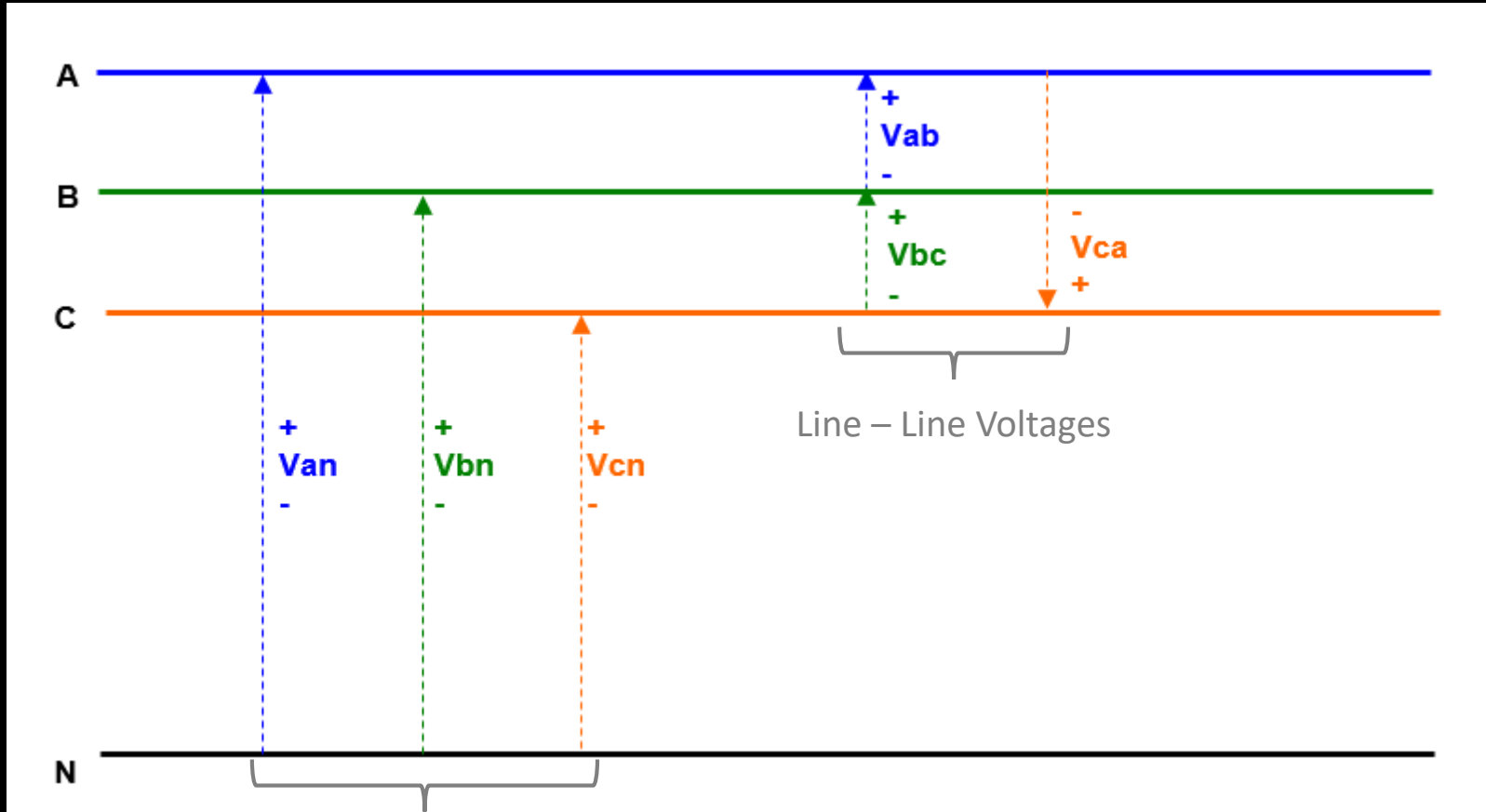
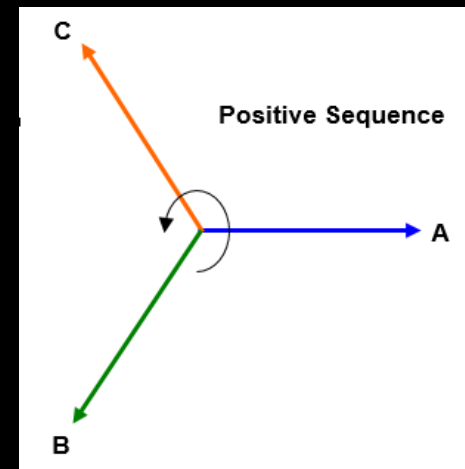


# Line - Line voltage compared to Line - Neutral voltage



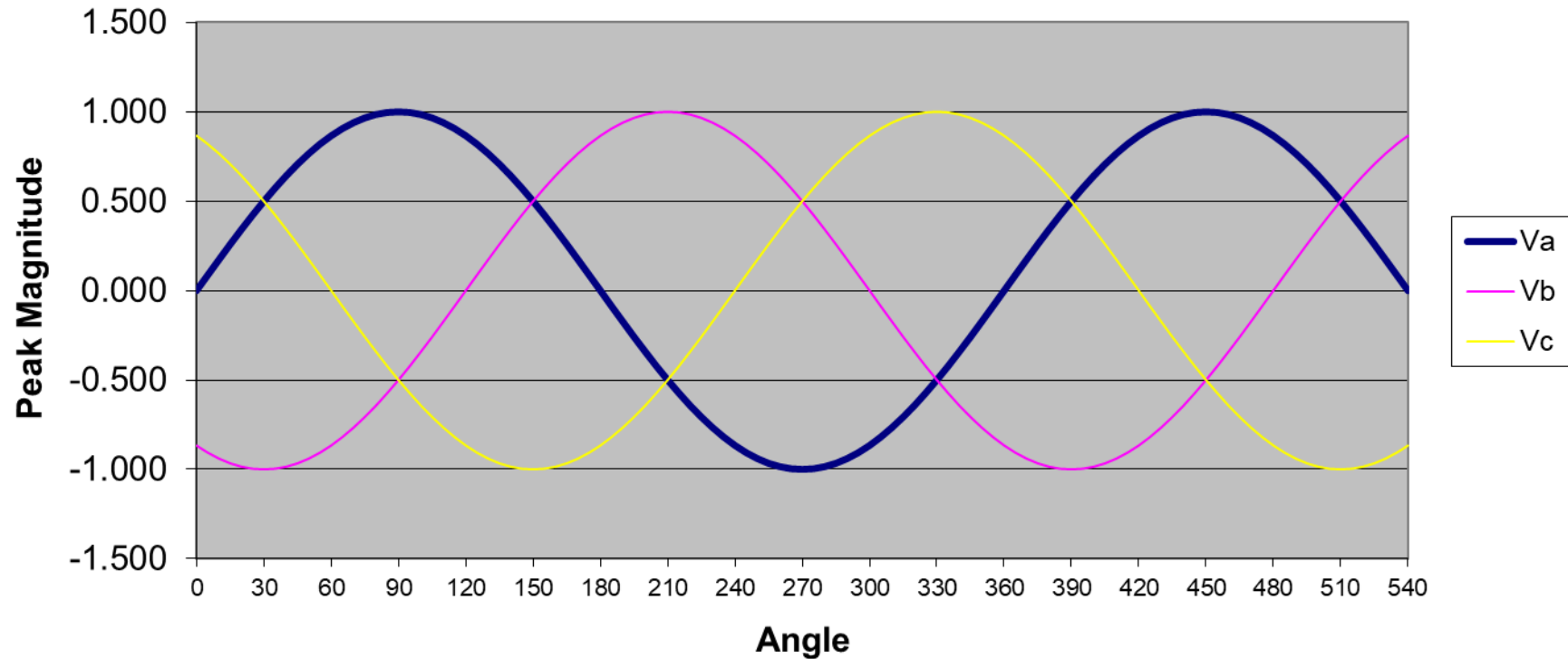
Line - Neutral  
- or -  
Phase Voltages



# Line - Line voltage compared to Line – Neutral voltage

Plot A-B-C Line – Neutral voltages

## 3 Phase Line-Neutral Voltage



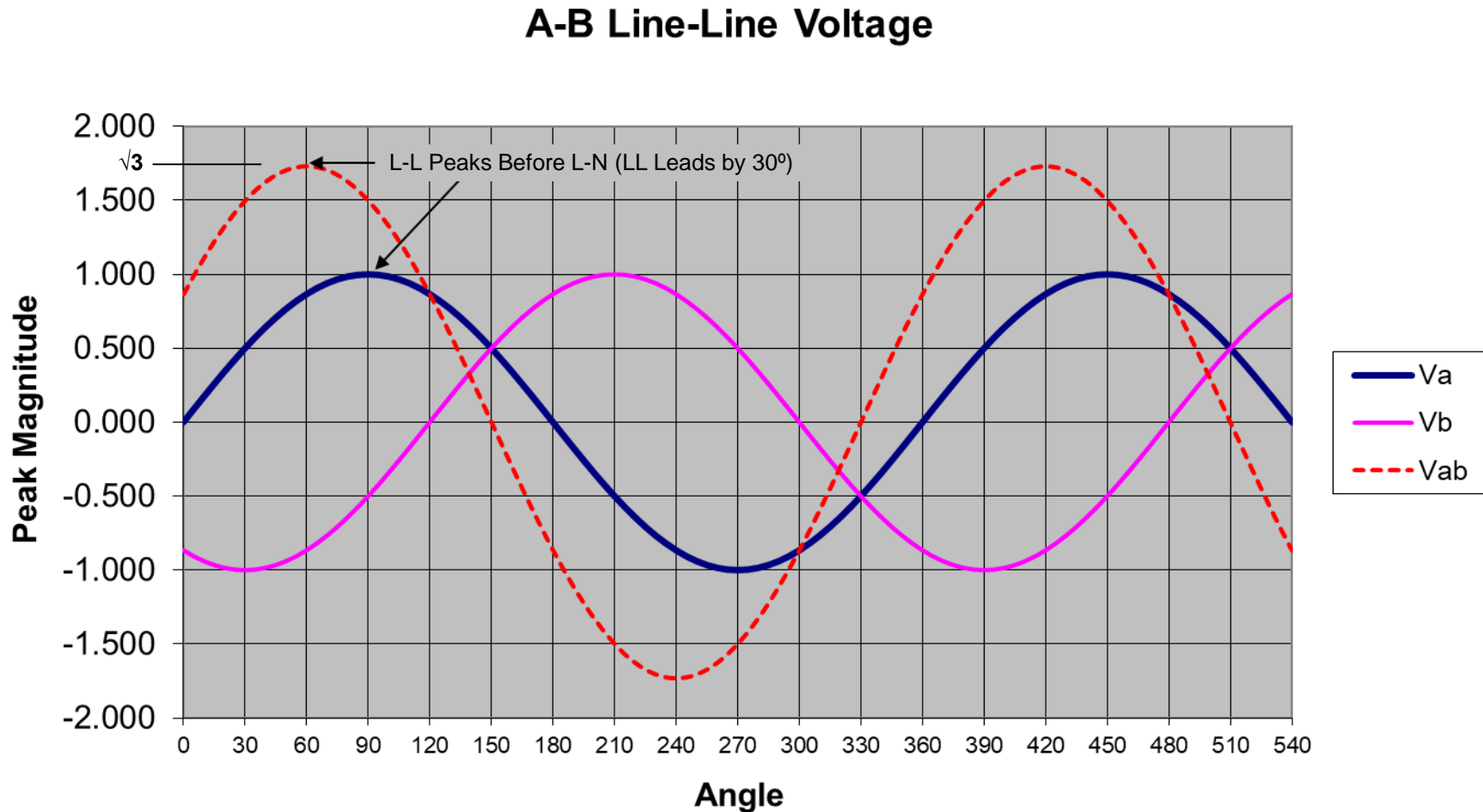
A leads B by  $120^\circ$

B leads C by  $120^\circ$

C leads A by  $120^\circ$

# Line - Line voltage .vs. Line – Neutral voltage (cont.)

Plot A-B Line – line voltage



$V_{AB}$  leads  $V_A$  by  $30^\circ$

$V_{AB}$  is larger than  $V_A$  by  $\sqrt{3}$

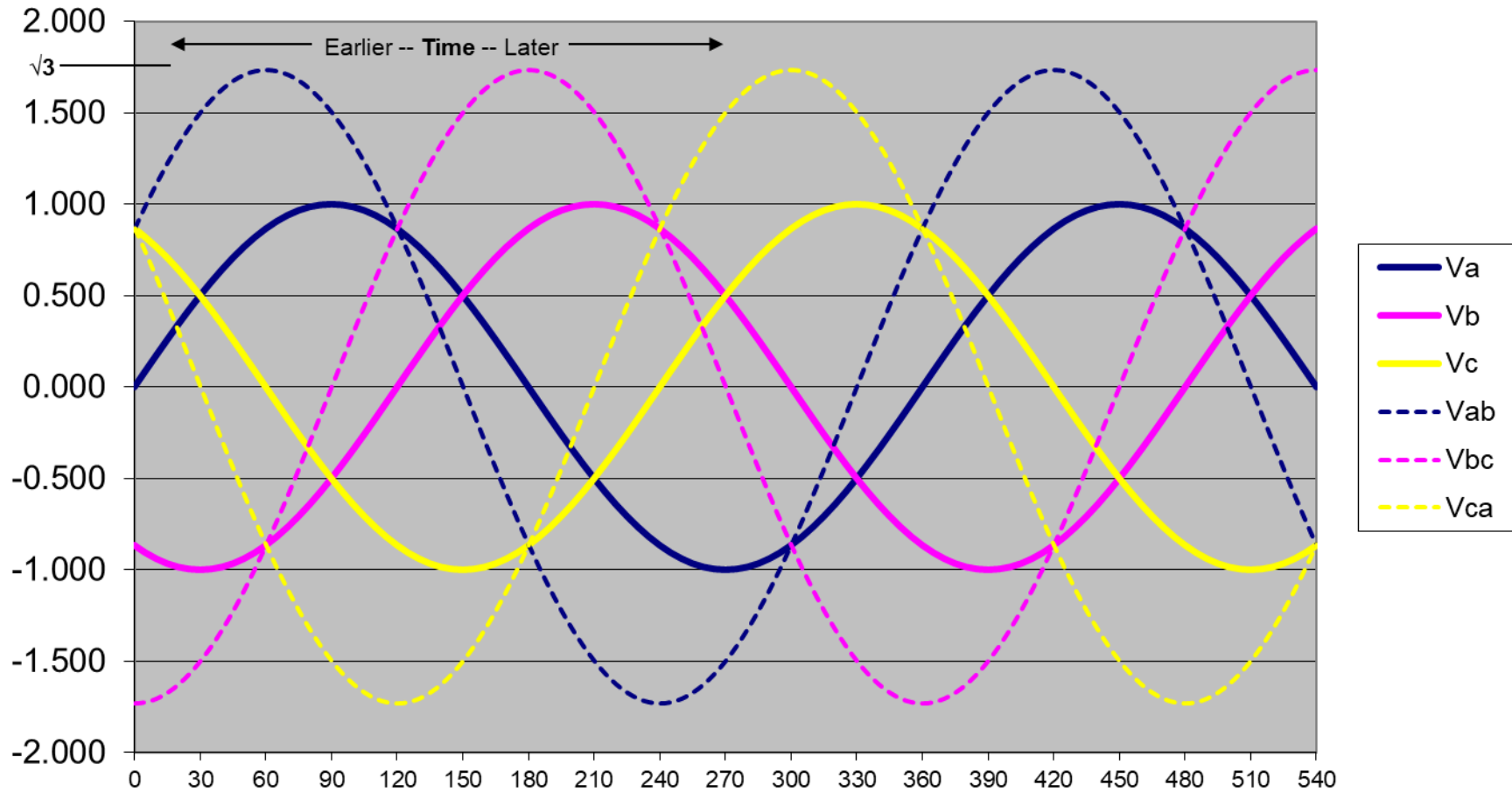
another way to say it:

$$V_{LL} = \sqrt{3}V_\phi \angle 30^\circ \text{ or } V_{LL} = \sqrt{3}V_\phi e^{j30^\circ}$$

# Line - Line voltage .vs. Line – Neutral voltage (cont.)

Plot  $V_{AB}$   $V_{BC}$   $V_{CA}$  line – line voltages

## 3 Phase Line-Line Voltage



$V_{AB}$  leads  $V_{BC}$  by  $120^\circ$

$V_{BC}$  leads  $V_{CA}$  by  $120^\circ$

$V_{CA}$  leads  $V_{AB}$  by  $120^\circ$

# Line - Line voltage .vs. Line – Neutral voltage (cont.)

## Mathematical Derivation

$$V_{an} = V_{\phi} \angle 0^{\circ}$$

$$V_{bn} = V_{\phi} \angle -120^{\circ}$$

$$V_{cn} = V_{\phi} \angle 120^{\circ}$$

$$V_{ab} = V_{an} - V_{bn}$$

$$V_{bc} = V_{bn} - V_{cn}$$

$$V_{ca} = V_{cn} - V_{an}$$

$$V_{ab} = V_{\phi} \angle 0^{\circ} - V_{\phi} \angle -120^{\circ}$$

$$V_{ab} = V_{\phi} (1 \angle 0^{\circ} - 1 \angle -120^{\circ})$$

$$V_{ab} = V_{\phi} (1 \angle 0^{\circ} + 1 \angle 60^{\circ})$$

$$V_{ab} = V_{\phi} \left[ 1 + \frac{1}{2} + j \frac{\sqrt{3}}{2} \right]$$

$$V_{ab} = V_{\phi} \left[ \frac{3}{2} + j \frac{\sqrt{3}}{2} \right]$$

$$|V_{ab}| = V_{\phi} \sqrt{\frac{9}{4} + \frac{3}{4}} = \sqrt{\frac{12}{4}} V_{\phi} = \sqrt{3} V_{\phi}$$

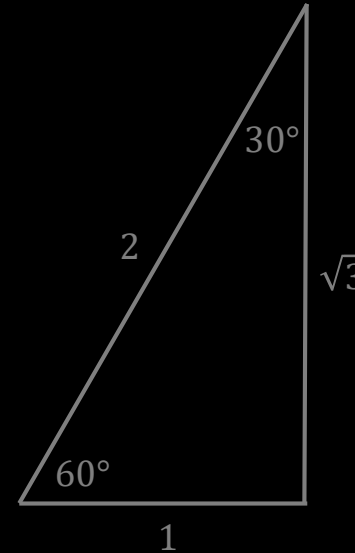
$$\angle V_{ab} = \tan^{-1} \frac{\sqrt{3}}{3} = \tan^{-1} \frac{1}{\sqrt{3}} = 30^{\circ}$$

$$V_{ab} = \sqrt{3} V_{\phi} \angle 30^{\circ}$$

similar analysis of  $V_{bc}$  and  $V_{ca}$  would yield:

$$V_{bc} = \sqrt{3} V_{\phi} \angle -90^{\circ}$$

$$V_{ca} = \sqrt{3} V_{\phi} \angle 150^{\circ}$$



$$\sin 30^{\circ} = \frac{1}{2}$$

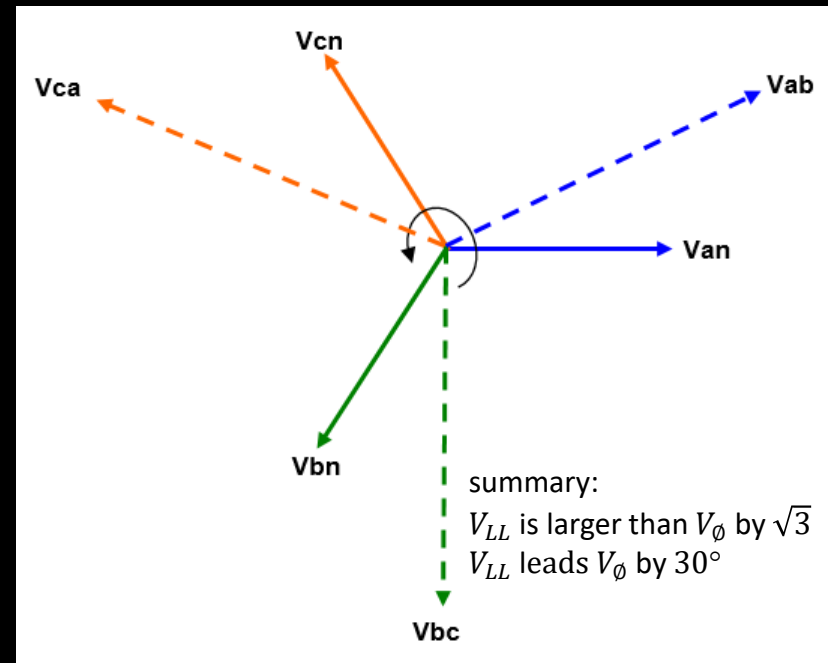
$$\cos 30^{\circ} = \frac{\sqrt{3}}{2}$$

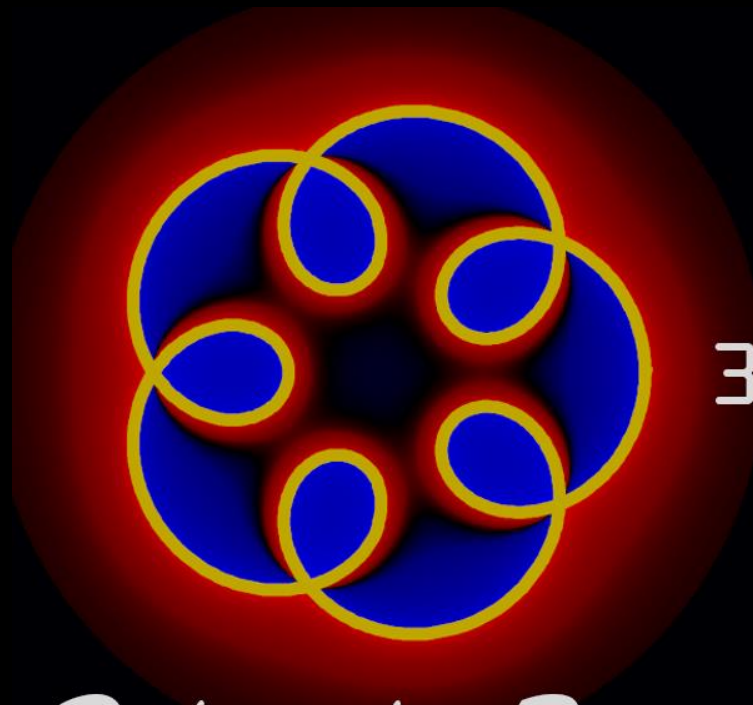
$$\tan 30^{\circ} = \frac{1}{\sqrt{3}}$$

$$\sin 60^{\circ} = \frac{\sqrt{3}}{2}$$

$$\cos 60^{\circ} = \frac{1}{2}$$

$$\tan 60^{\circ} = \sqrt{3}$$





ΕΦΕΕ

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Questions or Comments ...

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