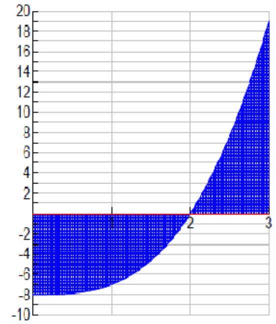
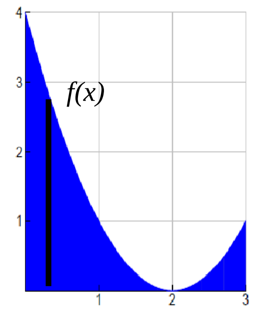
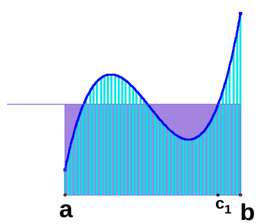
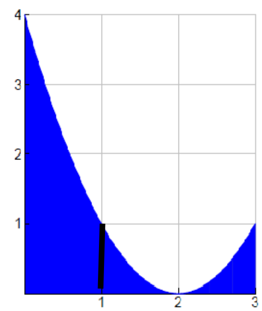
<table>
<tr><th>Topic</th><th>Equation</th><th>Graphic</th><th>Word Problems</th><th>Approximation</th><th>Algebraic</th></tr>
<tr>
<td>Definite Integral from a to b</td>
<td>$\int_a^b f(x)dx$</td>
<td>Signed area between
f and x-axis on [a,b].
</td>
<td>Accumulation of values of f on [a,b]
</td>
<td>Riemann Sum on [a,b]
(Not always equal length subintervals)
<table><tr><th>x</th><th>2</th><th>5</th><th>7</th><th>8</th></tr><tr><td>$f(x)$</td><td>10</td><td>30</td><td>40</td><td>20</td></tr></table>
$(5-2)(10)+(7-5)(30)+(8-7)(40)$
= Left Riemann Sum</td>
<td>F(b)-F(a) wher
F'(x)=f(x)
<u>Fundamental Theor</u>
<u>Calculus</u>
$F(b)-F(a)=\int_a^b f($
$F(b)=\int_a^b f(x)dx+$
$f(b)=\int_a^b f'(x)dx+$</td>
</tr>
<tr>
<td>Average Value for f</td>
<td>$\frac{1}{b-a}\int_a^b f(x)dx$</td>
<td>There is a
$c\in[a,b]$ such that
$\int_a^b f(x)dx = f(c)[b-a]$
There is some rectangle whose height is on the graph with area equal to the integral.</td>
<td>The average value of f on [a,b] is
$Avg(f)=\frac{1}{b-a}\int_a^b f(x)dx$

Find average value of $f(x)=(x-2)^2$ on [0,3]</td>
<td>Average value of f is approximately the Riemann Sum of f on [a, b] divided by b-a
<table><tr><th>x</th><th>2</th><th>5</th><th>7</th><th>8</th></tr><tr><td>$f(x)$</td><td>10</td><td>30</td><td>40</td><td>20</td></tr></table>
Use Right Riemann Sum to estimate average value of f.
$\frac{1}{8-2}[(5-2)(30)+(7-5)(40)+(8-7$
$=\frac{1}{6}[90+80+40]$
$=\frac{1}{6}(210)$
$=35$</td>
<td>Mean Value Theo for Integrals
$\frac{1}{b-a}\int_a^b f(x)d$
$= f(c)$
where $c\in[a,b$</td>
</tr>
</table>

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<tr><th>Topic</th><th>Equation</th><th>Graphic</th><th>Word Problems</th><th>Approximation</th><th>Algebraic</th></tr>
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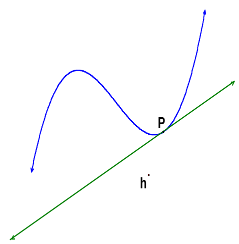
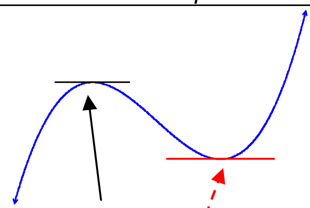
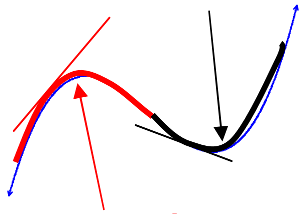
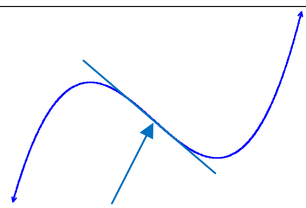
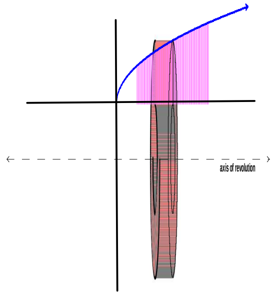
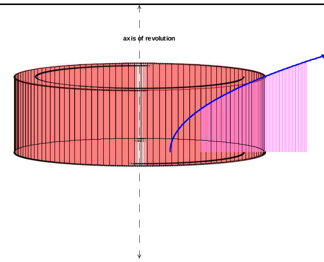
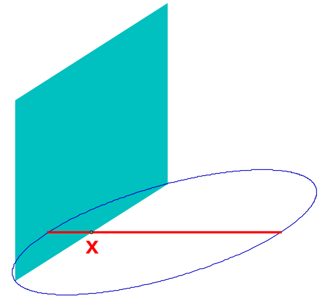
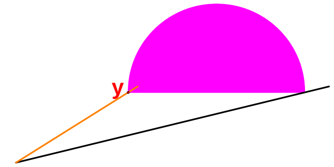
<td>Derivative</td>
<td>$f'(x) = \frac{df}{dx}$</td>
<td>
The slope of the tangent line to f</td>
<td>Instantaneous Rate of Change:
<u>Example:</u>
Instantaneous velocity = p’(t)
where p(t) is position function</td>
<td><table><tr><td>x</td><td>2</td><td>5</td><td>7</td><td>8</td></tr><tr><td>$f(x)$</td><td>10</td><td>30</td><td>40</td><td>20</td></tr></table>
$f'(6) \approx \frac{40-30}{7-5} = 5$</td>
<td>The limit of the rat change of f.
$f'(x)$
$= \lim_{h\to 0} \frac{f(x+h)-f}{h}$</td>
</tr>
<tr>
<td>Relative Extrema</td>
<td>$f'(x)$
changes sign</td>
<td>
At this point, f’ changes from positive to negative

At this point, f’ changes from negative to positive</td>
<td>The rate of change changes sign
The particle changes direction
The values change from increasing to decreasing or vice-versa
The particle stops momentarily
The velocity is momentarily zero</td>
<td><table><tr><th>t (hours)</th><th>$R(t)$ (gallons per hour)</th></tr><tr><td>0</td><td>9.6</td></tr><tr><td>3</td><td>10.4</td></tr><tr><td>6</td><td>10.8</td></tr><tr><td>9</td><td>11.2</td></tr><tr><td>12</td><td>11.4</td></tr><tr><td>15</td><td>11.3</td></tr><tr><td>18</td><td>10.7</td></tr><tr><td>21</td><td>10.2</td></tr><tr><td>24</td><td>9.6</td></tr></table>
By MVT, $\frac{11.4-9.6}{12-0} = .15$
$c \in (0,12)$
so there is a such that
$R'(c) = .15$
Similarly, there is a
$d \in (12,24)$
such that $R'(d) = -0.15$</td>
<td><u>Relative max</u>
$f(a) \geq f(x)$
for all x in some interval

<u>Relative Min</u>
$f(a) \leq f(x)$
for all x in some interval</td>
</tr>
</table>

Topic	Equation	Graphic	Word Problems	Approximation	Tangent Lines
Concavity	$f''(x) > 0$ concave up $f''(x) < 0$ concave down	concave up: tangent line is below curve  concave down: The tangent line is above the curve	Concave Up: • the rate of change is increasing (more positive) • acceleration > 0 • **v(t) < 0**: particle is **slowing down** • **v(t) > 0**: particle is **speeding up** Concave Down: • the rate of change is decreasing (more negative) • acceleration < 0 • **v(t) < 0:** particle is **speeding up** • **v(t) > 0:** particle is **slowing down**	x: 2, 5, 7, 8 $f(x)$: 10, 30, 40, 20 $\frac{30-10}{5-2} = 6.667$ $\frac{40-30}{7-5} = 5$ $\frac{20-40}{8-7} = -20$ Concave down because the derivative is decreasing.	**Concave up:** The tangent line approximations are under approximatio **Concave down:** The tangent line approximations are approximations
Inflection Points	$f''(x)$ changes sign	 inflection point	Rate of Change goes from increasing to decreasing or vice versa. Velocity of particle changes from speeding up to slowing down or vice versa.	t (hours) / $R(t)$ (gallons per hour): 0 / 9.6 3 / 10.4 6 / 10.8 9 / 11.2 12 / 11.4 15 / 11.3 18 / 10.7 21 / 10.2 24 / 9.6 If G(t) is the number of gallons that has flowed through the pipe from *time = 0* to *time = t* then *G''(t) = 0 for t between 0 and 24 hours.*	The tangent line cro the graph of the cur an inflection point.

AP Calculus AB   Synopsis of AP Calculus AB   Name:_______________ _____________

Volume	Horizontal Axis	Vertical Axis	Cross-Sections Perpendicular to x axis	Cross-Sections Perpendicular to y axis
Volume = $\int_{x=a}^{x=b} A(x)dx$ Volume = $\int_{y=c}^{y=d} A(y)dy$	 Volume = $\pi\int_a^b (R(x)^2 - r(x)^2)dx$ $R(x) = f(x) - axis$ $r(x) = g(x) - axis$ *f(x) is furthest from axis* *g(x) is closest to axis*	 Volume = $\int_a^b 2\pi(height)(radius)dx$ **height** = $f(x) - g(x)$ where *f* is furthest from x-axis, and *g(x)* is closer to x-axis. **radius** = (*x – axis)*	 Volume = $\int_a^b A(x)dx$ Where A(x) is the area of the cross-section as a function of *x*.	 Volume = $\int_c^d A(y)dy$ Where *A(y)* is the area of the cross-section as a function of *y*.