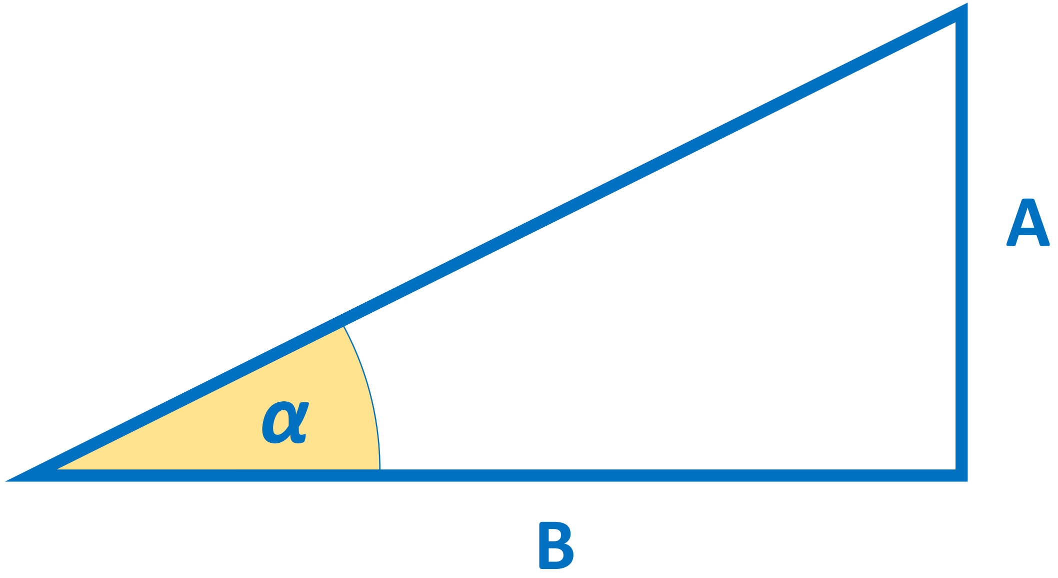
VI
RULE OF THUMB
(1:60 RULE)

Concept



$$\alpha = tan^{-1}\left(\frac{A}{B}\right)$$

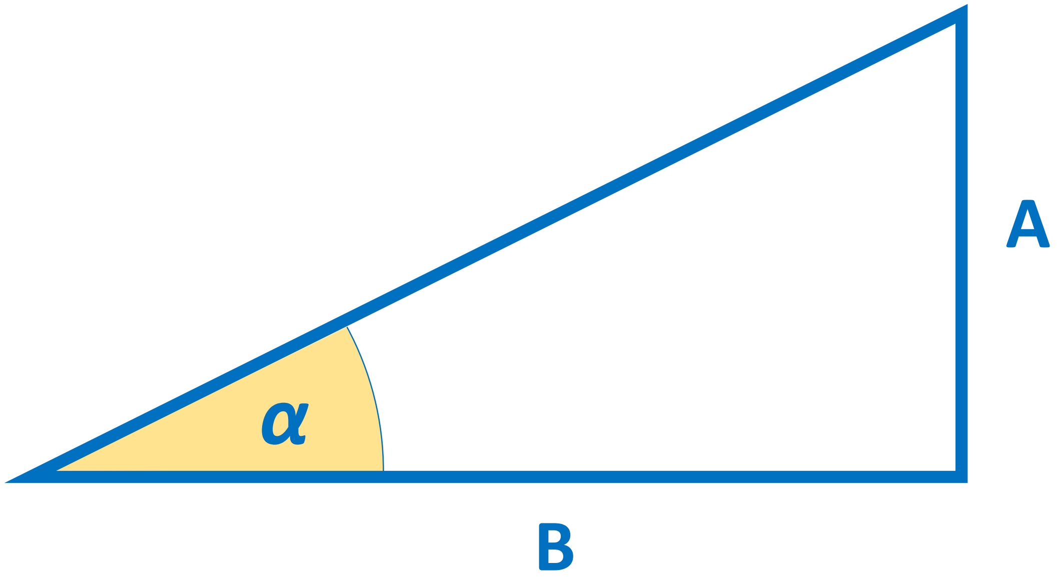
For angle up to 20°, it exists an approximation to quickly calculate the angle α:

$$\alpha \approx \frac{A}{B} \text{ x } 60$$

For the purpose of this topic, we will assume that it not an approximation anymore, since in navigation, we rarely calculate angle more than 20°, and the difference for small angle is just a small fraction of degrees

$$\boxed{\alpha = \frac{A}{B} \text{ x } 60}$$

Angle & Gradient



$$\alpha = \frac{A}{B} \text{ x } 60$$

The ratio A to B is actually the gradient of the slope at the angle α

$$Gradient\ \% = \frac{A}{B} \text{ x } 100$$

If we multiply the ratio A to B

- By 100, we obtain a gradient (%)
- By 60, we obtain an angle ($\measuredangle$)

So now we can easily switch between an angle and a gradient

$$\% = \frac{\measuredangle}{60} \text{ x } 100$$

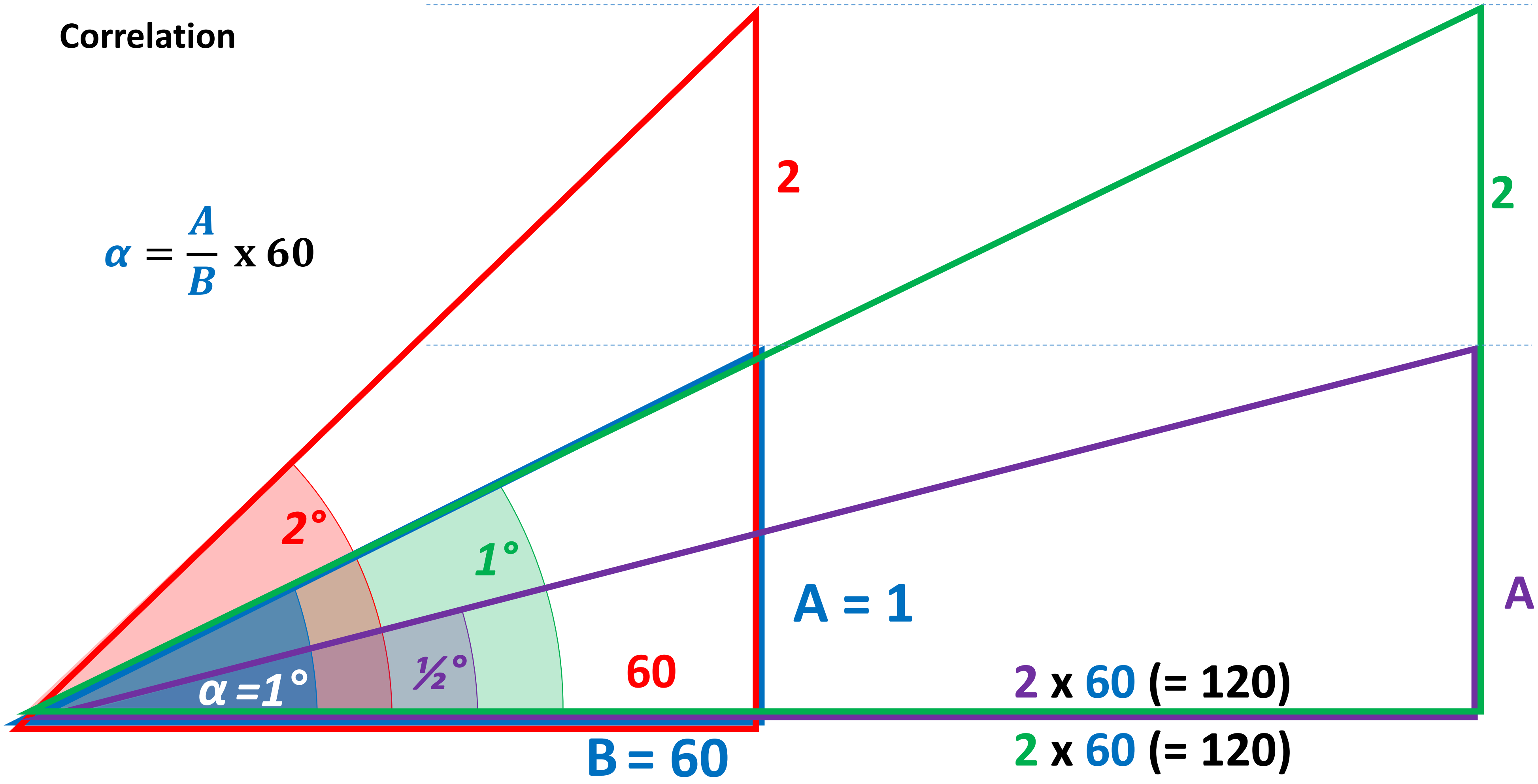
$$\% = \frac{\measuredangle}{3} \text{ x } 5$$

$$\measuredangle = \frac{\%}{100} \text{ x } 60$$

$$\measuredangle = \frac{\%}{5} \text{ x } 3$$

Correlation

$$\alpha = \frac{A}{B} \text{ x } 60$$



So for the same angle α, if the height A changes by a factor *n*, so the base B also changes by the same factor *n*.

$$\alpha = \frac{nA}{n\cancel{60}} \text{ x } \cancel{60}$$

$$eg.: 1° = \frac{\cancel{2}\text{x}1}{\cancel{2}\text{x}\cancel{60}} \text{ x } \cancel{60}$$

If the B=60, so the value of A is equal to the value of α. In this demonstration let's imagine that the initial angle α=1°, so A=1

This means that, for the same base if we multiply the height A by *n*, so α will also be multiplied by *n* (α is directly proportional to A)

$$n\alpha = \frac{nA}{\cancel{60}} \text{ x } \cancel{60}$$

$$eg.: 2° = \frac{2\text{x}1}{\cancel{60}} \text{ x } \cancel{60}$$

For the same height A., if we change the base B = 60 by *n*, α will be divided by *n* (α is inversely proportional to B)

$$\frac{\alpha}{n} = \frac{A}{n\cancel{60}} \text{ x } \cancel{60}$$

$$eg.: ½° = \frac{1}{2\text{x}\cancel{60}} \text{ x } \cancel{60}$$

1 Nm = 6080 ft

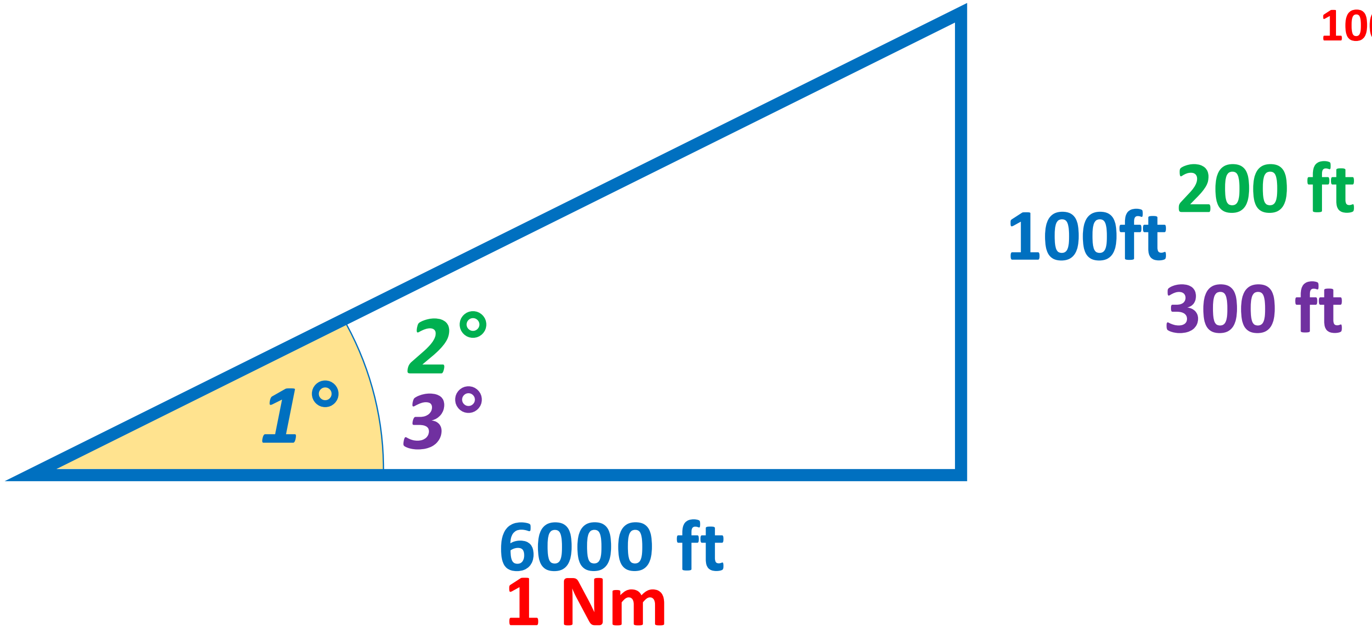
Angle of Descent

We will apply the Rule of Thumb to calculate an angle of descent

If for 1° angle of descent, we need to descent 1 ft of height every 60 ft of ground distance, so we need to descent 100 ft of height every 6000 ft of ground distance.

However the forward distances are expressed in Nautical Mile.

Remember, 1 Nm is approximately equal to 6080 ft, however for the purpose of this demonstration we will assume that 1 Nm is approximately equal to 6000 ft



This is ideal because it means that you need to descent :

100 ft per 1° angle of descent per 1 Nautical Mile

100 ft / 1° / 1 Nm

200 ft / 2° / 1 Nm

300 ft / 3° / 1 Nm

Top of Descent (TOD)

Since we know that we descent

100 ft per 1° angle of descent per 1 Nautical Mile

So we can easily calculate the minimum distance at which we should start to descent at a given angle of descent (∡) to intercept a point at a given altitude

The descents are usually made at **3°** angle, so we should:

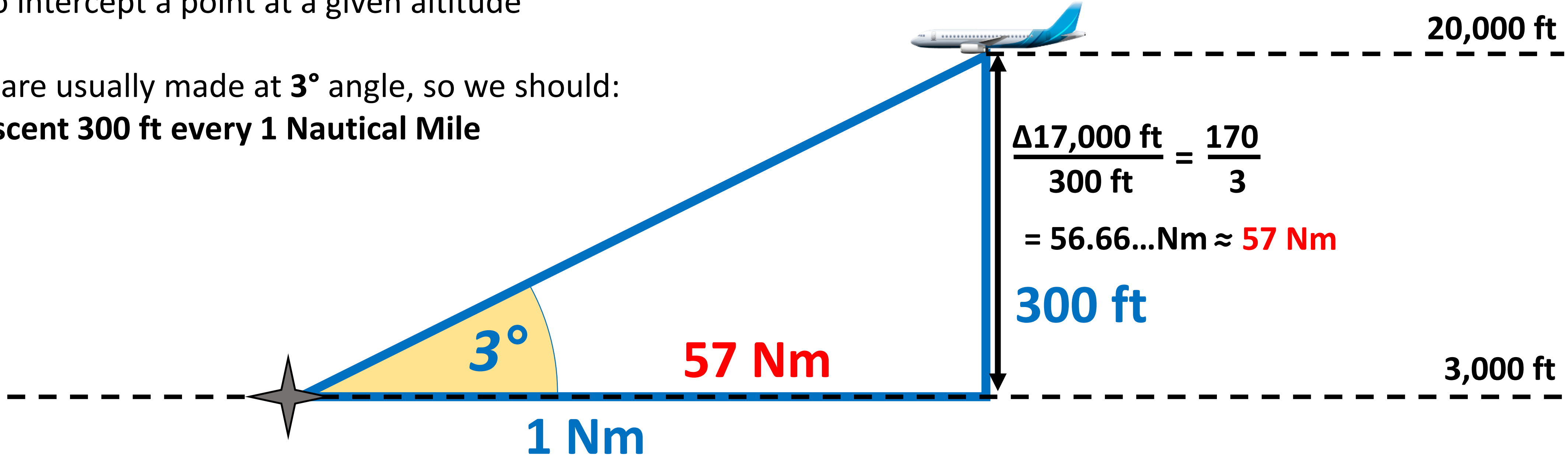
Descent 300 ft every 1 Nautical Mile

We can deduce, for 3° angle of descent:

$$TOD\ (Nm) = \frac{\Delta\text{height to descent}}{300}$$

$$\boldsymbol{TOD\ (Nm) = \frac{\Delta\text{height to descent}/100}{3}}$$

Note:
For any other ∡, we replace 3 by the value of ∡



Let's suppose that we are at 20,000 ft and we need to descent to intercept a point at 3,000 ft. What the is the minimum distance from the point ✦ to commence descent?

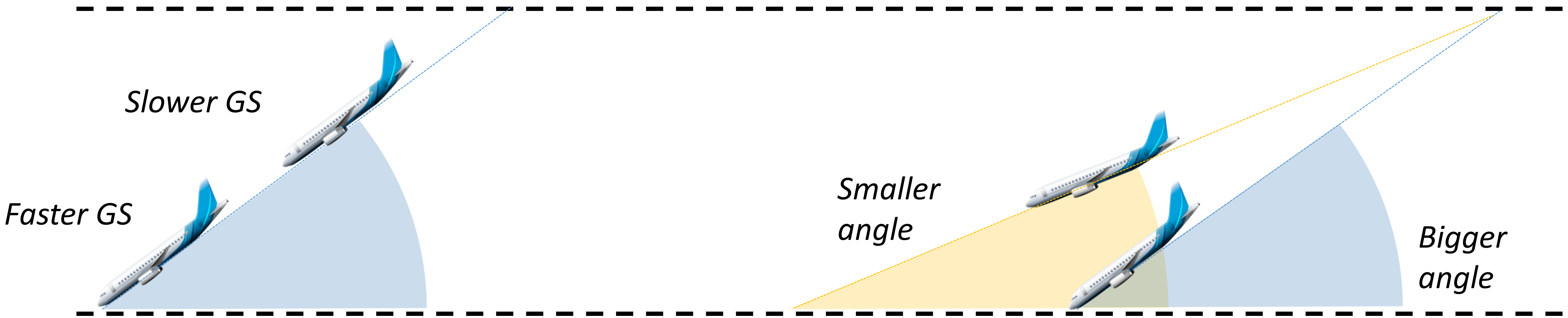
We have (20,000 – 3,000) = Δ17,000 ft of height to descent. If 300 ft are to be done in 1 Nm

So we should commence our descent not later than **57 Nm** from the point ✦

Rate of Descent (ROD) & Groundspeed (GS)

To maintain the angle of descent, we need to know which ROD we shall maintain

The ROD is a vertical speed expressed usually in feet per min (FPM). It is function of **angle of descent** and **GS**.



For the same angle of descent, the slower the GS and the slower the ROD

For the same GS, the smaller the angle of descent and the slower the ROD

ROD = Ground Gradient x GS

Rate of Descent (ROD) & Groundspeed (GS)

1 Nm = 6080 ft

ROD = Ground Gradient x GS

Only issue, it's that the **ROD** is in ***FPM***, and the **GS** in ***kt***, therefore we need to make a conversion

$$\frac{feet}{minutes} = \frac{Number}{100} \text{ x } \frac{Nm \text{ x } 6000\ feet}{hour \text{ x } 60\ minutes} = \frac{Number}{100} \text{ x } \frac{Nm}{hour} \text{ x } 100 = Number \text{ x } \frac{Nm}{hour}$$

ROD (FPM) = % x GS (kt)

Or

ROD (FPM) = $\frac{4}{3}$ x 5 x GS (kt)

Remember

$$\% = \frac{4}{3} \text{ x } 5$$

Demonstration

$$\text{ROD (FPM)} = \% \times \text{GS (kt)}$$

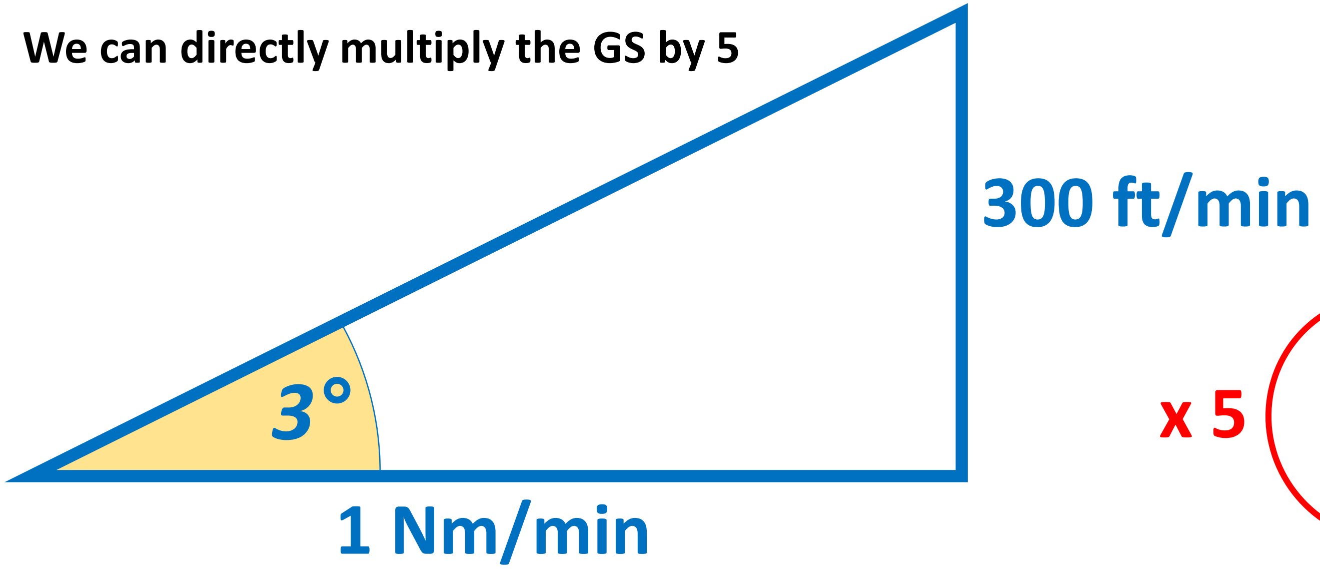
Or

$$\text{ROD (FPM)} = \frac{\cancel{4}}{3} \times 5 \times \text{GS (kt)}$$

For a typical 3° angle of descent

$$\text{ROD (FPM)} = \frac{\cancel{3}}{\cancel{3}} \times 5 \times \text{GS (kt)}$$

We can directly multiply the GS by 5



Examples:

An Airbus A320 with an approach GS 120 kt, for 3° angle of descent, what is the ROD to be maintained?

120 kt = 120 Nm/h = 2 Nm/min

If in 1 min we cover 2 Nm, so in 1 min we need to descent 600 ft

x 5

So for 3° angle, we must maintain a ROD of **600 ft/min**

An Tecnam P2006T with an approach GS 90 kt, for 3° angle of descent, what is the ROD to be maintained?

90 kt = 90 Nm/h = 1.5 Nm/min

If in 1 min we cover 1.5 Nm, so in 1 min we need to descent 450 ft

x 5

So for 3° angle, we must maintain a ROD of **450 ft/min**

Fluctuations

We saw that, to obtain the ROD to maintain for a given angle, we simply multiply the gradient by the GS. However if the GS is fluctuating, this can become an issue and it is not convenient to recalculate the new ROD to be maintained.

Let's imagine we are descending at 3° angle of descent with a GS 120 kt

ROD (FPM) = 5 x GS (kt) = 5 x 120 = 600 FPM

- 25 = (-5) x 5

Now imagine that we experience a **loss of 5 kt** in the GS (GS = 115 kt)

ROD (FPM) = 5 x GS (kt) = 5 x 115 = 575 FPM

Our ROD has **decreased by 25 ft/min**.
Which is actually the result of the GS (115 kt) fluctuation multiplied by the gradient (5%)

+ 50 = (+10) x 5

Now imagine that we experience a **gain of 10 kt** in the GS (GS = 125 kt)

ROD (FPM) = 5 x GS (kt) = 5 x 125 = 625 FPM

Our ROD has **increased by 50 ft/min**.
Which is actually the result of the GS (125 kt) fluctuation multiplied by the gradient (5%)

So when the GS fluctuates, simply multiply the fluctuation by the gradient, to obtain the adjustment to make to the actual ROD.

Other

We saw that the typical approach angle of descent is 3°, also in you career you will encounter many times an approach angle of descent of 3.3°

$$\text{ROD (FPM)} = \frac{\not{4}}{3} \times 5 \times \text{GS (kt)}$$

For 3.3° angle of descent

$$\text{ROD (FPM)} = \frac{\color{red}{3.3}}{3} \times 5 \times \text{GS (kt)} = 1.1 \times 5 \times \text{GS (kt)}$$

$$\text{ROD (FPM)} = 5 \times \text{GS (kt)} + 10\%$$

This means that for 3.3° approach angle of descent, you can simply multiply the GS by 5, and add 10% to the result to obtain the ROD to be maintained.

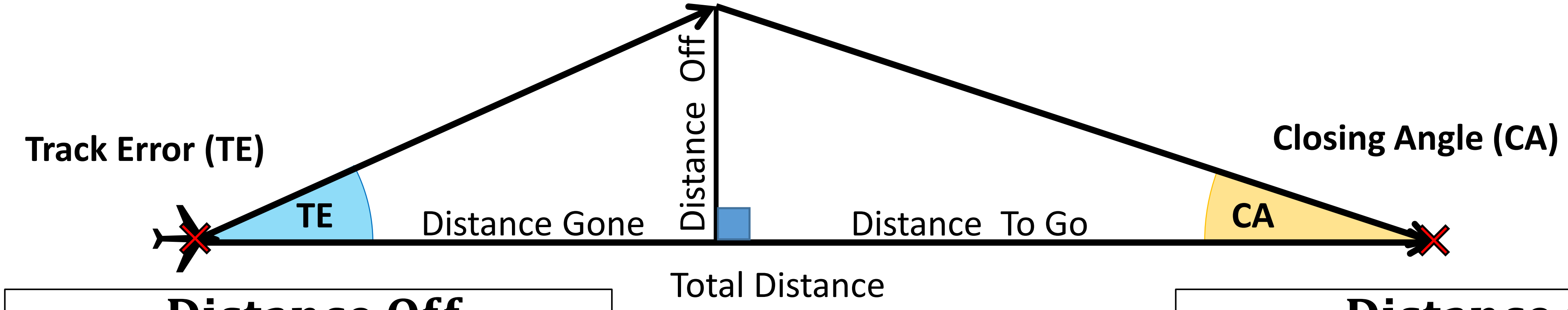
Examples:

Let's imagine we are descending at 3.3° angle of descent with a GS 120 kt

ROD (FPM) = 5 x GS (kt) + 10% = (5 x 120) + 60 = 600 + 60 = 660 FPM

Note: *On some Vertical Speed Indicators, the ROD is shown in hundredths (5, 6, 7 etc). In this case you will not be able to see 660 FPM, so you will have to "play" between 6 (600 FPM) and 7 (700 FPM).*

Change Of Direction



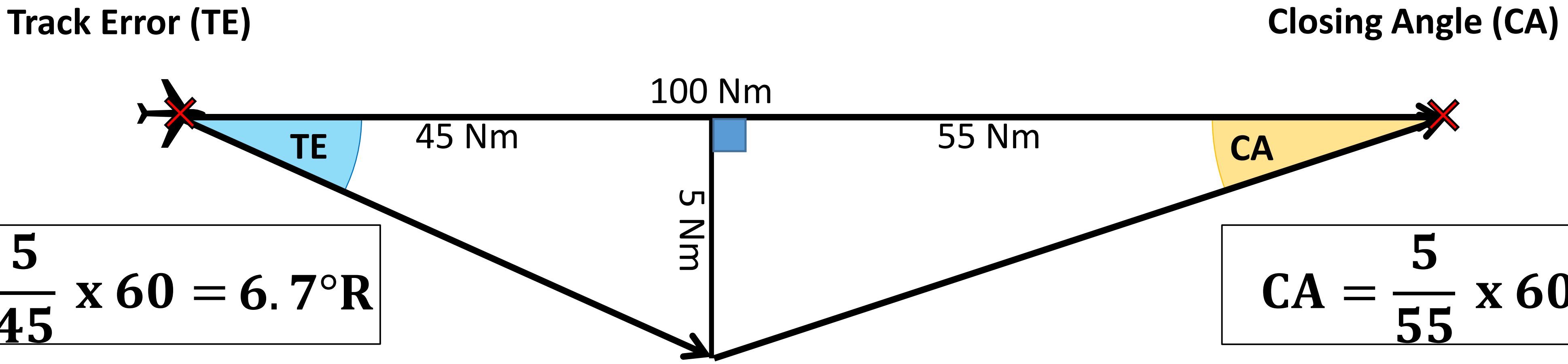
$$TE = \frac{\text{Distance Off}}{\text{Distance Gone}} \times 60$$

$$CA = \frac{\text{Distance Off}}{\text{Distance To Go}} \times 60$$

$$\text{Change of Direction} = TE + CA$$

Change Of Direction

On a easterly route of 100 Nm, you find yourself 5 Nm south of track after 45 Nm.
What is the change of direction to reach the next point?



$$\mathbf{TE} = \frac{\mathbf{5}}{\mathbf{45}}\ \mathbf{x\ 60} = \mathbf{6.7°R}$$

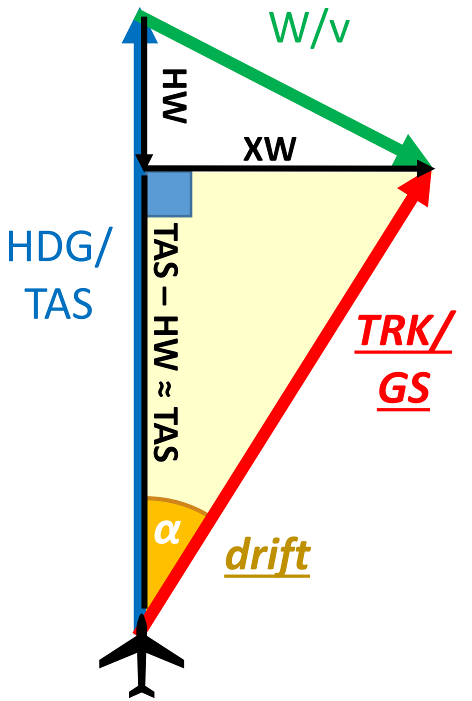
$$\mathbf{CA} = \frac{\mathbf{5}}{\mathbf{55}}\ \mathbf{x\ 60} = \mathbf{5.45°L}$$

$$\mathbf{Change\ of\ Direction} = \boldsymbol{TE} + \boldsymbol{CA} = \mathbf{6.7} + \mathbf{5.45} = \mathbf{12°L}$$

(If Triangle of Velocity covered)

Quick calculation for the drift calculation by Rule of Thumb:

Since the accuracy will vary only by fractions of degrees, we can therefore calculate the approximate full degree of drift with the Rule of Thumb, and by assuming a triangle rectangle between the TAS and the XW



$$\boldsymbol{drift = \frac{XW}{TAS} \text{ x } 60}$$

$$drift = \frac{Ws \text{ x } \sin \alpha}{TAS} \text{ x } 60$$

$$\boldsymbol{drift = \frac{Ws}{TAS} \text{ x } 60 \text{ x } \sin \alpha}$$

To determine the approximate value of the sinus, we can use the clock angle:

sin 0° = 0 → 0

sin 15° ≈ 0.25 → ¼

sin 20° ≈ 0.33… → ⅓

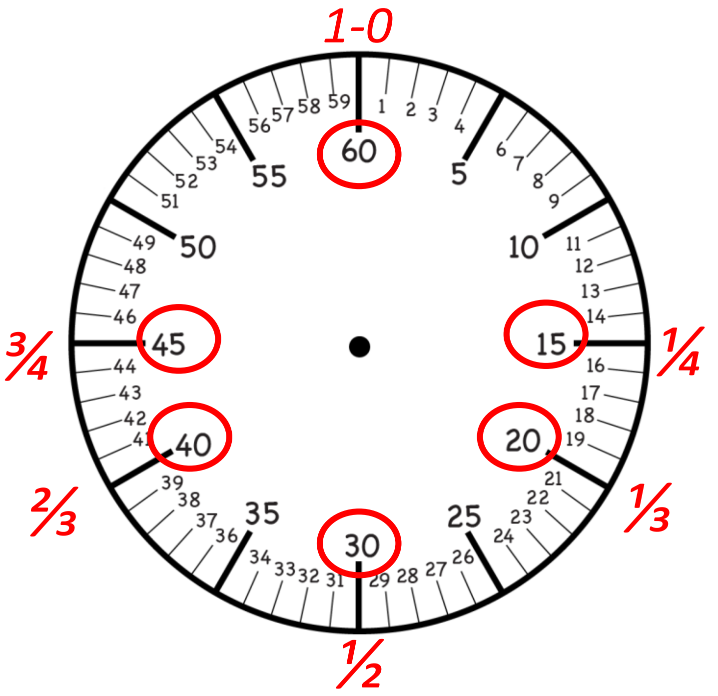
sin 30° = 0.5 → ½

sin 40° ≈ 0.66… → ⅔

sin 45° ≈ 0.75 → ¾

sin 60° ≈ 1 → 1

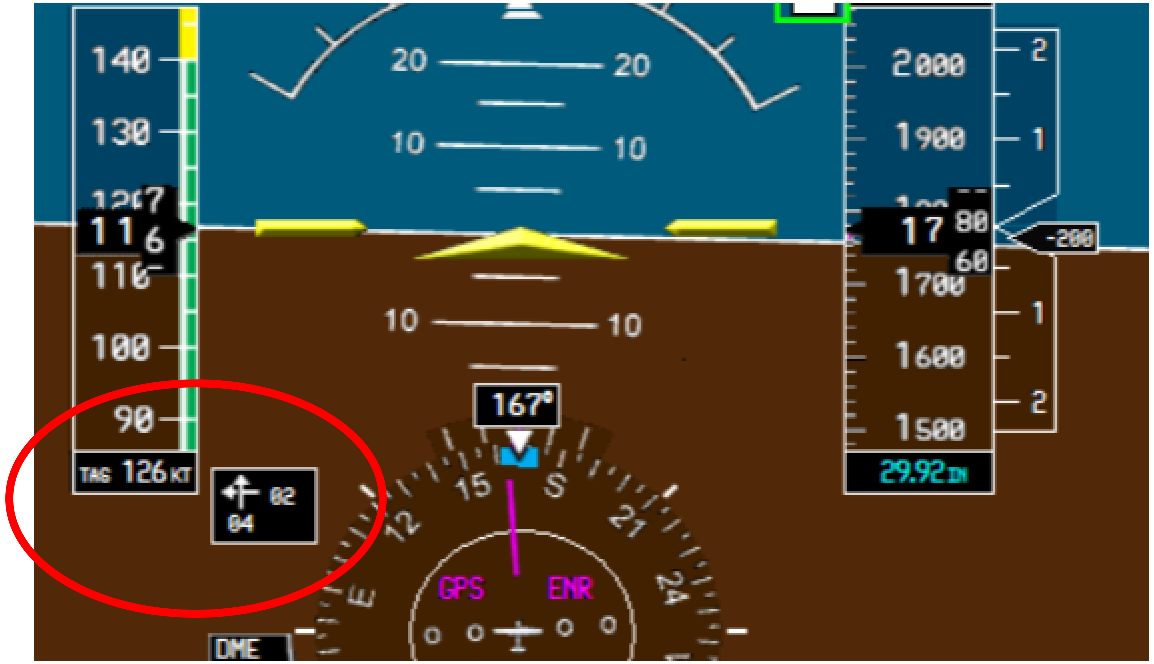
***Note**: If you can calculate SIN, you can also calculate COS:*
cos α = sin (90 – α)



Example: 20 x sin 40 = "20 x 40minutes" = "20 x 2/3 hour" ≈ 20 x 2/3 ≈ 13°

(If Triangle of Velocity covered)
Quick adaptation

On the G1000, it exists an option that could display the XW directly:



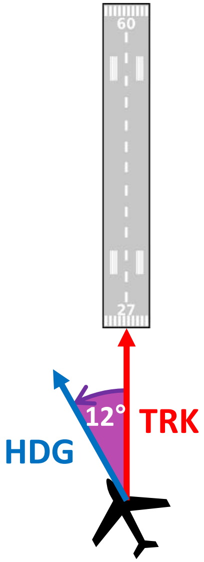
So the following equation can be used

$$drift = \frac{XW}{TAS} \text{ x } 60$$

In this example

$$drift = \frac{2}{126} \text{ x } 60 \approx \frac{60}{120} \text{ x } 2$$

$$drift \approx 1°L$$



You can always improve the calculation method when you know your aircraft

For example, the Tecnam P2006T (which is equipped with G1000), has typical approach speed of 90 KTAS:

$$drift\ during\ approach = \frac{XW}{90} \text{ x } 60 = \frac{60}{90} \text{ x } XW$$

$$drift\ during\ approach = 2/3\ of\ XW$$

*So for example during approach with a Tecnam 2006T, if you see XW=19 kt to the right, so the **WCA** to keep tracking the runway centerline will be 2/3 of 19 which is **approximately 12° to the left.***