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1. The 1 in 60 Rule — Concept & Application

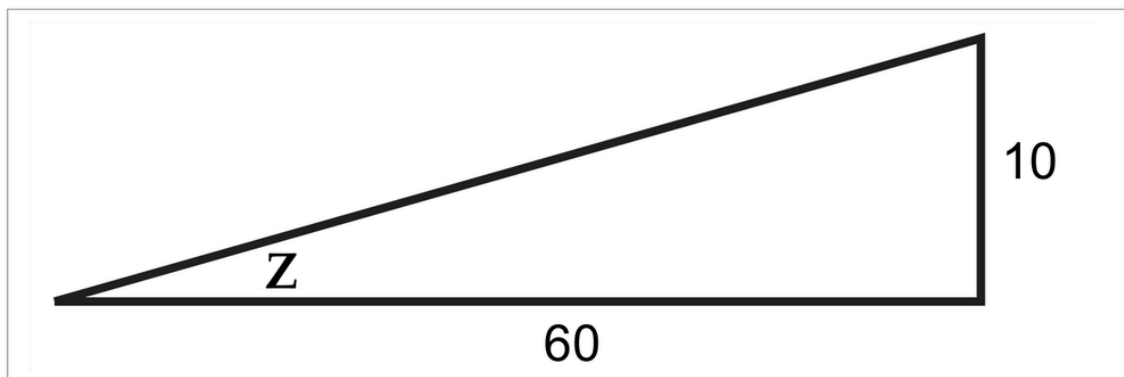
➔ The Core Idea

For any angle up to about **20°**, if the adjacent side of a right-angled triangle is **60 units long**, then the length of the opposite side (in the same units) is *numerically equal* to the angle in degrees.

In flight: if you have travelled **60 NM** along-track and you are **N NM** off-track, your track error angle is approximately **N degrees**.

Figure 10.1

Now raise a perpendicular at one end, exactly 10 mm high, and join them with a hypotenuse:



The 1 in 60 Rule
10

Figure 1 — The 1 in 60 Rule — a right-angled triangle with an adjacent side of 60 units: the angle z° equals the opposite side in the same units

This is an enormously useful tool for in-flight calculations, removing the need for a protractor. The rule works because:

- When the adjacent = 60, $\tan(z^\circ) \approx z/60$ for small angles (up to $\sim 20^\circ$)
- Equivalently: one *radian* = $57.3^\circ \approx 60^\circ$ for this approximation

2. Measuring Angles in Flight

Suppose you are flying on a planned track of **100°(T)**. After **60 NM** from your last on-track fix, you identify a ground feature that is **4 NM right of track**.

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✎ Applying the rule directly:

Adjacent = 60 NM, Opposite = 4 NM → **Track Error Angle = 4°** right

Your Track Made Good (TMG) = $100^\circ + 4^\circ = \mathbf{104^\circ(T)}$

No protractor needed — simply read off the angle from the numbers. The next chapter covers what to do once you have the error angle.

3. Geometry of the 1 in 60 Rule — The Radian Derivation

Why does this rule work? The key lies in the definition of a **radian**.

Imagine a circle of 1 metre radius.

What is the formula to calculate the circumference?

Circumference = $2 \pi r$

Taking π as 3.142, which is close enough for our purposes, then the

circumference = $2 \times 3.142 \times 1 = 6.284$ metres.

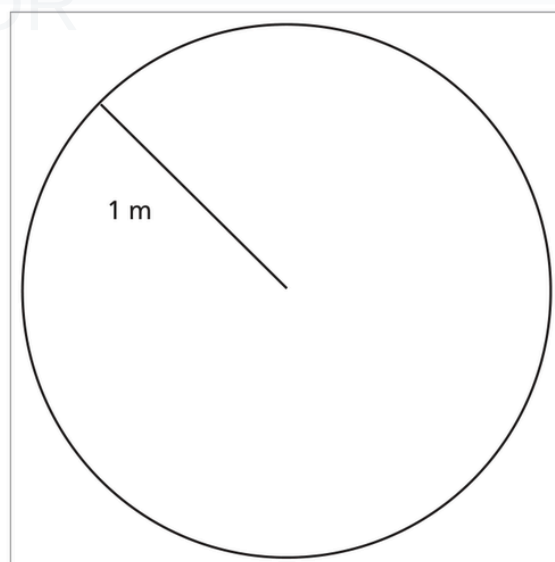


Figure 2 — A circle of 1 metre radius — travelling 1 metre along the circumference subtends angle θ at the centre

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The 1 in 60 Rule

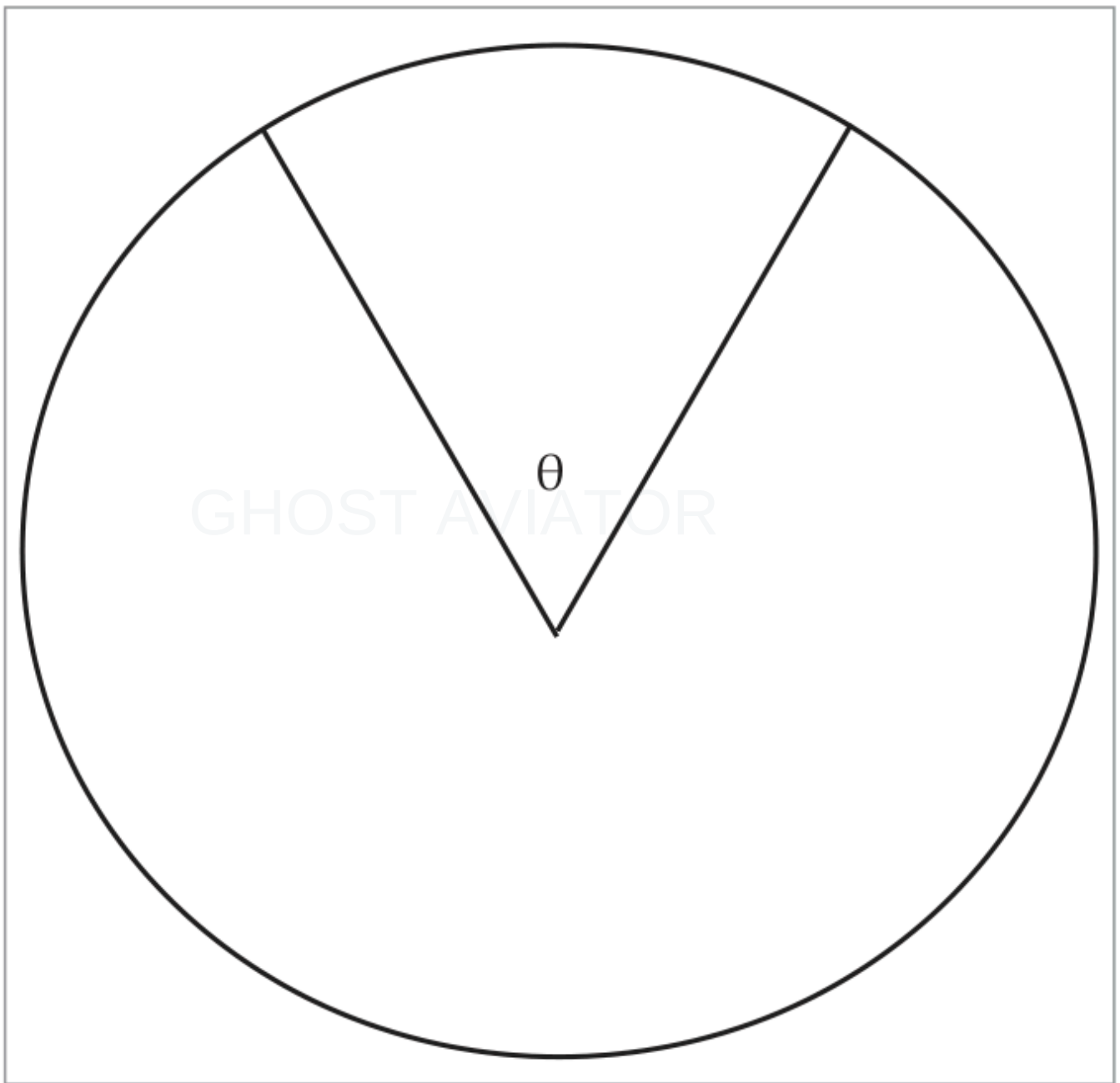


Figure 3 — The arc of 1 metre on a unit circle subtends $\theta = 57.3^\circ$ at the centre (1 radian)

The Radian Calculation

Step-by-step derivation

Circle circumference: $2\pi r = 2 \times 3.142 \times 1 = \mathbf{6.284\text{ m}}$

Full circle = 360° corresponds to 6.284 m of arc

1 metre of arc corresponds to θ , where: $\theta/1 = 360^\circ/6.284 \rightarrow \mathbf{\theta = 57.3^\circ}$

Scaling: This ratio holds for any circle radius — 57.3° always corresponds to an arc = radius

Rounding: $57.3 \rightarrow \mathbf{60}$ (introduces ~5% error — acceptable for flight calculations)

📖 Why 60 and not 57.3?

Strictly, this should be the "1 in 57.3 rule". But 57.3 is awkward for mental arithmetic at high workload in the cockpit. Rounding to **60** introduces only ~5% error, which is perfectly acceptable for navigation.

4. The Tangent Explanation

An alternative derivation shows why the rule works for a flat right-angled triangle (rather than an arc).

Let's see how it is as follows:

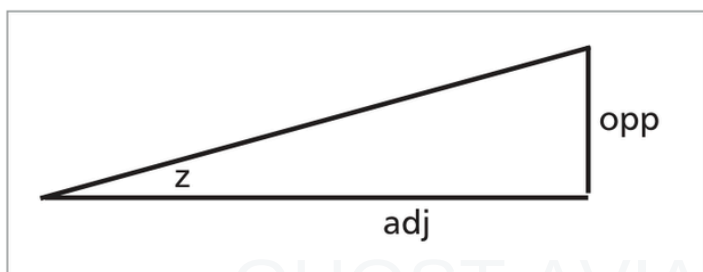


Figure 4 — Right-angled triangle with angle z — adjacent, opposite, and hypotenuse

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The 1 in 60 Rule

z	1	2	5	10	15	20
$\tan z$	.017	.035	.087	.176	.268	.364

Figure 5 — Tangent table: values of $\tan z$ for angles 1° to 20°

z	1	2	5	10	15	20
tan z	.017	.035	.087	.176	.268	.364
60 tan z	1.02	2.1	5.22	10.56	16.08	21.84

Figure 6 — Expanded table: $60 \times \tan z$ compared with z — showing the close numerical correlation

The Tangent Table

Angle z	1°	2°	5°	10°	15°	20°
tan z	0.017	0.035	0.087	0.176	0.268	0.364
60 × tan z	1.02	2.10	5.22	10.56	16.08	21.84

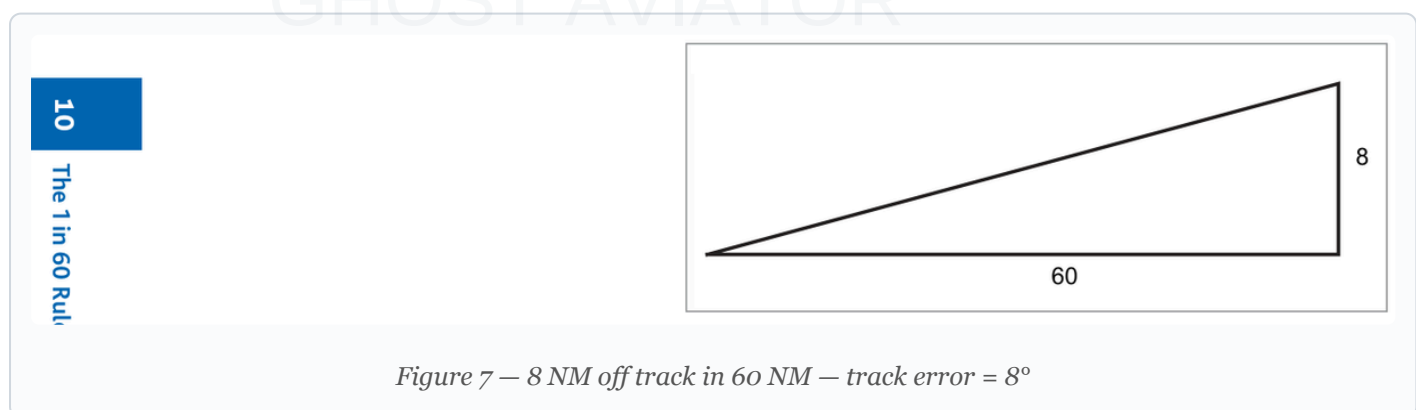
Up to about **10°**, the correlation between angle z and $60 \times \tan z$ is excellent (within 1%). Above 15°–20° the error grows, but in practice you should rarely need the rule for angles that large.

⚠ Validity Limit

The 1 in 60 rule is acceptably accurate for angles up to **~20°**. Above this, the tangent relationship becomes significantly non-linear. For track errors larger than 20°, use the nav computer or trigonometry.

5. Expanding or Contracting the Triangle

Fixes don't always occur at exactly 60 NM intervals. The 1 in 60 rule can be adapted for any along-track distance using the principle of **similar triangles**.



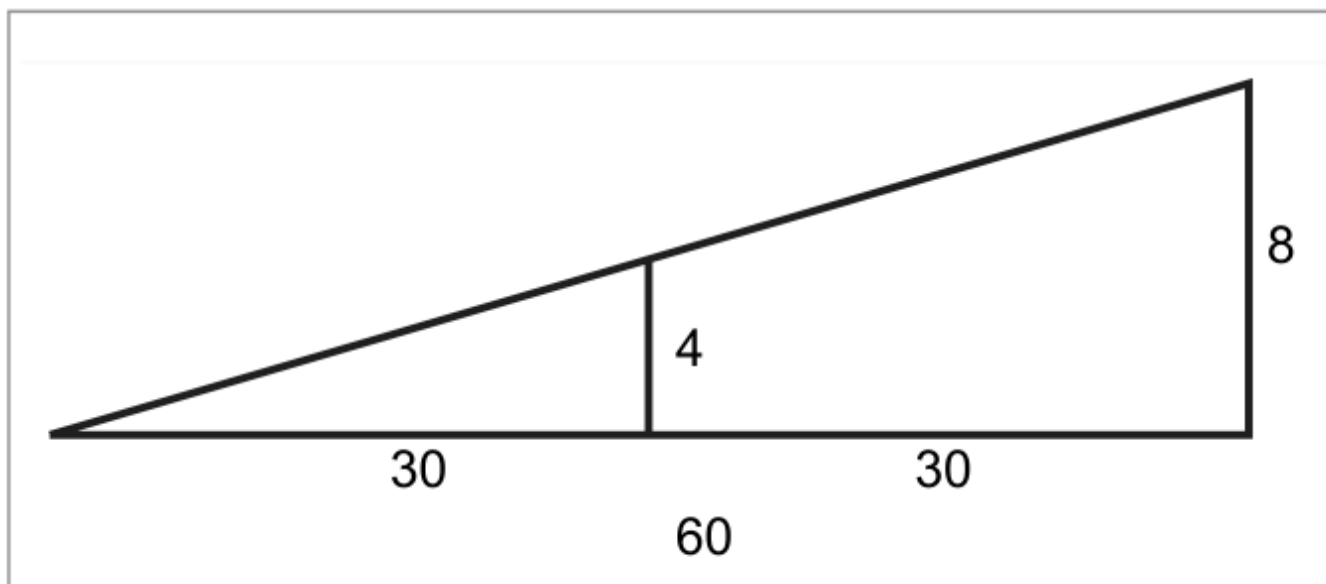


Figure 8 — Same 8° track error at 30 NM along-track gives only 4 NM off track — similar triangles

✂ Scale the Cross-Track Distance

For a given track error angle, the cross-track error scales proportionally with along-track distance:

- 4 NM off in 30 NM = 8 NM off in 60 NM → track error = **8°**
- 10 NM off in 120 NM = 5 NM off in 60 NM → track error = **5°**

6. The Formula & Worked Applications

Track Error Angle

$$z = (\text{Distance Off} / \text{Distance Gone}) \times 60$$

$$\text{Or rearranged: Distance Off} = (z \times \text{Distance Gone}) / 60$$

Applications

Use case	Known	Find	Formula
Track error angle	Distance off, distance gone	Angle z	$z = (\text{off} / \text{gone}) \times 60$
Cross-track distance	Angle z, distance gone	Distance off	$\text{off} = (z \times \text{gone}) / 60$
Along-track distance	Angle z, distance off	Distance gone	$\text{gone} = (\text{off} \times 60) / z$
Glide slope height	GS angle, range	Height	$H = (\text{angle} \times \text{range_ft}) / 60$
Glide slope range	GS angle, height	Range	$\text{range_ft} = (H \times 60) / \text{angle}$

✈️ TMG vs Track Error

Track Made Good (TMG) = planned track $\pm$ track error angle

If aircraft is **left** of track: TMG = planned track – error (track is less than planned)

If aircraft is **right** of track: TMG = planned track + error (track is more than planned)

🔪 Glide Slope Worked Example

GS angle 3°, range 2 NM (1 NM = 6 000 ft):

Range = $2 \times 6\,000 = 12\,000$ ft

Height = $(3 \times 12\,000) / 60 = \mathbf{600\text{ ft}}$

GS angle 2.5°, height 1 000 ft QFE (1 NM = 6 000 ft):

Range (ft) = $(1\,000 \times 60) / 2.5 = 24\,000$ ft

Range (NM) = $24\,000 / 6\,000 = \mathbf{4\text{ NM}}$

📖 Quick Revision — Chapter 10

- Core rule: adjacent = **60** → opposite (numerically) = angle in degrees
- Formula: **$z = (\text{off} / \text{gone}) \times 60$**
- Left of track → TMG = planned – z; Right → TMG = planned + z
- Valid up to **~20°**; 5% error from using 60 instead of 57.3
- Closing angle to destination: same formula using distance from destination
- Glide slope: $H(\text{ft}) = (\text{GS angle} \times \text{range_ft}) / 60$

Practice Questions & Detailed Answers

12 calculation questions • Track error, TMG, glide slope, closing angle • Full worked solutions

Q1. You are flying from A to B. Position: 60 NM outbound from A, 7 NM left of track. Track error angle?

Anchor: [§6 – Formula](#)

Answer: 7° Left

$z = (7 / 60) \times 60 = 7^\circ$ left. At exactly 60 NM, the formula simplifies directly — the off-track distance IS the angle.

Instructor's Note: Source key: 7°L. Verified.

Q2. Flying C to D. Position: 120 NM outbound, 8 NM right of track. Track error angle?

Anchor: [§6 – Formula](#)

Answer: 4° Right

$z = (8 / 120) \times 60 = 4^\circ$ right.

At 120 NM, halve the off-track distance to get the angle: $8 \div 2 = 4^\circ$.

Instructor's Note: Source key: 4°R. Verified.

Q3. Flying E to F. Position: 90 NM outbound, 6 NM right of track. Track error angle?

Anchor: [§6 – Formula](#)

Answer: 4° Right

$z = (6 / 90) \times 60 = 360 / 90 = 4^\circ$ right.

At 90 NM, multiply off-track by 2/3: $6 \times (60/90) = 4^\circ$.

Instructor's Note: Source key: 4°R. Verified.

Q4. Flying G to H. Position: 30 NM outbound, 4 NM left of track. Track error angle?

Anchor: [§6 – Formula](#)

Answer: 8° Left

$z = (4 / 30) \times 60 = 240 / 30 = 8^\circ$ left.

At 30 NM (half of 60), double the off-track: $4 \times 2 = 8^\circ$.

Instructor's Note: Source key: 8°L. Verified.

Q5. Flying J to K, planned track 045°(T). Position: 80 NM outbound, 4 NM left of track. Track Made Good?

Anchor: [§6 – Formula](#)

Answer: 042°(T)

Step 1 — Track error angle: $z = (4 / 80) \times 60 = 3^\circ$

Step 2 — Apply: Aircraft is left of track, so TMG < planned.

TMG = $045^\circ - 3^\circ = 042^\circ(T)$

Instructor's Note: Source key: 042°(T). Verified.

Q6. Flying L to M, planned track 220°(T). Position: 45 NM outbound, 3 NM right of track. Track Made Good?

Anchor: [§6 – Formula](#)

Answer: 224°(T)

Step 1 — Track error: $z = (3 / 45) \times 60 = 4^\circ$

Step 2 — Apply: Aircraft is right of track, so TMG > planned.

TMG = $220^\circ + 4^\circ = 224^\circ(T)$

Instructor's Note: Source key: 224°(T). Verified.

Q7. Flying N to P, planned track $315^\circ(\text{T})$. Position: 40 NM outbound, 6 NM left of track. Track Made Good?

Anchor: [§6 – Formula](#)

Answer: $306^\circ(\text{T})$

Step 1 — Track error: $z = (6 / 40) \times 60 = 9^\circ$

Step 2 — Apply: Aircraft is left of track, so $\text{TMG} < \text{planned}$.

$\text{TMG} = 315^\circ - 9^\circ = \mathbf{306^\circ(\text{T})}$

Instructor's Note: Source key: $306^\circ(\text{T})$. Verified.

Q8. A surveyor stands 660 metres from a mast and measures an elevation angle of 4° to the top. What is the height of the mast?

Anchor: [§6 – Formula](#)

Answer: 44 metres

Distance off: $H = (z \times \text{distance}) / 60 = (4 \times 660) / 60 = 2\,640 / 60 = \mathbf{44\,m}$

The surveyor's 660 m horizontal distance is the 'adjacent' and the mast height is the 'opposite'.

Instructor's Note: Source key: 44 m. Verified.

Q9. Instrument approach, glide slope 3.00° , exactly 2 NM from touchdown. What height should you be passing? (Use 1 NM = 6 000 ft)

Anchor: [§6 – Formula](#)

Answer: 600 ft

Step 1 — Convert range to feet: $2\,\text{NM} \times 6\,000 = 12\,000\,\text{ft}$

Step 2 — Height: $H = (3 \times 12\,000) / 60 = 36\,000 / 60 = \mathbf{600\,ft}$

Instructor's Note: Source key: 600 ft. Verified.

Q10. Instrument approach, glide slope 2.5°, correctly on slope, passing 1 000 ft QFE. Range from touchdown? (1 NM = 6 000 ft)

Anchor: [§6 – Formula](#)

Answer: 4 NM

Step 1 — Find range in feet: $\text{range_ft} = (H \times 60) / \text{angle} = (1\,000 \times 60) / 2.5 = 60\,000 / 2.5 = 24\,000 \text{ ft}$

Step 2 — Convert to NM: $24\,000 / 6\,000 = \mathbf{4 \text{ NM}}$

Instructor's Note: Source key: 4 NM. Verified.

Q11. Flying Q to R, planned track 125°(T). Position: 40 NM from R, 2 NM left of track. What track must you fly to arrive overhead R?

Anchor: [§6 – Formula](#)

Answer: 128°(T)

Closing angle: $z = (2 / 40) \times 60 = 3^\circ$

Direction: Aircraft is left of track. To close onto R, turn right (increase track).

Track to R = $125^\circ + 3^\circ = \mathbf{128^\circ(T)}$

Note: When flying toward the destination with a closing angle, the correction adds to or subtracts from the planned track to point at R — not at a parallel offset.

Instructor's Note: Source key: 128°(T). Verified.

Q12. Flying S to T, planned track 272°(T). Position: 50 NM from T, 5 NM right of track. What track must you fly to arrive overhead T?

Anchor: [§6 – Formula](#)

Answer: 266°(T)

Closing angle: $z = (5 / 50) \times 60 = 6^\circ$

Direction: Aircraft is right of track. To close onto T, turn left (decrease track).

Track to T = $272^\circ - 6^\circ = \mathbf{266^\circ(T)}$

Instructor's Note: Source key: 266°(T). Verified.

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Master Reference Tables — Chapter 10

The 1 in 60 Formulae

Find	Formula	Notes
Track error angle	$z = (\text{off} / \text{gone}) \times 60$	z in degrees
Cross-track distance	$\text{off} = (z \times \text{gone}) / 60$	Units consistent
Along-track distance	$\text{gone} = (\text{off} \times 60) / z$	—
Glide slope height (ft)	$H = (\text{angle} \times \text{range_ft}) / 60$	1 NM = 6 000 ft for calcs
Glide slope range (ft)	$\text{range_ft} = (H \times 60) / \text{angle}$	Then ÷ 6 000 for NM

Key Facts

Parameter	Value
Exact value (radians)	57.3°
Practical approximation	60° (~5% error)
Valid angle range	up to $\sim 20^\circ$
Left of track → TMG	planned – error (TMG less than planned)
Right of track → TMG	planned + error (TMG more than planned)
Closing angle (left)	planned + closing angle
Closing angle (right)	planned – closing angle

Answer Key — No 🚩 Flags

Q	1	2	3	4	5	6	7	8	9	10	11	12
Ans	7°L	4°R	4°R	8°L	042°T	224°T	306°T	44 m	600 ft	4 NM	128°T	266°T

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