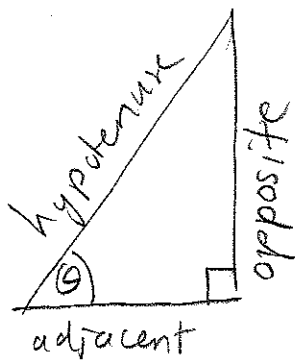


Useful Formulae for Optimization / Related Rates

Trigonometry

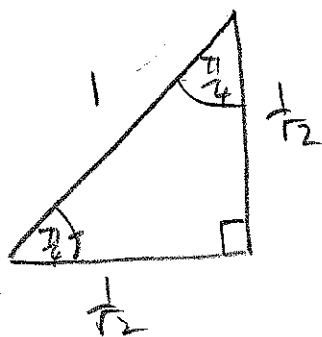


'SOHCAHTOA'

$$\sin \theta = \frac{\text{opp}}{\text{hyp}}, \quad \cos \theta = \frac{\text{adj}}{\text{hyp}}$$

$$\tan \theta = \frac{\text{opp}}{\text{adj}}$$

Special Triangles

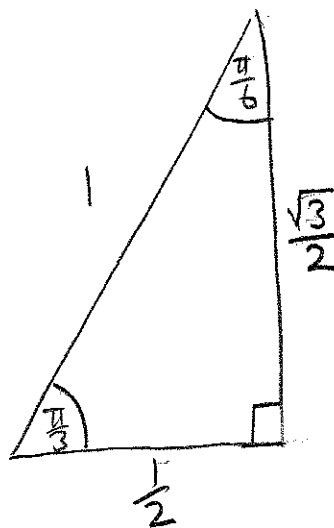


$$\sin \frac{\pi}{4} = \frac{1}{\sqrt{2}}$$

$$\cos \frac{\pi}{4} = \frac{1}{\sqrt{2}}$$

$$\tan \frac{\pi}{4} = 1$$

Isosceles right-angled



$$\sin \frac{\pi}{6} = \frac{1}{2}$$

$$\cos \frac{\pi}{6} = \frac{\sqrt{3}}{2}$$

$$\tan \frac{\pi}{6} = \frac{1}{\sqrt{3}}$$

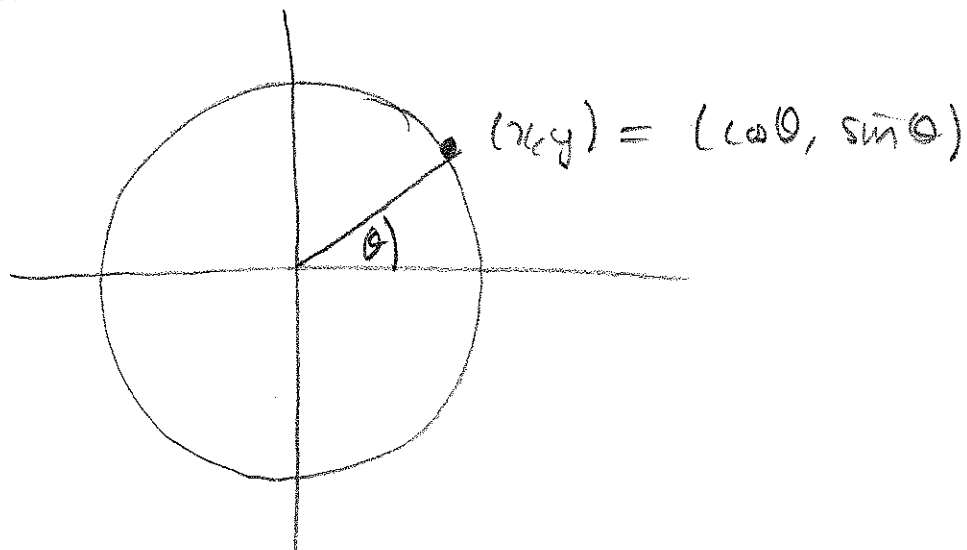
$$\sin \frac{\pi}{3} = \frac{\sqrt{3}}{2}$$

$$\cos \frac{\pi}{3} = \frac{1}{2}$$

$$\tan \frac{\pi}{3} = \sqrt{3}$$

Half an equilateral triangle.

Unit Circle



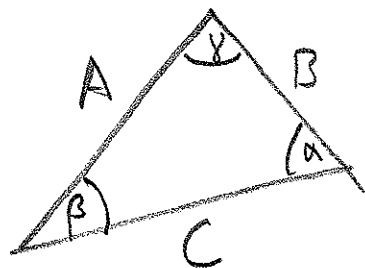
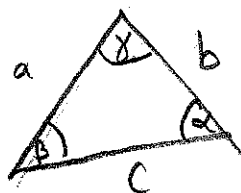
$$x = \cos \theta$$

$$y = \sin \theta$$

$$x^2 + y^2 = 1$$

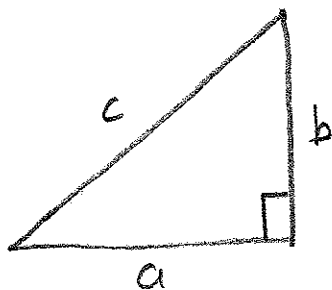
$$\cos^2 \theta + \sin^2 \theta = 1$$

Similar Triangles



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

Pythagoras



$$c^2 = a^2 + b^2$$

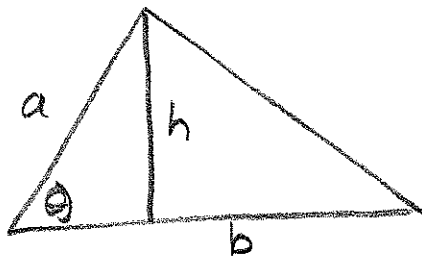
$$c = \sqrt{a^2 + b^2}$$

$$a = \sqrt{c^2 - b^2}$$

$$b = \sqrt{c^2 - a^2}$$

Mensuration (Area / Volume)

Triangle



$$A = \frac{1}{2} b \cdot h$$

$$A = \frac{1}{2} a \cdot b \cdot \sin \theta$$

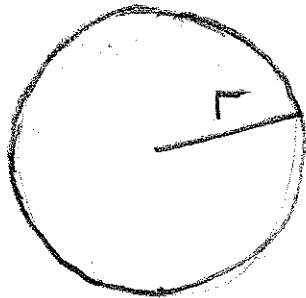
Rectangle



$$A = l \cdot w$$

$$\text{Perimeter} = 2l + 2w$$

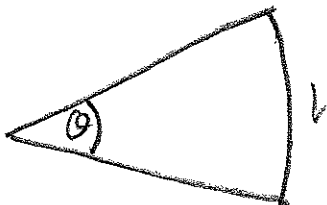
Circle



$$A = \pi r^2$$

$$\text{Circumference} = 2\pi r$$

Arc / Sector

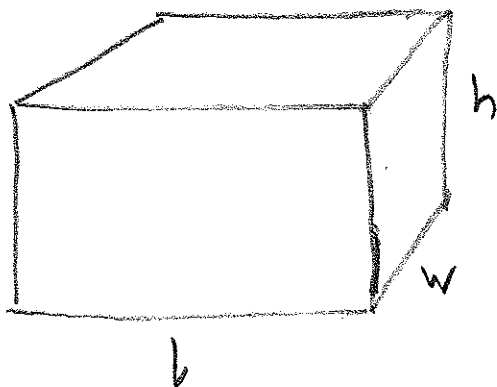


$$A = \frac{1}{2} r^2 \theta$$

$$l = r \theta$$

(θ in radians)

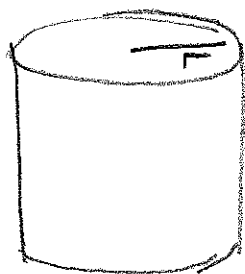
Box



$$V = l \cdot w \cdot h$$

$$A = 2l \cdot w + 2l \cdot h + 2w \cdot h$$

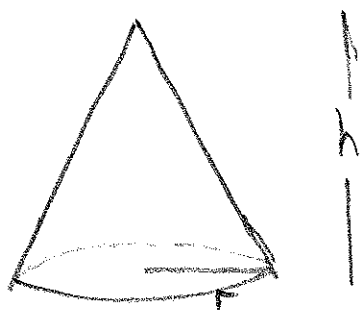
Cylinder



$$V = \pi r^2 \cdot h$$

$$A = 2\pi r^2 + 2\pi r \cdot h$$

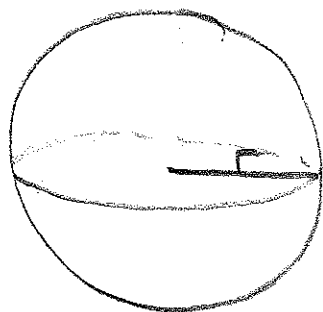
Cone



$$V = \frac{1}{3} \pi r^2 \cdot h$$

$$A = \pi r^2 + \pi r \sqrt{r^2 + h^2}$$

Sphere



$$V = \frac{4}{3} \pi r^3$$

$$A = 4\pi r^2$$