8)) - ((\frac{-1}{2}) - \frac{2}{3})$
 $\Rightarrow \text{calculator} \rightarrow -403/96$
 Fine

d) $\int \cos^3 x \sin x dx$ $u = \cos x$
 $\frac{du}{dx} = -\sin x$
 $-du = \sin x dx$
 $-\int u^3 du$
 $-\frac{1}{4} u^4 + C \rightarrow -\frac{1}{4} \cos^4 x + C$

f) $\int_1^2 \frac{2 \ln x}{x} dx$ $u = \ln x$ $\frac{du}{dx} = \frac{1}{x}$
 $2 \int_0^{\ln 2} u du$ $u = \ln 2$
 $u = \ln 1 = 0$
 $\rightarrow \frac{2u^2}{2} \Big|_0^{\ln 2} \rightarrow (\ln 2)^2 - 0^2$
 $= (\ln 2)^2$

h) $\int \frac{7}{\sqrt{25 - 4x^2}} dx$ $u = \frac{2}{5}x$
 $\frac{du}{dx} = \frac{2}{5}$
 $\frac{5}{2} du = dx$
 $\frac{7}{5} \int \frac{1}{\sqrt{1 - u^2}} du$
 $\rightarrow \frac{7}{5} \sin^{-1} u + C \rightarrow \frac{7}{2} \sin^{-1}(\frac{2}{5}x) + C$

$$\textcircled{a} \frac{dy}{dx} = \frac{4x}{y}$$

$$\int y dy = \int 4x dx$$

$$\frac{y^2}{2} = 2x^2 + C \rightarrow (0, 5)$$

$$\frac{25}{2} = 0 + C \rightarrow C = \frac{25}{2}$$

$$\frac{y^2}{2} = \frac{2x^2 + 25}{2}$$

$$y^2 = 4x^2 + 25$$

$$y = \sqrt{4x^2 + 25}$$

Be careful b/c sometimes it's negative depending on initial condition.

$$\textcircled{b} \frac{dy}{dx} = 3x^2 y$$

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

$$\ln|y| = x^3 + C \rightarrow (0, 2)$$

$$\ln 2 = C$$

$$\ln|y| = x^3 + \ln 2$$

$$y = e^{(x^3 + \ln 2)}$$

$$\rightarrow e^{x^3} \cdot e^{\ln 2}$$

$$y = 2e^{x^3}$$

$$\textcircled{c} \frac{dy}{dx} = 4xy^2$$

$$\int \frac{dy}{y^2} = \int 4x dx$$

$$-\frac{1}{y} = 2x^2 + C \rightarrow (0, 1)$$

$$-1 = 2(0)^2 + C \rightarrow C = -1$$

$$y \cdot \left(-\frac{1}{y} = 2x^2 - 1\right) \cdot y$$

$$-1 = (2x^2 - 1) \cdot y$$

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

$$f(x) = \frac{1}{x^2} = x^{-2}$$

$$f'(x) = -2x^{-3} = -\frac{2}{x^3}$$

$$f(x) = \frac{1}{x^3} = x^{-3}$$

$$f'(x) = -3x^{-4} = -\frac{3}{x^4}$$

$$f(x) = \frac{1}{x^4} = x^{-4}$$

$$f'(x) = -4x^{-5} = -\frac{4}{x^5}$$

$$f(x) = \frac{1}{x^5} = x^{-5}$$

$$f'(x) = -5x^{-6} = -\frac{5}{x^6}$$

$$f(x) = \frac{1}{x^6} = x^{-6}$$

$$f'(x) = -6x^{-7} = -\frac{6}{x^7}$$

$$f(x) = \frac{1}{x^7} = x^{-7}$$

$$f'(x) = -7x^{-8} = -\frac{7}{x^8}$$

$$f(x) = \frac{1}{x^8} = x^{-8}$$

$$f'(x) = -8x^{-9} = -\frac{8}{x^9}$$

$$f(x) = \frac{1}{x^9} = x^{-9}$$

$$f'(x) = -9x^{-10} = -\frac{9}{x^{10}}$$

$$f(x) = \frac{1}{x^{10}} = x^{-10}$$

$$f'(x) = -10x^{-11} = -\frac{10}{x^{11}}$$

$$f(x) = \frac{1}{x^{11}} = x^{-11}$$

$$f'(x) = -11x^{-12} = -\frac{11}{x^{12}}$$

$$f(x) = \frac{1}{x^{12}} = x^{-12}$$

$$f'(x) = -12x^{-13} = -\frac{12}{x^{13}}$$

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$$f'(x) = -13x^{-14} = -\frac{13}{x^{14}}$$

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$$f(x) = \frac{1}{x^{98}} = x^{-98}$$

$$f'(x) = -98x^{-99} = -\frac{98}{x^{99}}$$

$$f(x) = \frac{1}{x^{99}} = x^{-99}$$

$$f'(x) = -99x^{-100} = -\frac{99}{x^{100}}$$

$$f(x) = \frac{1}{x^{100}} = x^{-100}$$

$$f'(x) = -100x^{-101} = -\frac{100}{x^{101}}$$

$$d) \frac{dy}{dx} = \frac{y^2}{x}$$

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

$$-\frac{1}{y} = \ln|x| + C$$

$$(1, \frac{1}{3}) \quad -\frac{1}{1/3} = \ln|1| + C$$

$$-3 = C$$

$$-\frac{1}{y} = \ln|x| - 3$$

$$\frac{-1}{\ln|x| - 3} = y$$

$$\Rightarrow y = \frac{-1}{\ln|x| - 3}$$

3)

$$a(t) = -32$$

$$v(0) = 64$$

$$s(0) = 32$$

$$\int a(t) = \int v'(t)$$

$$-32t + C = v(t) \rightarrow (0, 64) \Rightarrow v(t) = -32t + 64$$

$$\int v(t) = \int s'(t)$$

$$-16t^2 + 64t + C = s(t) \rightarrow (0, 32) \Rightarrow s(t) = -16t^2 + 64t + 32$$

4.) on graphs

6.)

old pt	dx	m = $\frac{dy}{dx}$	dy = m · dx	new pt
(2, 5)	·5	·4	·2	(2.5, 5.2)
(2.5, 5.2)	·5	·6	·3	(3, 5.5)

5.)

old pt	dx	m = $\frac{dy}{dx}$	dy = m · dx	new pt
(0, 3)	·5	2	2(·5) = 1	(.5, 4)
(.5, 4)	·5	2.5	2.5(·5) = 12.5	(1, 5.25)

$$z = \frac{1}{\sqrt{2}}(1, i, 1)$$

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$$\frac{1}{\sqrt{2}}(1, i, 1) = \frac{1}{\sqrt{2}}(1, i, 1)$$

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