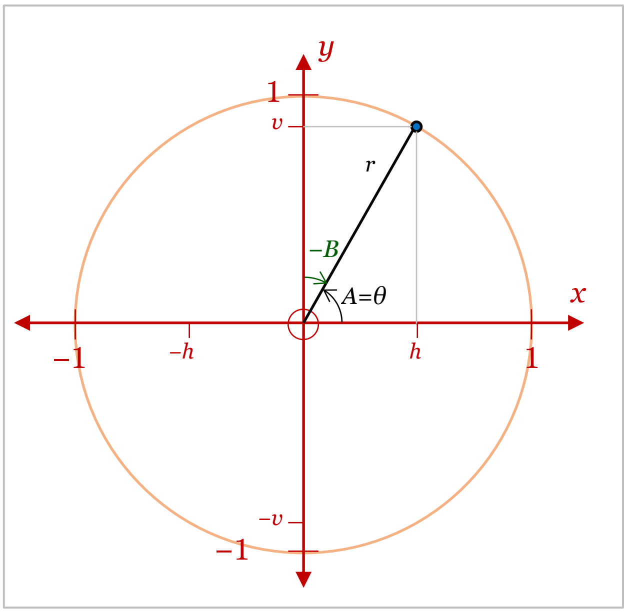
Trigonometric Functions of Angles in Each Quadrant

1. First quadrant

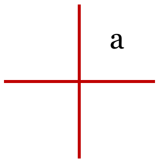


Note: angles are considered to be *positive* when measured anticlockwise, and *negative* when measured clockwise.

Functions of reference angle A:

$\sin(\theta)$ $= \sin(A) = v/r$	$\cos(\theta)$ $= \cos(A) = h/r$	$\tan(\theta)$ $= \tan(A) = v/h$
$\text{cosec}(\theta)$ $= \text{cosec}(A) = 1/\sin(A) = r/v$	$\sec(\theta)$ $= \sec(A) = 1/\cos(A) = r/h$	$\cot(\theta)$ $= \cot(A) = 1/\tan(A) = h/v$

Observe that **all** trigonometric functions of θ are positive in quadrant I.
A mnemonic for this is to associate "a" with quadrant I.



Functions of complementary angle B:

$\sin(\theta)$ $= \sin(90°-B) = \cos(B) = v/r$ $= \sin(A)$	$\cos(\theta)$ $= \cos(90°-B) = \sin(B) = h/r$ $= \cos(A)$	$\tan(\theta)$ $= \tan(90°-B) = \cot(B) = v/h$ $= \tan(A)$
$\text{cosec}(\theta)$ $= \text{cosec}(90°-B) = \sec(B) = r/v$ $= \text{cosec}(A)$	$\sec(\theta)$ $= \sec(90°-B) = \text{cosec}(B) = r/h$ $= \sec(A)$	$\cot(\theta)$ $= \cot(90°-B) = \tan(B) = h/v$ $= \cot(A)$

Note: $A + B = 90°$ by definition of complementary angles.

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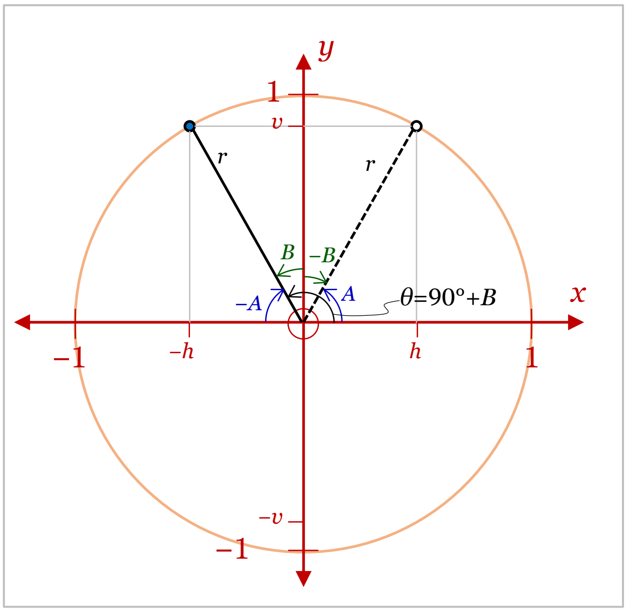
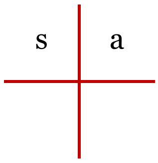
2. Second quadrant



Functions of reference angle A:

$\sin(\theta)$ $= \sin(180°-A)$ $= \sin(A) = v/r$	$\cos(\theta)$ $= \cos(180°-A)$ $= -\cos(A) = -h/r$	$\tan(\theta)$ $= \tan(180°-A)$ $= -\tan(A) = -v/h$
$\operatorname{cosec}(\theta)$ $= \operatorname{cosec}(180°-A)$ $= 1/\sin(180°-A)$ $= \operatorname{cosec}(A) = 1/\sin(A) = r/v$	$\sec(\theta)$ $= \sec(180°-A)$ $= 1/\cos(180°-A)$ $= -\sec(A) = -1/\cos(A) = -r/h$	$\cot(\theta)$ $= \cot(180°-A)$ $= 1/\tan(180°-A)$ $= -\cot(A) = -1/\tan(A) = -h/v$

Observe that only the **s**ine and cosecant of θ are positive in quadrant II.
A mnemonic for this is to associate “s” with quadrant II.



Knowing that $\sin(\theta)$ is positive automatically tells us that $\operatorname{cosec}(\theta)$ must likewise be positive, as $\operatorname{cosec}(\theta) = 1/\sin(\theta)$.

Functions of complementary angle B:

$\sin(\theta)$ $= \sin(90°+B)$ $= \cos(B) = v/r$ $= \sin(180°-A)$	$\cos(\theta)$ $= \cos(90°+B)$ $= -\sin(B) = -h/r$ $= \cos(180°-A)$	$\tan(\theta)$ $= \tan(90°+B)$ $= -\cot(B) = -v/h$ $= \tan(180°-A)$
$\operatorname{cosec}(\theta)$ $= \operatorname{cosec}(90°+B)$ $= \sec(B) = r/v$ $= \operatorname{cosec}(180°-A)$	$\sec(\theta)$ $= \sec(90°+B)$ $= -\operatorname{cosec}(B) = -r/h$ $= \sec(180°-A)$	$\cot(\theta)$ $= \cot(90°+B)$ $= -\tan(B) = -h/v$ $= \cot(180°-A)$

Note: $A + B = 90°$, by definition of complementary angles.

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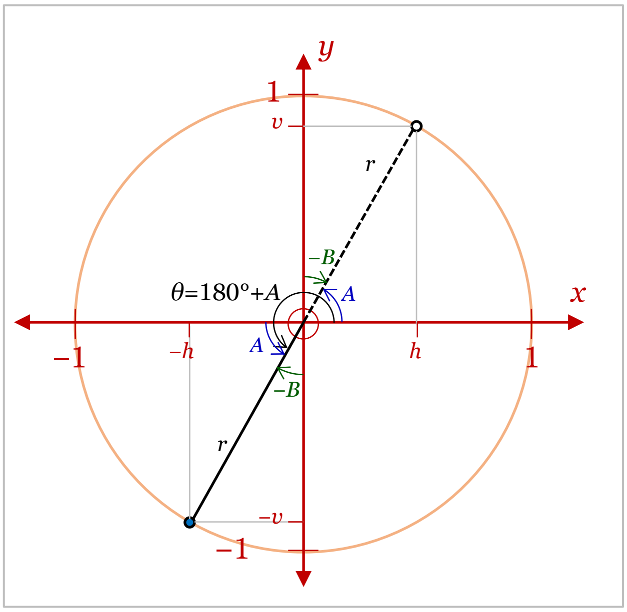
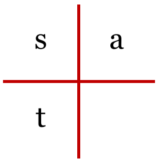
3. Third quadrant



Functions of reference angle A:

$\sin(\theta)$ $= \sin(180°+A)$ $= -\sin(A) = -v/r$	$\cos(\theta)$ $= \cos(180°+A)$ $= -\cos(A) = -h/r$	$\tan(\theta)$ $= \tan(180°+A)$ $= \tan(A) = v/h$
$\mathrm{cosec}(\theta)$ $= \mathrm{cosec}(180°+A)$ $= 1/\sin(180°-A)$ $= -\mathrm{cosec}(A) = -1/\sin(A) = -r/v$	$\sec(\theta)$ $= \sec(180°+A)$ $= 1/\cos(180°-A)$ $= -\sec(A) = -1/\cos(A) = -r/h$	$\cot(\theta)$ $= \cot(180°+A)$ $= 1/\tan(180°-A)$ $= \cot(A) = 1/\tan(A) = h/v$

Observe that only the <u>**t**angent</u> and cotangent of θ are positive in quadrant III.
A mnemonic for this is to associate "t" with quadrant III.



Knowing that $\tan(\theta)$ is positive automatically tells us that $\mathrm{cotan}(\theta)$ must likewise be positive, as $\mathrm{cotan}(\theta) = 1/\tan(\theta)$.

Functions of complementary angle B:

$\sin(\theta)$ $= \sin(270°-B)$ $= -\cos(B) = -v/r$ $= \sin(180°-A)$	$\cos(\theta)$ $= \cos(270°-B)$ $= -\sin(B) = -h/r$ $= \cos(180°-A)$	$\tan(\theta)$ $= \tan(270°-B)$ $= \cot(B) = v/h$ $= \tan(180°-A)$
$\mathrm{cosec}(\theta)$ $= \mathrm{cosec}(270°-B)$ $= -\sec(B) = -r/v$ $= \mathrm{cosec}(180°-A)$	$\sec(\theta)$ $= \sec(270°-B)$ $= -\mathrm{cosec}(B) = -r/h$ $= \sec(180°-A)$	$\cot(\theta)$ $= \cot(270°-B)$ $= \tan(B) = h/v$ $= \cot(180°-A)$

Note: $A + B = 90°$, by definition of complementary angles.

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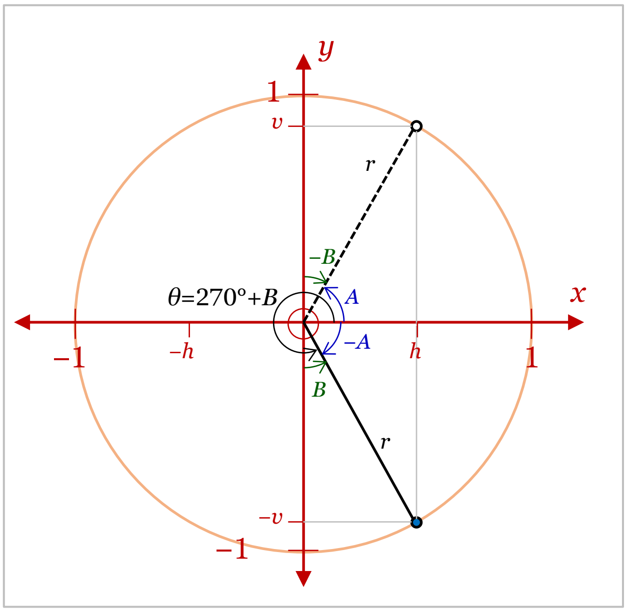
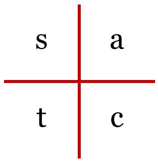
4. Fourth quadrant



Functions of reference angle A:

$\sin(\theta)$ $= \sin(360°-A)$ $= -\sin(A) = -v/r$	$\cos(\theta)$ $= \cos(360°-A)$ $= \cos(A) = h/r$	$\tan(\theta)$ $= \tan(360°-A)$ $= -\tan(A) = -v/h$
$\mathrm{cosec}(\theta)$ $= \mathrm{cosec}(360°-A)$ $= 1/\sin(360°-A)$ $= -\mathrm{cosec}(A) = -1/\sin(A) = -r/v$	$\sec(\theta)$ $= \sec(360°-A)$ $= 1/\cos(360°-A)$ $= \sec(A) = 1/\cos(A) = r/h$	$\cot(\theta)$ $= \cot(360°-A)$ $= 1/\tan(360°-A)$ $= -\cot(A) = -1/\tan(A) = -h/v$

Observe that only the **cosine** and secant of θ are positive in quadrant IV.
A mnemonic for this is to associate "c" with quadrant IV.



Knowing that $\cos(\theta)$ is positive automatically tells us that $\sec(\theta)$ must likewise be positive, as $\sec(\theta) = 1/\cos(\theta)$.

Functions of complementary angle B:

$\sin(\theta)$ $= \sin(270°+B)$ $= -\cos(B) = -v/r$ $= \sin(360°-A)$	$\cos(\theta)$ $= \cos(270°+B)$ $= \sin(B) = h/r$ $= \cos(360°-A)$	$\tan(\theta)$ $= \tan(270°+B)$ $= -\cot(B) = -v/h$ $= \tan(360°-A)$
$\mathrm{cosec}(\theta)$ $= \mathrm{cosec}(270°+B)$ $= -\sec(B) = -r/v$ $= \mathrm{cosec}(360°-A)$	$\sec(\theta)$ $= \sec(270°+B)$ $= \mathrm{cosec}(B) = r/h$ $= \sec(360°-A)$	$\cot(\theta)$ $= \cot(270°+B)$ $= -\tan(B) = -h/v$ $= \cot(360°-A)$

Note: $A + B = 90°$, by definition of complementary angles.

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