Differentiation Rules	Integration Rules
$\frac{d}{dx}(c) = 0$	$\int 0\,dx = C$
$\frac{d}{dx}(kx) = k$	$\int k\,dx = kx + C$
$\frac{d}{dx}(kf(x)) = kf'(x)$	$\int kf'(x)dx = kf(x) + C$
$\frac{d}{dx}(x^n) = nx^{n-1}$	$\int x^n dx = \frac{x^{n+1}}{n+1} + C$ when $n \neq -1$
$\frac{d}{dx}(\sin x) = \cos x$	$\int \cos x\,dx = \sin x + C$
$\frac{d}{dx}(\cos x) = -\sin x$	$\int \sin x\,dx = -\cos x + C$
$\frac{d}{dx}(\tan x) = \sec^2 x$	$\int \sec^2 x\,dx = \tan x + C$
$\frac{d}{dx}(\cot x) = -\csc^2 x$	$\int \csc^2 x\,dx = -\cot x + C$
$\frac{d}{dx}(\sec x) = \sec x \tan x$	$\int \sec x \tan x\,dx = \sec x + C$
$\frac{d}{dx}(\csc x) = -\csc x \cot x$	$\int \csc x \cot x\,dx = -\csc x + C$
$\frac{d}{dx}(e^x) = e^x$	$\int e^x dx = e^x + C$
$\frac{d}{dx}(\ln x) = \frac{1}{x}$, $x > 0$	$\int \frac{1}{x} dx = \ln\lvert x\rvert + C$

- For Exam 4, we can ignore the $+C$ for the integration rules because we have upper and lower bound.

$$\int_a^b f(x)\,dx = \text{Signed Area}$$

- Always take derivative of your answer, before evaluating when integrating. Especially when you have trig functions!!!

E4P1

Signed Area: Area enclosed by $f(x)$ and x-axis.

- If $f(x)$ above the x-axis, then area is positive.
- If $f(x)$ below the x-axis, then area is negative.

Riemann Sums

Left: $L_n = \sum_{i=0}^{n-1} f(x_i)\Delta x$ Right: $R_n = \sum_{i=1}^{n} f(x_i)\Delta x$

where $x_i = a + i\Delta x$ and $\Delta x = \frac{b-a}{n}$

Tips: ① Determine what a, b, and n are.
② Calculate the following in the following order:
ⓘ Δx ⓘⓘ x_i ⓘⓘⓘ $f(x_i)$ ⓘⓥ L_n or R_n

Trapezoid Rule

$$T_n = \frac{1}{2}\Delta x\left(f(x_0) + 2f(x_1) + \ldots + 2f(x_{n-1}) + f(x_n)\right)$$

where $x_i = a + i\Delta x$ and $\Delta x = \frac{b-a}{n}$

Tips: ① Determine what a, b, and n are.
② Calculate the following in the following order:

ⓘ Δx	ⓘⓘ x_0	ⓘⓘⓘ $f(x_0)$	ⓘⓥ $f(x_0)$
	x_1	$f(x_1)$	$2f(x_1)$
	⋮	⋮	⋮
	x_{n-1}	$f(x_{n-1})$	$2f(x_{n-1})$
	x_n	$f(x_n)$	$f(x_n)$

③ Sum all values from ⓘⓥ and multiply by $\frac{1}{2}\Delta x$ Yielding T_n.

E4P2

When given the graph of a shaded region, to determine the integral,

① Left-most x-value $\Rightarrow a$

② Right-most x-value $\Rightarrow b$

③ the line connecting them $\Rightarrow f(x)$

↳ Use algebra to determine the equation

$\int_a^b f(x)\,dx$

Properties of Definite Integrals

① $\int_a^a f(x)\,dx = 0$ ② $\int_a^b f(x)\,dx = -\int_b^a f(x)\,dx$

③ $\int_a^b k f(x)\,dx = k\int_a^b f(x)\,dx$

④ $\int_a^b [f(x) \pm g(x)]\,dx = \int_a^b f(x)\,dx \pm \int_a^b g(x)\,dx$

⑤ $\int_a^c f(x)\,dx = \int_a^b f(x)\,dx + \int_b^c f(x)\,dx$

FTC: $\int_a^b f(x)\,dx = F(x)\Big]_a^b = F(b) - F(a)$

Exponential Growth/Decay Models

$\frac{dy}{dt} = y' = ky \Rightarrow y = Ce^{kt}$ where k - growth rate, C - initial value } Constan

Growth $\Rightarrow k > 0$ Decay $\Rightarrow k < 0$

Half-Life $\Rightarrow k = -\frac{\ln(2)}{\text{half-life}}$ or $k = \frac{\ln(1/2)}{\text{half-life}}$

E4P3