Pre-Calculus Reference Sheet

Standard Form of a Quadratic Equation
$ax^2 + bx + c = 0$

Quadratic Formula
$x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ (where $ax^2 + bx + c = 0$, $a \neq 0$)

Compounding Interest Formulas
Periodic: $A = P\,(1 + \frac{r}{n})^{nt}$ **Continuous:** $A = Pe^{rt}$ (where A is the amount due on a principal P invested for t years at an annual interest rate r compounded n times per year)

Combination and Permutation Formulas
Combination: ${}_nC_r = C\,(n, r) = \dfrac{n!}{(n-r)!\,r!}$ **Permutation:** ${}_nP_r = P\,(n, r) = \dfrac{n!}{(n-r)!}$

Sequences and Series

Arithmetic sequence: $a_n = a_1 + (n - 1)d$

Arithmetic series: $S_n = \dfrac{n}{2}(a_1 + a_n)$

Geometric sequence: $a_n = a_1 r^{n-1}$ or $a_n = a_{n-1} r$

Geometric series: $S_n = \dfrac{a_1 - a_1 r^n}{1 - r}$, where $r \neq 1$

Infinite Geometric series: $\sum_{k=1}^{\infty} ar^{k-1} = \dfrac{a}{1-r}$, if $-1 < r < 1$

(where a_1 is the first term, n is the number of the term, d is the common difference, r is the common ratio, a_n is the nth term and S_n is the sum of the first n terms)

General Formula for Growth and Decay

$A = A_0 e^{kt}$ (where A is the amount at the time t, A_0 is the amount at $t = 0$, and k is a constant)	$e \approx 2.718$

Descriptive Statistics

For a set of paired data $\{(x_1, y_1), (x_2, y_2) \ldots, (x_n, y_n)\}$:

correlation coefficient $= \dfrac{n(x_1 y_1 + \ldots + x_n y_n) - (x_1 + \ldots + x_n)(y_1 + \ldots + y_n)}{\sqrt{\{[n(x_1^2 + \ldots + x_n^2) - (x_1 + \ldots + x_n)^2][n(y_1^2 + \ldots + y_n^2) - (y_1 + \ldots + y_n)^2]\}}}$

The equation of the least squares regression line for the data is $y = \overline{y} + b\,(x - \overline{x})$, where $\overline{x}$ and $\overline{y}$ are the means of the x and y values and

$$b = \frac{n(x_1 y_1 + \ldots + x_n y_n) - (x_1 + \ldots + x_n)(y_1 + \ldots + y_n)}{n(x_1^2 + \ldots + x_n^2) - (x_1 + \ldots + x_n)^2}$$

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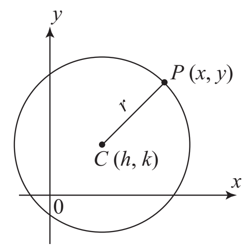
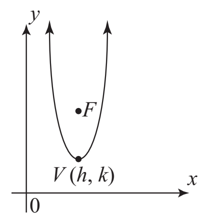
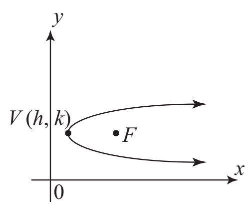
<table>
<tr><th colspan="2">Conic Section</th><th>Equation</th><th>Characteristics</th></tr>
<tr><td>Circle</td><td></td><td>$(x-h)^2+(y-k)^2=r^2$</td><td>Center (h, k)
radius r</td></tr>
<tr><td rowspan="2">Parabola</td><td></td><td>$y=a(x-h)^2+k$</td><td>axis of symmetry $x=h$
directrix $y=k-\frac{1}{4a}$
focus $(h, k+\frac{1}{4a})$</td></tr>
<tr><td></td><td>$x=a(y-k)^2+h$</td><td>axis of symmetry $y=k$
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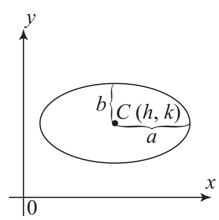
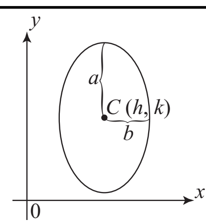
focus $(h+\frac{1}{4a}, k)$</td></tr>
<tr><td rowspan="2">Ellipse</td><td></td><td>$\frac{(x-h)^2}{a^2}+\frac{(y-k)^2}{b^2}=1$</td><td>foci $(h \pm c, k)$,
where $c^2=a^2-b^2$</td></tr>
<tr><td></td><td>$\frac{(y-k)^2}{a^2}+\frac{(x-h)^2}{b^2}=1$</td><td>foci $(h, k \pm c)$,
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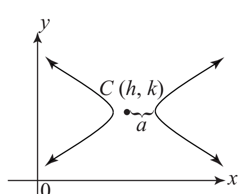
<tr><td rowspan="2">Hyperbola</td><td></td><td>$\frac{(x-h)^2}{a^2}-\frac{(y-k)^2}{b^2}=1$</td><td>foci $(h \pm c, k)$,
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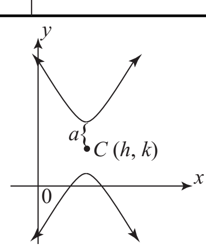
<tr><td></td><td>$\frac{(y-k)^2}{a^2}-\frac{(x-h)^2}{b^2}=1$</td><td>foci $(h, k \pm c)$,
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Trigonometry

Addition Formulas

$$\sin(A+B) = \sin A\cos B + \cos A\sin B$$

$$\cos(A+B) = \cos A\cos B - \sin A\sin B$$

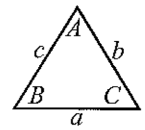
$$\tan(A+B) = \frac{\tan A + \tan B}{1 - \tan A\tan B}$$

Laws of Sines and Cosines

$$a^2 = b^2 + c^2 - 2bc\cos A$$

$$b^2 = a^2 + c^2 - 2ac\cos B$$

$$c^2 = a^2 + b^2 - 2ab\cos C$$



$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$\textit{Area of triangle} = \frac{1}{2}ac\sin B$$

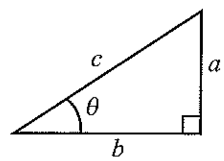
Subtraction Formulas

$$\sin(A-B) = \sin A\cos B - \cos A\sin B$$

$$\cos(A-B) = \cos A\cos B + \sin A\sin B$$

$$\tan(A-B) = \frac{\tan A - \tan B}{1 + \tan A\tan B}$$

Triangle Relationships



$$a^2 + b^2 = c^2 \qquad \sec\theta = \frac{1}{\cos\theta}$$

$$\sin\theta = \frac{a}{c} \qquad \csc\theta = \frac{1}{\sin\theta}$$

$$\cos\theta = \frac{b}{c} \qquad \tan\theta = \frac{\sin\theta}{\cos\theta}$$

$$\tan\theta = \frac{a}{b} \qquad \cot\theta = \frac{1}{\tan\theta} = \frac{\cos\theta}{\sin\theta}$$

Half Angle Identities

$$\sin\frac{x}{2} = \pm\sqrt{\frac{1-\cos x}{2}}$$

$$\cos\frac{x}{2} = \pm\sqrt{\frac{1+\cos x}{2}}$$

$$\tan\frac{x}{2} = \frac{1-\cos x}{\sin x}$$

$$\tan\frac{x}{2} = \frac{\sin x}{1+\cos x}$$

Pythagorean Identities

$$\sin^2\theta + \cos^2\theta = 1$$

$$1 + \tan^2\theta = \sec^2\theta$$

$$1 + \cot^2\theta = \csc^2\theta$$

Double Angle Identities

$$\sin 2x = 2\sin x\cos x$$

$$\cos 2x = \cos^2 x - \sin^2 x$$

$$\cos 2x = 2\cos^2 x - 1$$

$$\cos 2x = 1 - 2\sin^2 x$$

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

Polar and Rectangular Coordinates; Trigonometric Form of a Complex Number

$$x = r\cos\theta$$

$$y = r\sin\theta$$

$$r^2 = x^2 + y^2$$

$$\tan\theta = \frac{y}{x}$$

$$x + yi = r(\cos\theta + i\sin\theta)$$