Difference of Squares 1	$a^2 - b^2 = (a+b)(a-b)$ 1
Sum of Cubes 2	$a^3 + b^3 = (a+b)(a^2 - ab + b^2)$ 2
Difference of Cubes 3	$a^3 - b^3 = (a-b)(a^2 + ab + b^2)$ 3
Even Function 4	$f(-x) = f(x)$ 4

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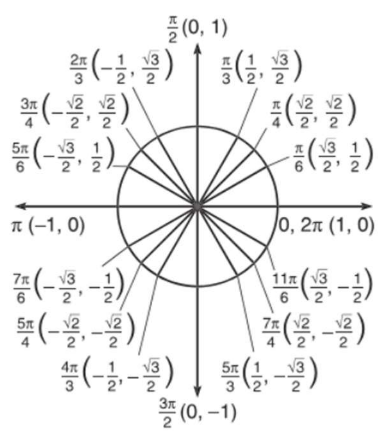
Odd Function 5	$f(-x) = -f(x)$ 5
If $f^{-1}(x)$ is the inverse of $f(x)$, then 6	$f\left(f^{-1}(x)\right) = f^{-1}\left(f(x)\right) = x$ 6
Unit Circle 7	 7
Unit Circle Basics – Trig Functions from the Unit Circle 8	$cos(\theta) = x$ $sin(\theta) = y$ $tan(\theta) = \frac{sin(\theta)}{cos(\theta)}$ 8

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Unit Circle Basics – Reciprocal Trig Functions from the Unit Circle 9	$cot(\theta) = \frac{cos(\theta)}{sin(\theta)}$ $sec(\theta) = \frac{1}{cos(\theta)}$ $csc(\theta) = \frac{1}{sin(\theta)}$ 9
Pythagorean Identities 10	$cos^2x + sin^2x = 1$ $1 + tan^2x = sec^2x$ $1 + cot^2x = csc^2x$ 10
Even and Odd Identities 11	$sin(-x) = -sin(x)$ $csc(-x) = -csc(x)$ $tan(-x) = -tan(x)$ $cot(-x) = -cot(x)$ $cos(-x) = cos(x)$ $sec(-x) = sec(x)$ 11
Double Angle Formula: sin 12	$sin(2x) = 2\ sinx\ cosx$ 12

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Double Angle Formula: cos 13	$cos(2x) = cos^2x - sin^2x = 2\ cos^2x - 1 = 1 - 2\ sin^2x$ 13
Double Angle Formula: tan 14	$tan(2x) = \frac{2\ tanx}{1 - tan^2x}$ 14
Power Reducing Formula: $\sin^2$ 15	$sin^2x = \frac{1 - cos(2x)}{2}$ 15
Power Reducing Formula: $\cos^2$ 16	$cos^2x = \frac{1 + cos(2x)}{2}$ 16

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Power Reducing Formula: $\tan^2$ 17	$$tan^2x = \frac{sin^2x}{cos^2x} = \frac{1 - cos(2x)}{1 + cos(2x)}$$ 17
Sum and Difference Formula: sin 18	$$sin(x \pm y) = sinx\ cosy \mp cosx\ siny$$ 18
Sum and Difference Formula: cos 19	$$cos(x \pm y) = cosx\ cosy \mp sinx\ siny$$ 19
Sum and Difference Formula: tan 20	$$tan(x \pm y) = \frac{tanx \pm tany}{1 \mp tanx\ tany}$$ 20

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Existence of two-sided limits from one-sided limits 21	If $\lim_{x \to a^-} f(x) = b$ and $\lim_{x \to a^+} f(x) = b$, then $\lim_{x \to a} f(x) = b$. 21
Core Limit Properties 22	$\lim_{x \to a} c = c$ $\lim_{x \to a} \Big(cf(x)\Big) = c \cdot \lim_{x \to a} f(x)$ $\lim_{x \to a} x = a$ $\lim_{x \to a} \Big(f(x) \pm g(x)\Big) = \lim_{x \to a} f(x) \pm \lim_{x \to a} g(x)$ 22
Product/Quotient Limit Properties 23	$\lim_{x \to a} \Big(f(x) \cdot g(x)\Big) = \lim_{x \to a} f(x) \cdot \lim_{x \to a} g(x)$ $\lim_{x \to a} \left(\frac{f(x)}{g(x)}\right) = \frac{\lim_{x \to a} f(x)}{\lim_{x \to a} g(x)}$, if $\lim_{x \to a} g(x) \neq 0$ 23
Power/Root Limit Properties 24	$\lim_{x \to a} \Big(f(x)\Big)^n = \Big(\lim_{x \to a} f(x)\Big)^n$ $\lim_{x \to a} \Big(\sqrt[n]{f(x)}\Big) = \sqrt[n]{\lim_{x \to a} f(x)}$ 24

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Squeeze Theorem 25	If **1.** $g(x) \le f(x) \le h(x)$, **2.** $\lim_{x\to a} g(x) = L$, and **3.** $\lim_{x\to a} h(x) = L$ Then $\lim_{x\to a} f(x) = L$ 25
Continuity at $x = a$ 26	A function $f(x)$ is continuous at $x = a$ if $\lim_{x\to a} f(x) = f(a)$. 26
L'Hospital's Rule 27	If $\lim_{x\to a} f(x) = \lim_{x\to a} g(x) = 0$ OR if $\lim_{x\to a} f(x) = \pm\infty$ AND $\lim_{x\to a} g(x) = \pm\infty$ then, $\lim_{x\to a} \frac{f(x)}{g(x)} = \lim_{x\to a} \frac{f'(x)}{g'(x)}$ 27
Derivative (general definition) 28	$f'(x) = \lim_{h\to 0} \frac{f(x+h)-f(x)}{h}$ 28

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Derivative at a point 29	$$f'(a) = \lim_{x \to a} \frac{f(x)-f(a)}{x-a}$$ 29
Trig Derivatives (sin/cos/tan) 30	$$\frac{d}{dx}sin(x) = cos(x)$$ $$\frac{d}{dx}cos(x) = -sin(x)$$ $$\frac{d}{dx}tan(x) = \frac{d}{dx}\frac{sin(x)}{cos(x)} = \frac{1}{cos^2(x)}$$ 30
Trig Derivatives (csc/sec/cot) 31	$$\frac{d}{dx}csc(x) = \frac{d}{dx}\frac{1}{sin(x)} = -\frac{cos(x)}{sin^2(x)} = -csc(x)cot(x)$$ $$\frac{d}{dx}sec(x) = \frac{d}{dx}\frac{1}{cos(x)} = \frac{sin(x)}{cos^2(x)} = sec(x)tan(x)$$ $$\frac{d}{dx}cot(x) = \frac{d}{dx}\frac{cos(x)}{sin(x)} = -\frac{1}{sin^2(x)} = -csc^2(x)$$ 31
Inverse Trig Derivatives (arcsin/arccos/arctan) 32	$$\frac{d}{dx}arcsin(x) = \frac{1}{\sqrt{1-x^2}}$$ $$\frac{d}{dx}arccos(x) = -\frac{1}{\sqrt{1-x^2}}$$ $$\frac{d}{dx}arctan(x) = \frac{1}{1+x^2}$$ 32

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Inverse Trig Derivatives (arccsc/arcsec/arccot) 33	$\frac{d}{dx}arccsc(x) = -\frac{1}{\lvert x\rvert\sqrt{x^2-1}}$ $\frac{d}{dx}arcsec(x) = \frac{1}{\lvert x\rvert\sqrt{x^2-1}}$ $\frac{d}{dx}arccot(x) = -\frac{1}{1+x^2}$ 33
Other important derivatives (constants/logarithms/exponentials) 34	$\frac{d}{dx}x = 1$ $\frac{d}{dt}c = 0$ $\frac{d}{dx}ln(x) = \frac{1}{x}$ $\frac{d}{dx}log_a(x) = \frac{1}{xln(a)}$ $\frac{d}{dx}e^x = e^x$ $\frac{d}{dx}a^x = ln(a) \cdot a^x$ 34
Power Rule 35	$\frac{d}{dx}\left(x^n\right) = nx^{n-1}$ 35
Product Rule 36	$\frac{d}{dx}\Big(f(x) \cdot g(x)\Big) = f'(x) \cdot g(x) + g'(x) \cdot f(x)$ 36

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Quotient Rule	$\frac{d}{dx}\left(\frac{f(x)}{g(x)}\right) = \frac{f'(x) \cdot g(x) - f(x) \cdot g'(x)}{g^2(x)}$	37
Chain Rule	$\frac{d}{dx}\left(f\left(g(x)\right)\right) = f'(g(x)) \cdot g'(x)$	38
Derivative of an Inverse Function	$\left(f^{-1}\right)'(x) = \frac{1}{f'\left(f^{-1}(x)\right)}$	39
Critical Values	Find critical values by solving: $f'(x) = 0$ And including x-values where $f'(x)$ does not exist.	40

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First Derivative Test 41	At critical point: $+$ then $-$ ⇒ local max $-$ then $+$ ⇒ local min Same sign on both sides ⇒ neither 41
Second Derivative Test 42	At critical point: $f''(x) < 0$ ⇒ local max $f''(x) > 0$ ⇒ local min $f''(x) = 0$ ⇒ inconclusive 42
Absolute Extrema on $[a, b]$ 43	Test a, b, and all critical values in (a, b) by plugging them into $f(x)$. Largest output = absolute max Smallest output = absolute min 43
Related Rates: 4 steps 44	1. Draw a sketch 2. Write an equation (no rates yet) 3. Differentiate with respect to time 4. Plug in values and solve 44

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Definite Integral (Reiman Sum) 45	$$\int_a^b f(x)dx = \lim_{n\to\infty} \sum_{i=1}^{n} f(x_i^*)\Delta x$$ Where $\Delta x = \frac{b-a}{n}$ 45
Left Endpoint Rule 46	$$\int_a^b f(x)dx \approx \sum_{i=1}^{n} f(x_{i-1})\Delta x$$ where $\Delta x = \frac{b-a}{n}$ and $x_{i-1} = a + (i-1)\Delta x$ 46
Right Endpoint Rule 47	$$\int_a^b f(x)dx \approx \sum_{i=1}^{n} f(x_i)\Delta x$$ where $\Delta x = \frac{b-a}{n}$ and $x_i = a + i\Delta x$ 47
Midpoint Rule 48	$$\int_a^b f(x)dx \approx \sum_{i=1}^{n} f(\bar{x}_i)\Delta x = \Delta x[f(\bar{x}_1) + ... + f(\bar{x}_n)]$$ where $\Delta x = \frac{b-a}{n}$ and $\bar{x}_i = \frac{1}{2}(x_{i-1} + x_i) = midpoint\ of\ [x_{i-1}, x_i]$ 48

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Trapezoidal Rule 49	$\int_a^b f(x)dx \approx \frac{b-a}{2n}[f(a)+2f(x_1)+2f(x_2)+...+2f(x_{n-1})+f(b)]$ 49
Definite Integral Properties (core) 50	$\int_b^a f(x)dx = -\int_a^b f(x)dx$ $\int_a^a f(x) = 0$ $\int_a^b c\ dx = c(b-a)$, where c is a constant $\int_a^b [f(x)+g(x)]dx = \int_a^b f(x)dx + \int_a^b g(x)dx$ $\int_a^b cf(x)dx = c\int_a^b f(x)dx$, where c is a constant $\int_a^b [f(x)-g(x)]dx = \int_a^b f(x)dx - \int_a^b g(x)dx$ 50
Definite Integral Additivity 51	$\int_a^c f(x)dx + \int_c^b f(x)dx = \int_a^b f(x)dx$ 51
Definite Integral Comparisons 52	If $f(x) \geq 0$ for $a \leq x \leq b$, then $\int_a^b f(x)dx \geq 0$ If $f(x) \geq g(x)$ for $a \leq x \leq b$, then $\int_a^b f(x)dx \geq \int_a^b g(x)dx$ If $m \leq f(x) \leq M$ for $a \leq x \leq b$, then $m(b-a) \leq \int_a^b f(x)dx \leq M(b-a)$ 52

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Fundamental Theorem of Calculus (Part 1)

53

If f is continuous on $[a, b]$, then the function g is defined by

$$g(x) = \int_a^x f(t)\ dt \quad a \leq x \leq b$$

is an antiderivative of f, meaning $g'(x) = f(x)$ for $a < x < b$.

53

Fundamental Theorem of Calculus (Part 2)

54

If f is continuous on $[a, b]$, then

$$\int_a^b f(x)\ dx = F(b) - F(a)$$

where F is any antiderivative of f, menaing $F' = f$.

54

u-substitution

55

$$\int f\big(g(x)\big)g'(x)\ dx = \int f(u)\ du$$

$$\int_a^b f\big(g(x)\big)g'(x)\ dx = \int_{g(a)}^{g(b)} f(u)\ du$$

55

Integrals of Symmetric Functions

56

As long is f is continuous on $[-a, a]$.

1. If f is even $\big[$which means : $f(-x) = f(x)\big]$, then $\int_{-a}^{a} f(x)\ dx = 2\int_0^a f(x)\ dx$.
2. If f is odd $\big[$which means : $f(-x) = -f(x)\big]$, then $\int_{-a}^{a} f(x)\ dx = 0$.

56

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Improper Integrals (Infinite Bounds) 57	(a) If $\int_a^t f(x)\,dx$ exists for every number $t \geq a$, then $$\int_a^\infty f(x)\,dx = \lim_{t\to\infty} \int_a^t f(x)\,dx$$ assuming this limit exists. (b) If $\int_t^b f(x)\,dx$ exists for every number $t \leq b$, then $$\int_{-\infty}^b f(x)\,dx = \lim_{t\to-\infty} \int_t^b f(x)\,dx$$ provided this limit exists as a finite number. 57
Improper Integrals (Discontinuity) 58	If both $\int_a^\infty f(x)\,dx$ and $\int_{-\infty}^a f(x)\,dx$ are convergent, then for any real number a $$\int_{-\infty}^\infty f(x)\,dx = \int_{-\infty}^a f(x)\,dx + \int_a^\infty f(x)\,dx$$ If f has a discontinuity at c, where $a < c < b$, and both $\int_a^c f(x)\,dx$ and $\int_c^b f(x)\,dx$ are convergent, then we define $$\int_a^b f(x)\,dx = \int_a^c f(x)\,dx + \int_c^b f(x)\,dx$$ 58
p-test for $\frac{1}{x^p}$ 59	$\int_1^\infty \frac{1}{x^p}\,dx$ is convergent if $p > 1$ and divergent if $p \leq 1$. 59
Area Between Curves 60	$$A = \int_a^b \left[f(x) - g(x)\right]dx$$ $f(x) \geq g(x)$ for all x in $[a,\ b]$ 60

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Washer or Disk Method 61	$\pi \int_a^b$ (outer radius)^2-(inner radius)^2 dx 61
Cylindrical Shell Method 62	$\int 2\pi rh\ dx$ 62
Average Value of a Function 63	$f_{ave} = \frac{1}{b-a}\int_a^b f(x)\ dx$ 63
Separable Differential Equations 64	$\frac{dy}{dx} = g(x)f(y)$ $\frac{dy}{f(y)} = g(x)\ dx$ $\int \frac{1}{f(y)}\ dy = \int g(x)\ dx$ Then integrate and solve for y 64

Exponential Growth and Decay Initial Value Problem 65	If $\frac{dy}{dt} = ky$, and $y(0) = y_0$ Then $y(t) = y_0 e^{kt}$ 65
Newton's Law of Cooling 66	$\frac{dT}{dt} = k(T - T_s)$ 66
Continuously Compounded Interest 67	$A(t) = A_0 e^{rt}$ 67

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