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1. A Reminder about Great Circles

Definition

A **Great Circle** is a circle on the surface of the Earth whose **centre and radius are those of the Earth itself**. It is called "great" because a disc cut in the plane of the Great Circle would have the largest area achievable — it divides the Earth into two equal hemispheres.

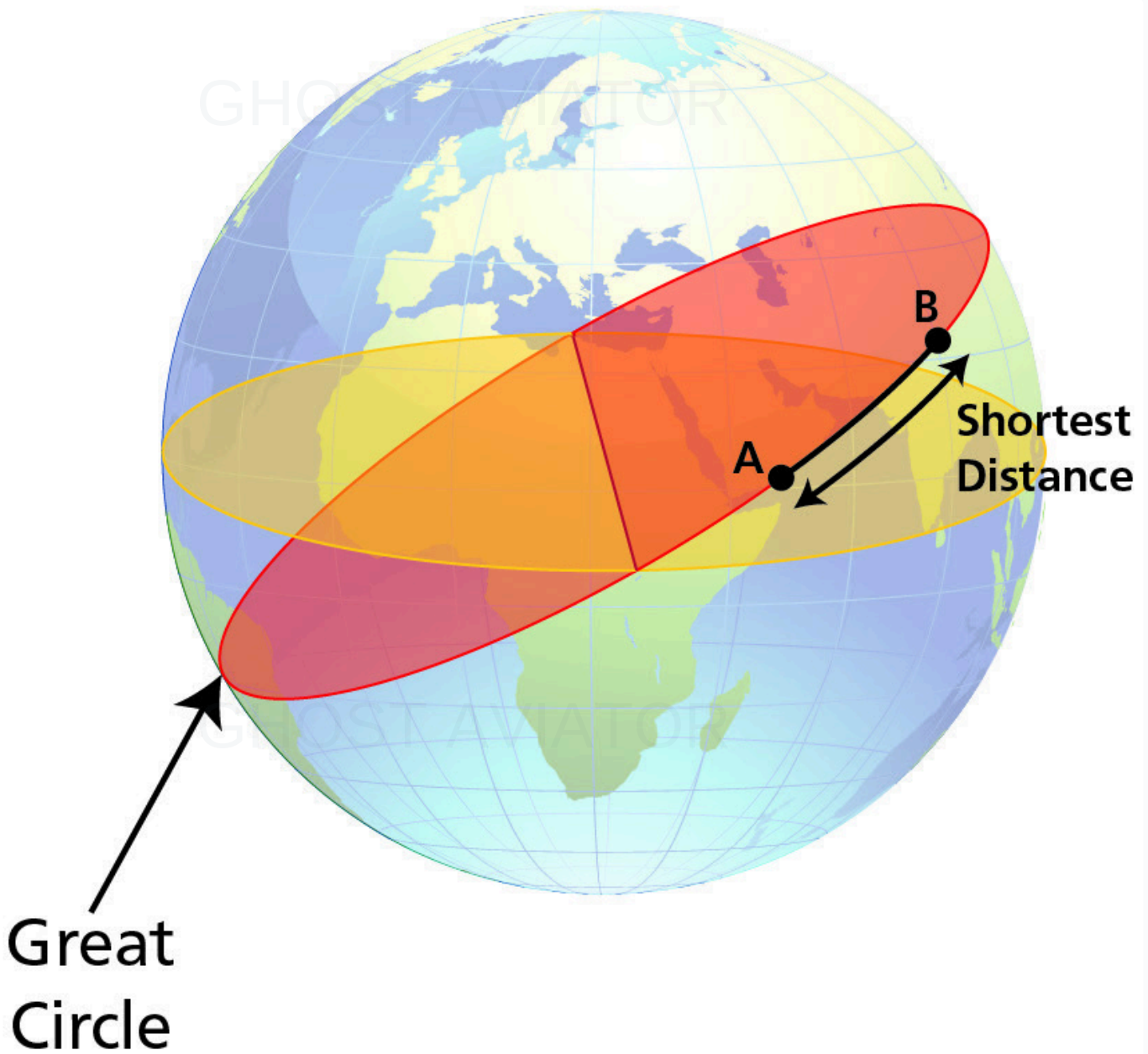


Figure 1 — A Great Circle — its centre and radius are those of the Earth itself

Key properties:

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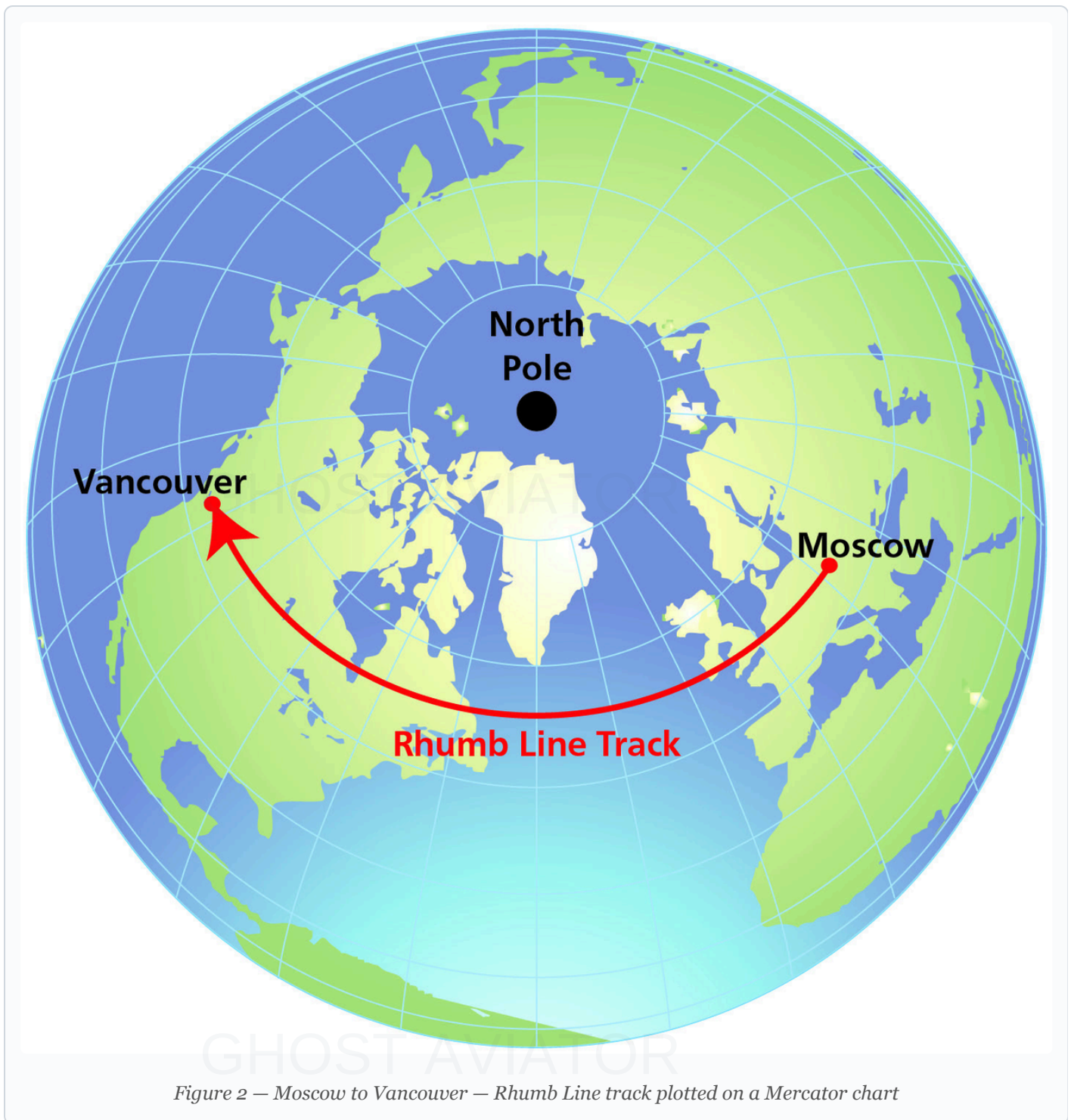
- **Shortest distance** — the shorter arc of the Great Circle joining two points is the shortest path between them on the Earth's surface.
- **Uniqueness** — given two non-antipodal points, only *one* Great Circle joins them.
- **Changing direction** — a Great Circle track changes direction continuously relative to True North (except along a meridian or the Equator).

2. The Rhumb Line — Definition & Properties

Definition

A **Rhumb Line** is a regularly curved line on the surface of the Earth that **cuts all meridians at the same angle** — a line of constant direction.

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The constant-direction property was enormously important to mariners and early aviators, who navigated by compass heading along straight Mercator chart tracks. Unlike the Great Circle, the Rhumb Line is *not* the shortest distance (except along the Equator, a meridian, or a parallel of latitude).



Figure 3 — Moscow to Vancouver — Great Circle track; note how it swings close to the North Pole

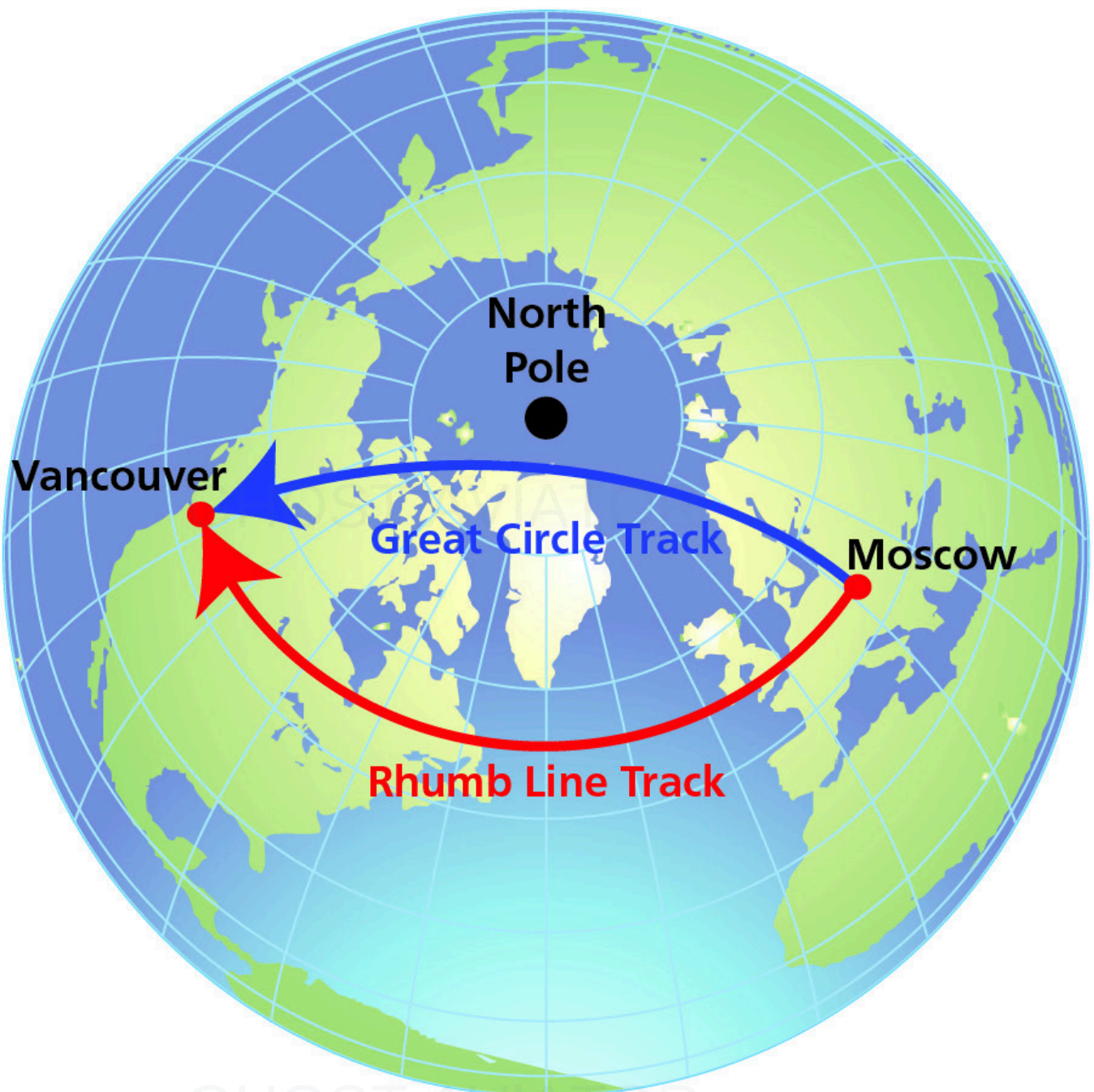
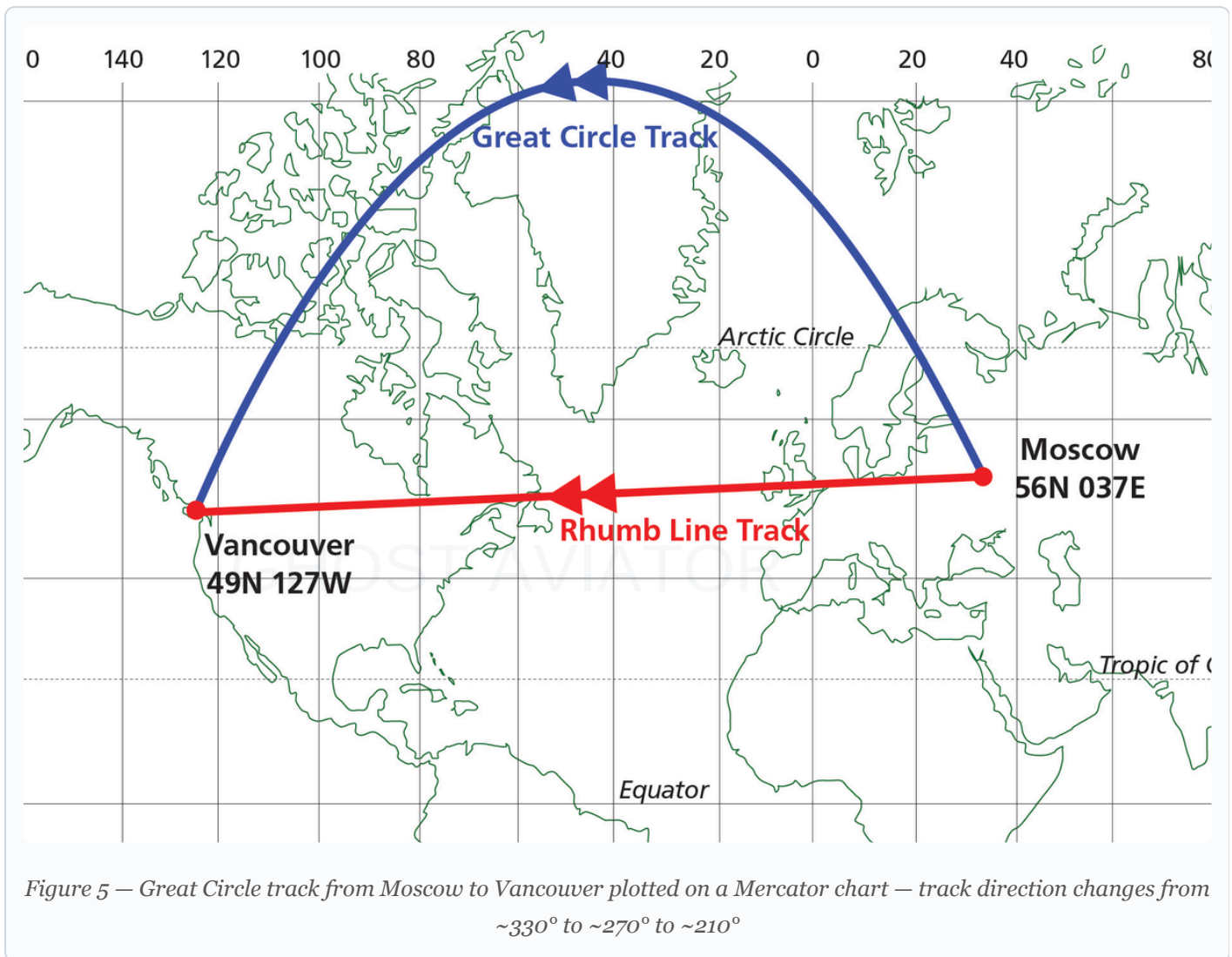


Figure 4 — Moscow to Vancouver — Great Circle track (curved, shorter) compared with Rhumb Line (straight, longer)

The Great Circle is always the **shorter** path; the Rhumb Line is always the **longer** one (again, except for the special cases — Equator, meridians).



GC vs Rhumb Line — Relative Position

⚠ Critical Exam Rule

- The **Great Circle** between any two points always lies nearer to the nearer Pole than the Rhumb Line.
- The **Rhumb Line** always lies nearer to the Equator than the Great Circle.
- In some textbooks: the Rhumb Line is described as *convex to the Equator* or *concave to the nearer Pole*.

There is only one Rhumb Line between any two points.

3. Lines That Are Both Great Circles and Rhumb Lines

➔ The Only Two Types

The only lines that are simultaneously Great Circles AND Rhumb Lines are:

- **The Equator** — cuts all meridians at 90° (Rhumb Line property) AND its plane passes through the Earth's centre (Great Circle property).
- **Any Meridian** (plus its anti-meridian) — a line of constant direction (0° or 180°) AND a semi-Great Circle.

Note: Parallels of latitude (other than the Equator) are Rhumb Lines but are *Small Circles* — their plane does not pass through the Earth's centre.

4. Great Circle Direction — The DIID Rule

Because a Great Circle track curves toward the nearer Pole, its direction changes continuously. The pattern of this change is captured in the **DIID rule**.

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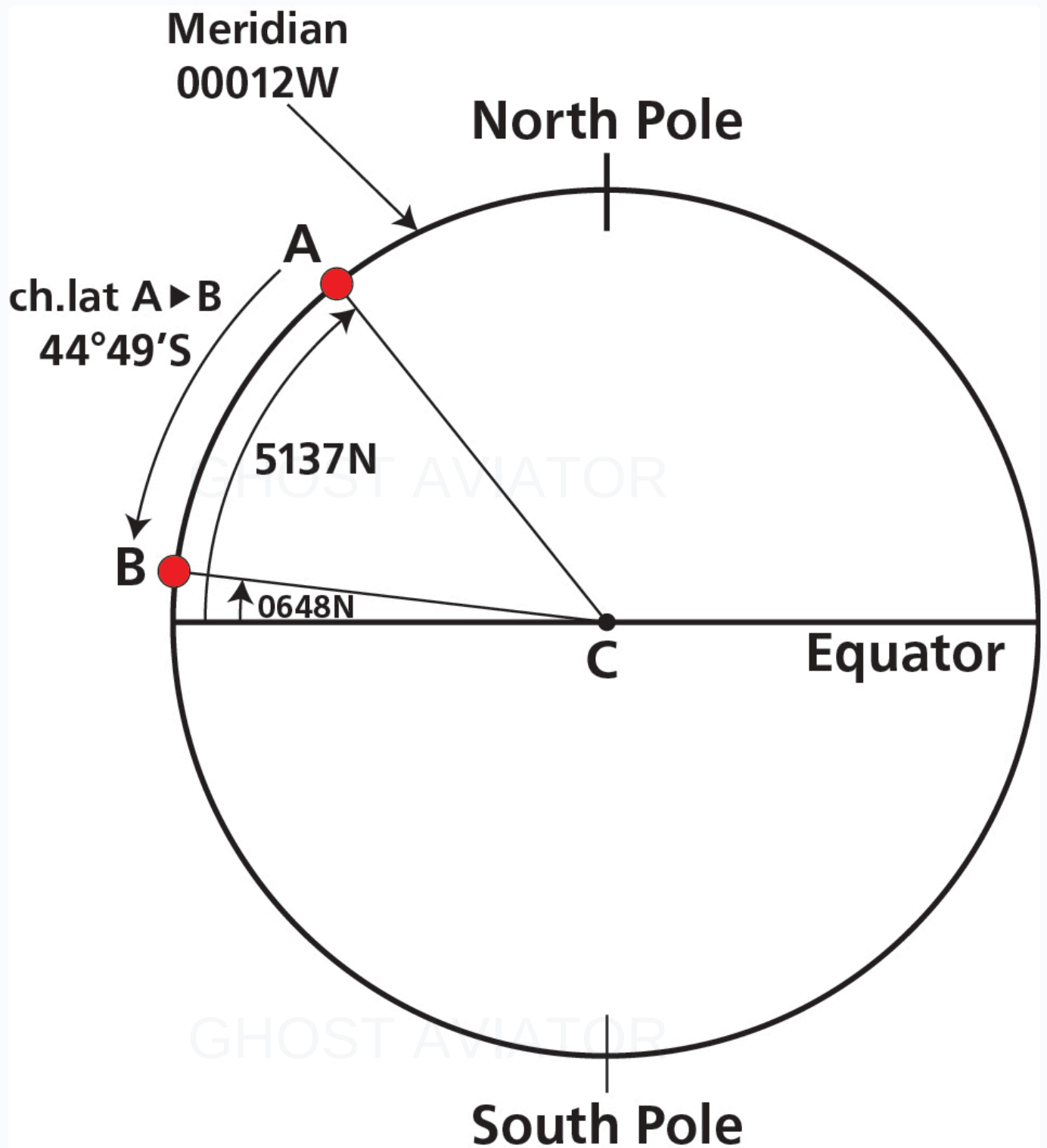


Figure 6 — Great Circle track direction change for an East–West Rhumb Line in the Northern and Southern hemispheres

Understanding DIID

Consider an East–West Rhumb Line track (090° or 270°) at **~50°N or ~50°S**:

Hemisphere	Going East (→)	Going West (←)
Northern	GC track starts high (030°), swings to 090°, finishes low (150°) — track angle INCREASING	GC track starts low (330°), swings to 270°, finishes high (210°) — track angle DECREASING
Southern	GC track starts low (150°), swings to 090°, finishes high (030°) — track angle DECREASING	GC track starts high (210°), swings to 270°, finishes low (330°) — track angle INCREASING

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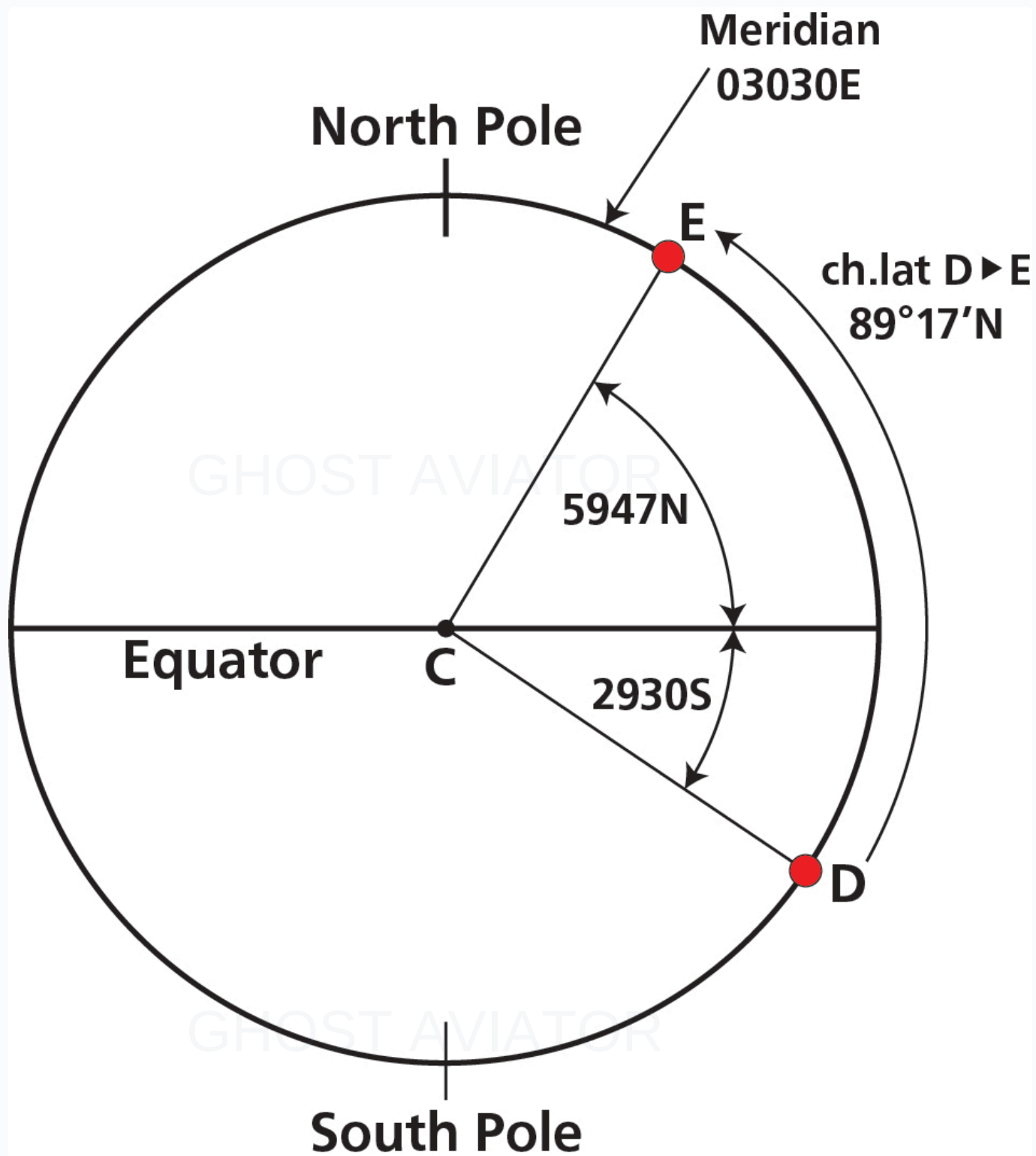


Figure 7 — The DIID diagram — Decreasing, Increasing, Increasing, Decreasing — GC track direction change relative to the Rhumb Line

Reading the DIID Diagram

Reading the four quadrants clockwise from the top-left: **D-I-I-D** (Decreasing-Increasing-Increasing-Decreasing).

- North + East = **Increasing**
- North + West = **Decreasing**
- South + East = **Decreasing**
- South + West = **Increasing**

In ALL cases: the GC direction always changes **towards the Equator**.

5. Distance on the Earth — Units & Conversions

Metric Units

Unit	Equivalent
1 metre (m)	100 cm = 1 000 mm
1 kilometre (km)	1/10 000th of Equator-to-Pole distance → Earth circumference = 40 000 km
1 km	3 280 ft
1 m	3.28 ft

Imperial Units

Unit	Equivalent
1 foot (ft)	12 inches
1 yard (yd)	3 feet
1 inch	2.54 cm
1 statute mile	5 280 ft

The Nautical Mile

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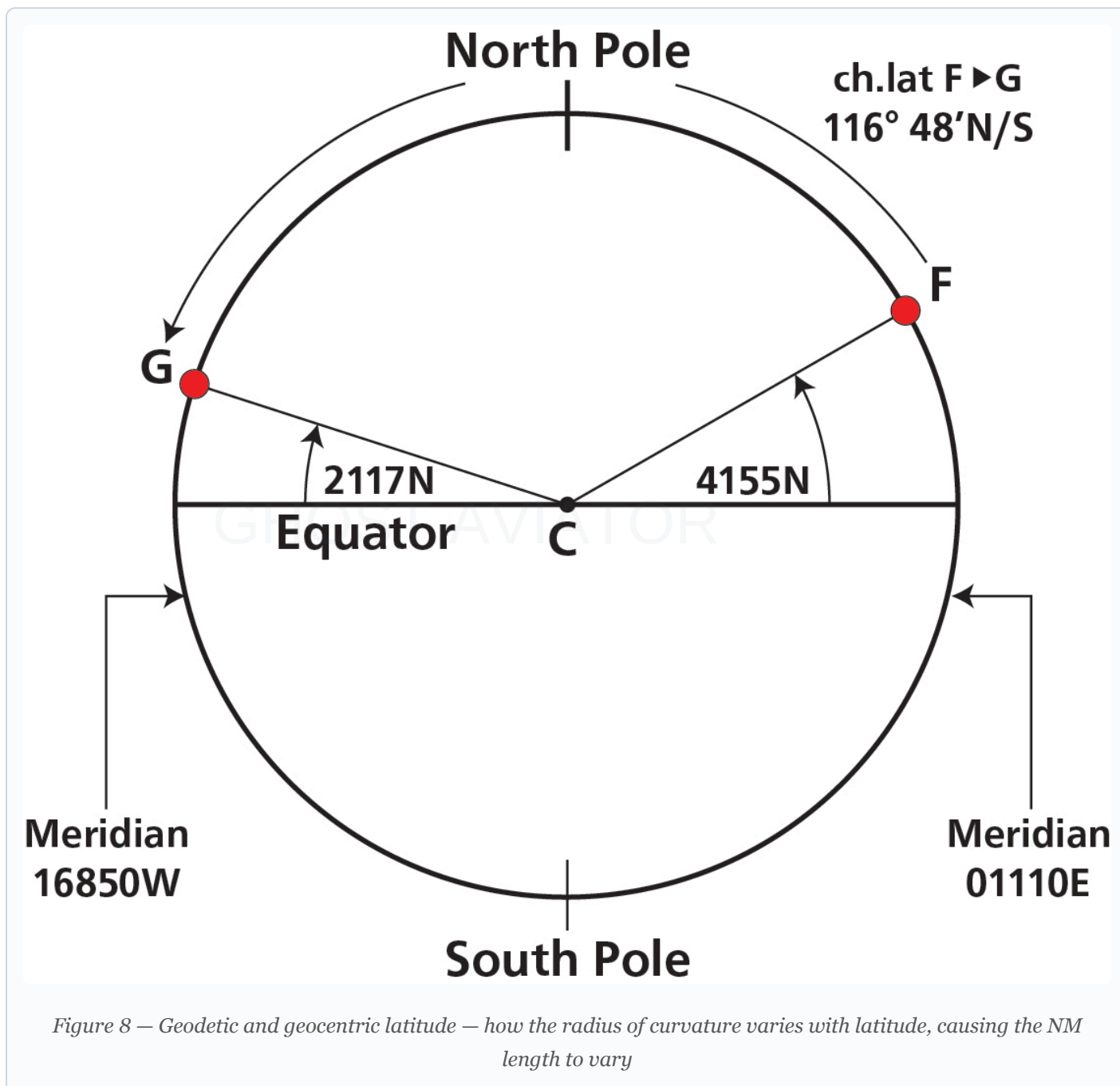
✈ The Most Important Aviation Distance Unit

The nautical mile is directly related to the Earth's angular measurements:

- **1 NM = 1 minute of arc on a Great Circle**
- ICAO definition: **1 NM = 1 852 metres**
- Standard (Admiralty) NM: **1 NM = 6 080 ft**
- 1 minute of **latitude** = 1 NM (everywhere, since all meridians are Great Circles)
- 1 minute of **longitude** = 1 NM **only at the Equator**

Angular Measurement	Distance
1° of latitude	60 NM
Equator to either Pole (90°)	5 400 NM
Earth circumference (360°)	21 600 NM

6. Variations in the Length of a Nautical Mile



The full definition: the NM is the arc of a Great Circle that subtends **1 minute of arc at the centre of curvature**. Because the Earth is an oblate spheroid, the radius of curvature varies with latitude:

Location	Radius of curvature	NM length
Equator	Smallest (most curved)	~6 048 ft (shortest)
Standard (mean)	Mean	6 076.1 ft (International NM = 1 852 m)
Poles	Largest (flattest)	~6 108 ft (longest)

Exam Use

For all DGCA exam calculations, use the **Standard NM of 6 080 ft**. The variation between 6 048 ft and 6 108 ft is not examined computationally — it is a conceptual understanding question only.

7. Conversion Factors

Conversion	Value
5 400 NM =	10 000 km
21 600 NM =	40 000 km
1 NM =	1 852 m = 6 080 ft
1 km =	3 280 ft
1 km =	0.5400 NM (= 5400/10000)
1 NM =	1.852 km

Ratio Method for NM ↔ km

Use the circumference ratio: **21 600 NM = 40 000 km**.

Therefore: $\text{NM} \times (40\,000/21\,600) = \text{km}$ | $\text{km} \times (21\,600/40\,000) = \text{NM}$

Or simply: $\text{NM} \times 1.852 = \text{km}$ | $\text{km} \div 1.852 = \text{NM}$

8. Great Circle Distances — Six Worked Examples

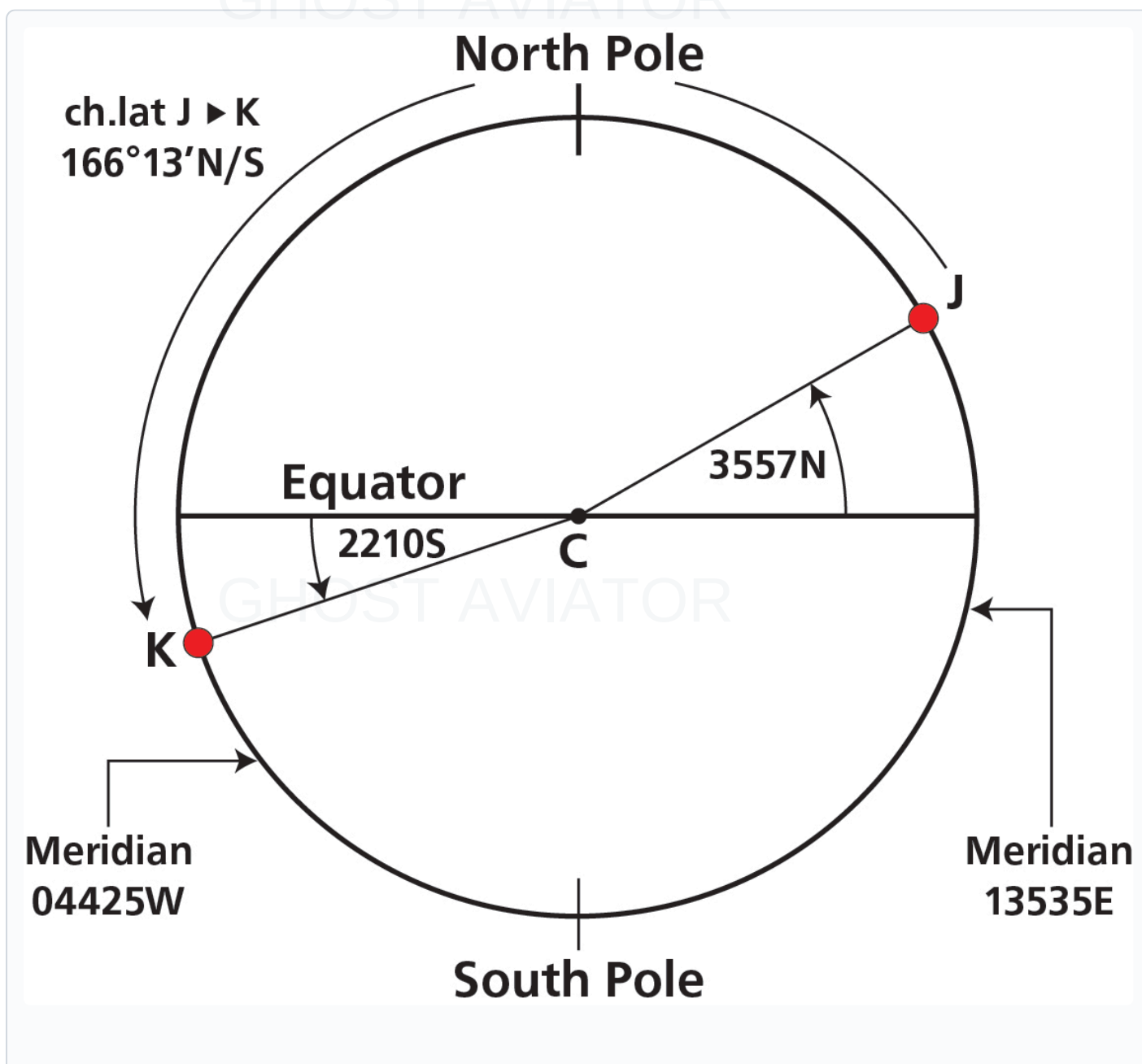
Scope of DGCA Exam Questions

General GC distance calculation requires spherical geometry — not in the DGCA syllabus. Exam questions are limited to points on **special Great Circles**: the same meridian, meridian & anti-meridian, or the Equator. There are five general cases plus a special antipodal case — all six are shown below.

How to Identify Which Case Applies

Condition	Case
Same longitude, same hemisphere	Case 1 — Ch.lat direct
Same longitude, different hemispheres	Case 2 — Ch.lat = sum of lats
Longitudes add to 180°, same hemisphere	Case 3 — Route via nearer Pole
Longitudes add to 180°, different hemispheres	Case 4 — Route via nearer Pole
Both at 0° latitude (Equator)	Case 5 — Ch.long at Equator
Same lat N & S, lons add to 180°	Case 6 — Antipodal (10 800 NM)

Case 1 — Same Meridian, Same Hemisphere



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Example: London (51°37'N 000°12'W) to Accra (06°48'N 000°12'W)

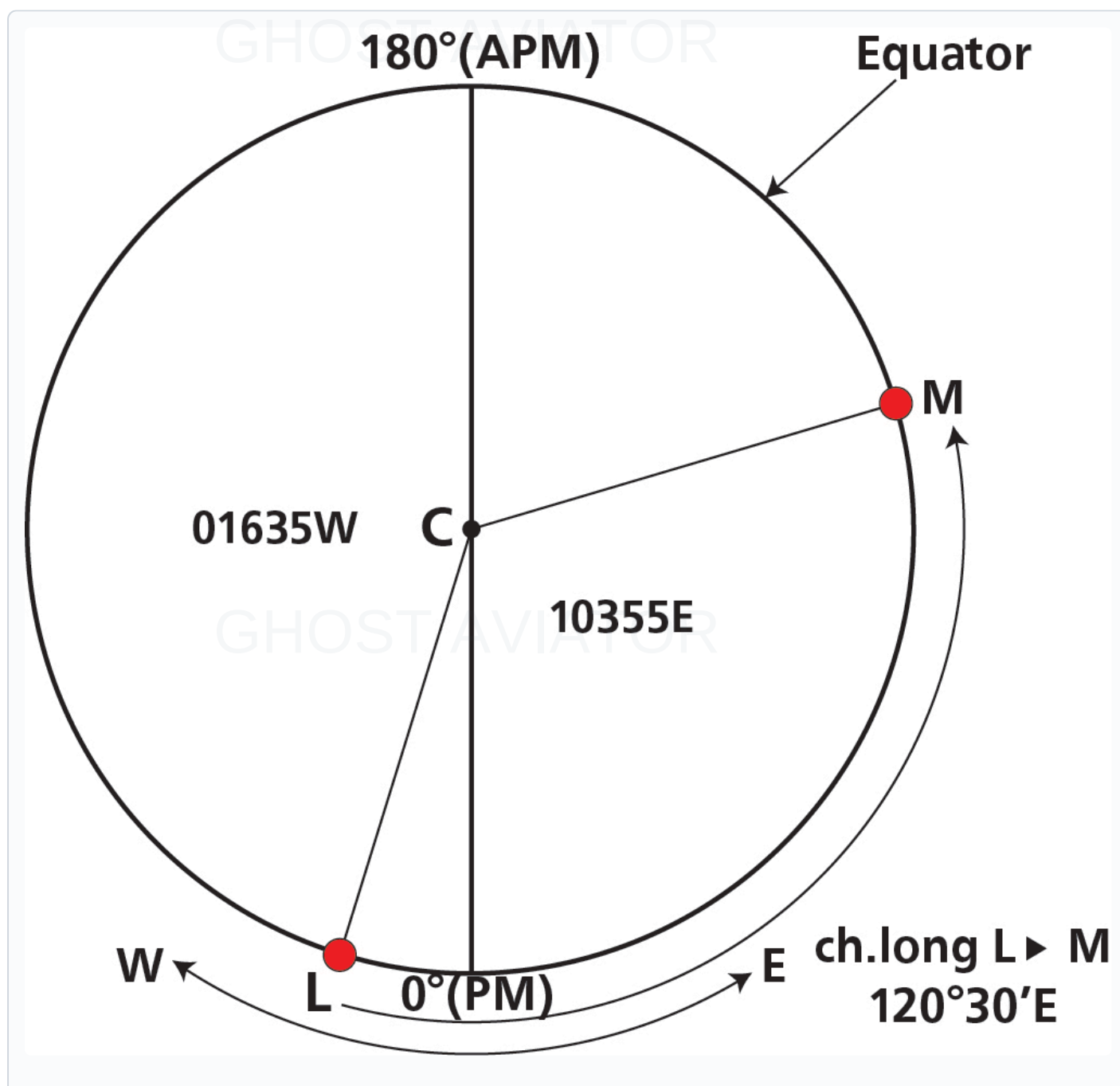
Step 1 – Confirm same meridian: both at 000°12'W ✓

Step 2 – Ch.lat: $51^{\circ}37' - 06^{\circ}48' = 44^{\circ}49'S$ (travelling south)

Step 3 – Convert to NM: $(44 \times 60) + 49 = 2\,689\text{ NM}$

Direction of flight: South (180°T)

Case 2 – Same Meridian, Different Hemispheres



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Figure 10 — Case 2 — Same meridian, different hemispheres: Durban (29°30'S) to Leningrad (59°47'N) along 030°30'E

Example: Durban (29°30'S 030°30'E) to Leningrad (59°47'N 030°30'E)

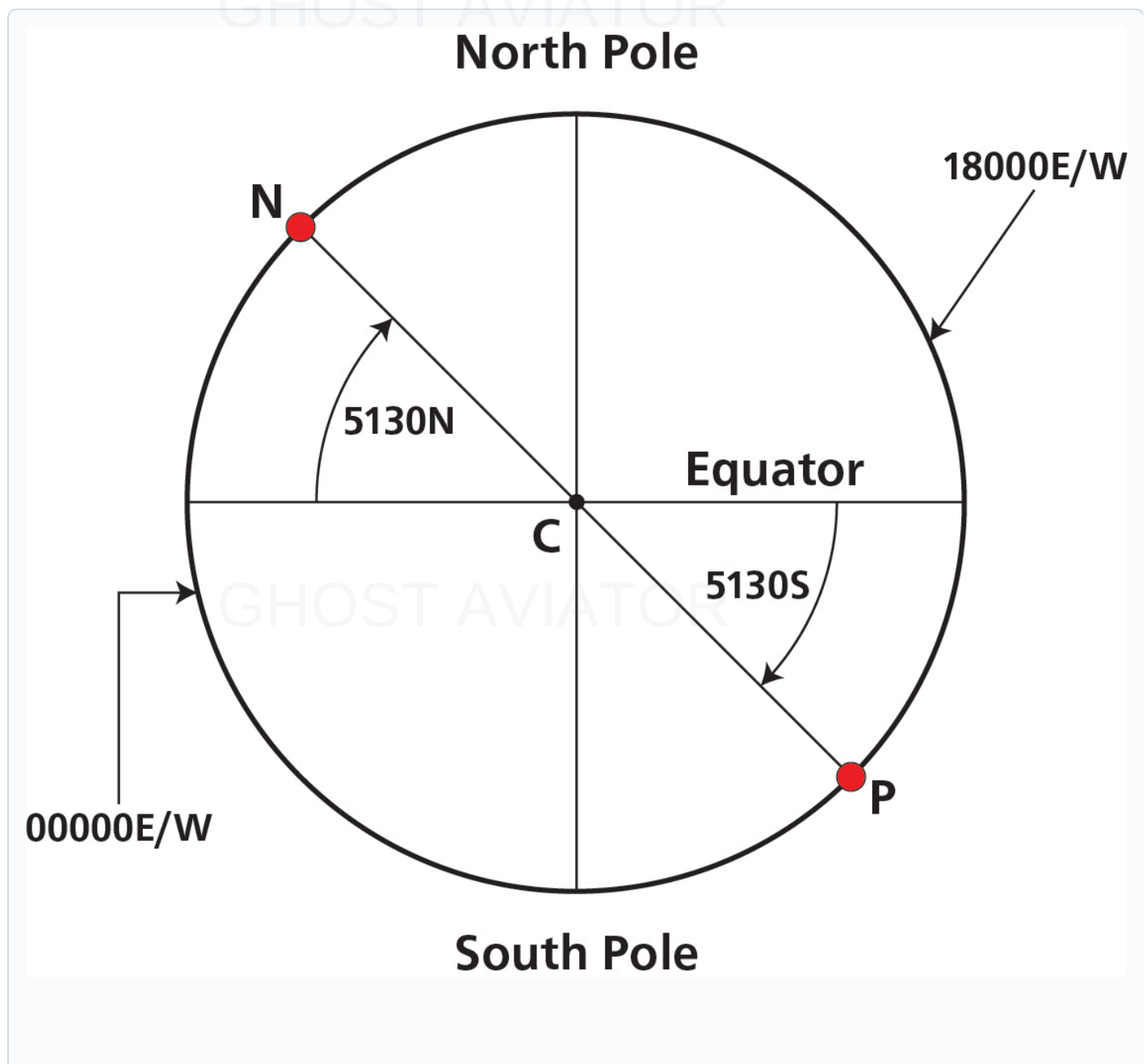
Step 1 — Confirm same meridian: both at 030°30'E ✓

Step 2 — Ch.lat: $29^{\circ}30' + 59^{\circ}47' = 89^{\circ}17'N$ (crossing the Equator, travelling north)

Step 3 — Convert to NM: $(89 \times 60) + 17 = 5\,357\text{ NM}$

Direction of flight: North (360°T)

Case 3 — Meridian and Anti-Meridian, Same Hemisphere



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Figure 11 — Case 3 — Meridian and anti-meridian, same hemisphere: Rome ($41^{\circ}55'N$ $011^{\circ}10'E$) to Honolulu ($21^{\circ}17'N$ $168^{\circ}50'W$) — route goes over the North Pole

Example: Rome ($41^{\circ}55'N$ $011^{\circ}10'E$) to Honolulu ($21^{\circ}17'N$ $168^{\circ}50'W$)

Step 1 — Confirm meridian/anti-meridian: $011^{\circ}10'E + 168^{\circ}50'W = 180^{\circ} \checkmark$

Step 2 — Route: GC goes over the **North Pole** (both in Northern Hemisphere)

Step 3 — Angular distance: $180^{\circ} - (41^{\circ}55' + 21^{\circ}17') = 180^{\circ} - 63^{\circ}12' = \mathbf{116^{\circ}48'}$

Alternative: $(90^{\circ} - 41^{\circ}55') + (90^{\circ} - 21^{\circ}17') = 48^{\circ}05' + 68^{\circ}43' = 116^{\circ}48' \checkmark$

Step 4 — NM: $(116 \times 60) + 48 = \mathbf{7\ 008\ NM}$

Direction of flight: Initially **North ($360^{\circ}T$)**, then South ($180^{\circ}T$) after the pole

Case 4 — Meridian and Anti-Meridian, Different Hemispheres

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Great Circles, Rhumb Lines & Directions on the Earth

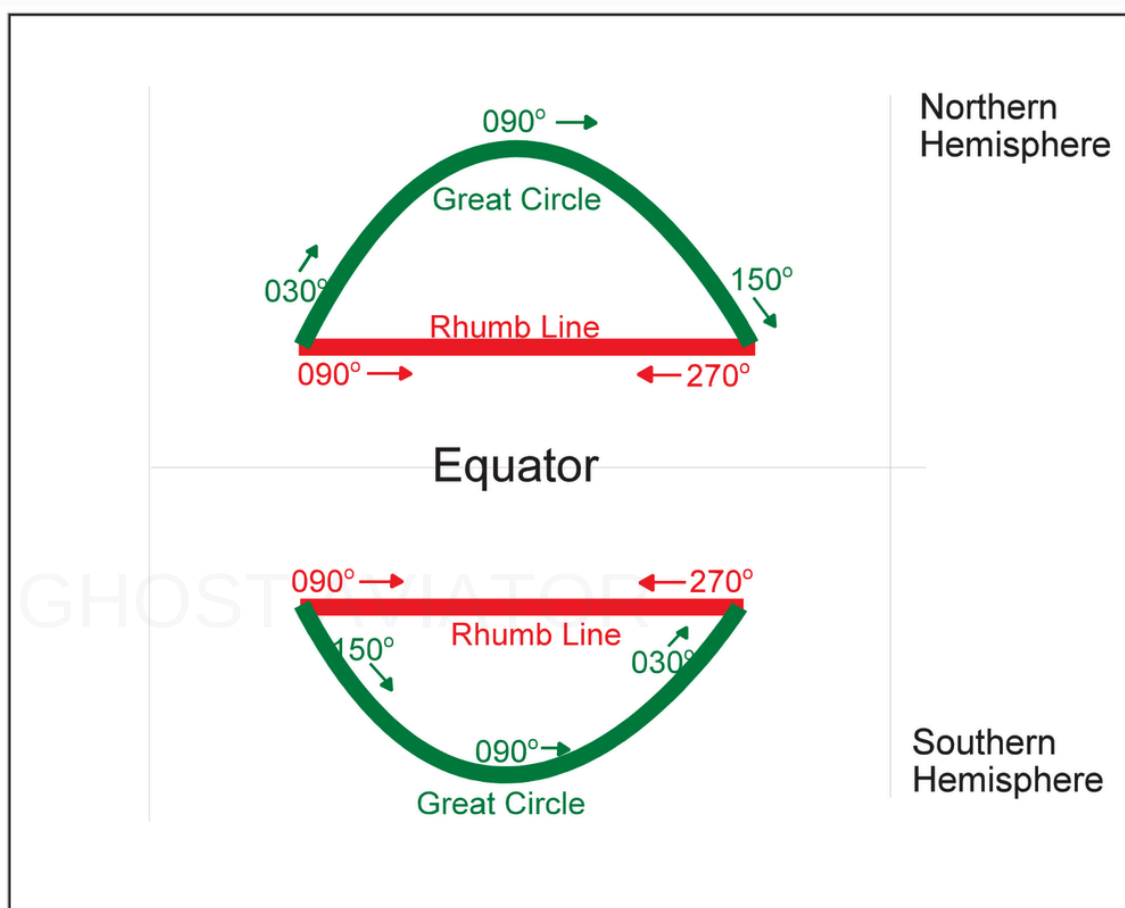


Figure 12 — Case 4 — Meridian and anti-meridian, different hemispheres: Tokyo ($35^{\circ}57'N$ $135^{\circ}35'E$) to Rio de Janeiro ($22^{\circ}10'S$ $044^{\circ}25'W$) — route via the North Pole

Example: Tokyo (35°57'N 135°35'E) to Rio de Janeiro (22°10'S 044°25'W)

Step 1 — Confirm meridian/anti-meridian: $135^{\circ}35'E + 044^{\circ}25'W = 180^{\circ} \checkmark$

Step 2 — Route: Draw diagram — route via **North Pole** is shorter

Step 3 — Angular distance (via N Pole):

Tokyo → N Pole: $90^{\circ} - 35^{\circ}57' = 54^{\circ}03'$

N Pole → Equator: 90°

Equator → Rio: $22^{\circ}10'$

Total: $54^{\circ}03' + 90^{\circ} + 22^{\circ}10' = \mathbf{166^{\circ}13'}$

Step 4 — NM: $(166 \times 60) + 13 = \mathbf{9\ 973\ NM}$

Check (via S Pole would give 193°47'): $360^{\circ} - 193^{\circ}47' = 166^{\circ}13' \checkmark$ — or: $21\ 600 - 11\ 627 = 9\ 973\ NM \checkmark$

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🔪 Self-Check: Wrong-direction check for Case 4

If your angular distance exceeds 180° , you've gone the wrong way around. **Subtract from 360°** for the angular answer, or **subtract from 21 600 NM** for the distance.

Case 5 — Two Points on the Equator

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gives you the track direction is Eastward (right) or Westward (left). This gives a high spells out DIID - (decreasing - increasing - increasing - decreasing).

2

Great Circles, Rhumb Lines & Directions on the Earth

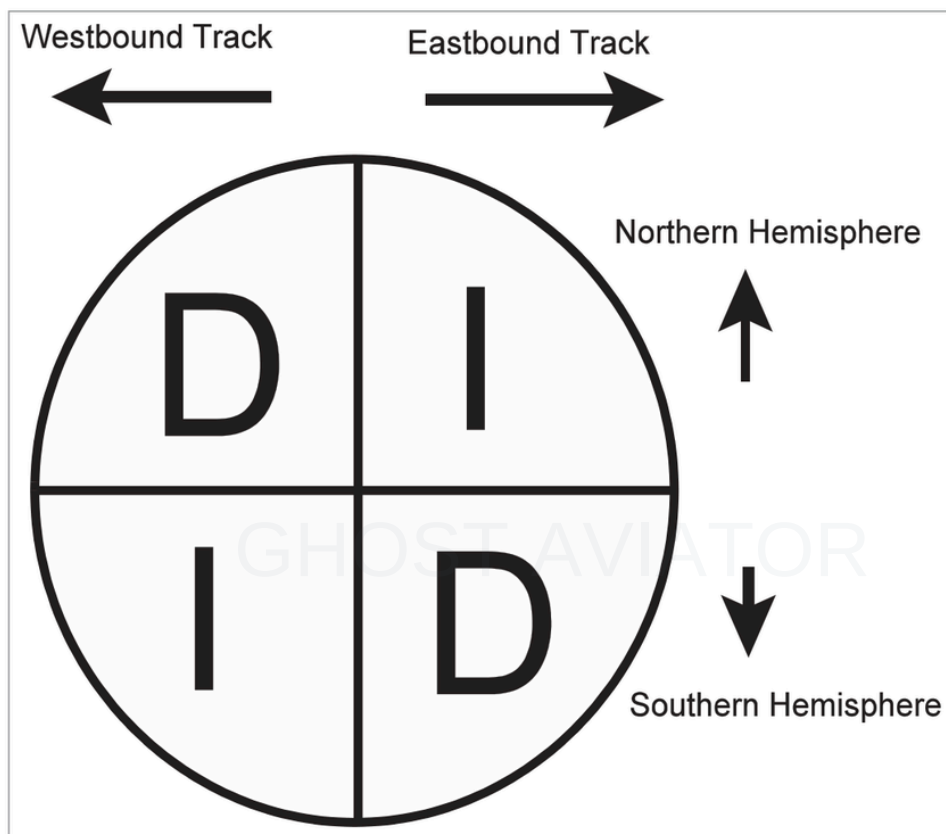


Figure 13 — Case 5 — Two points on the Equator: Dakar (000°N 016°35'W) to Singapore (000°N 103°55'E) — diagram viewed from above North Pole

Example: Dakar (00°00'N 016°35'W) to Singapore (00°00'N 103°55'E)

Step 1 — Both on Equator: ✓ (Equator is a Great Circle)

Step 2 — Ch.long: 016°35'W + 103°55'E = 120°30'E (going east from Dakar)

Step 3 — NM (Equator only — longitude minutes = NM): (120 × 60) + 30 = **7 230 NM**

Direction of flight: East (090°T)

⚠ Only at the Equator!

The conversion 1 minute of longitude = 1 NM is valid ONLY AT THE EQUATOR. At any other latitude, you must use the departure formula (covered in the Departure chapter).

Case 6 — Antipodal Points (Special Case)

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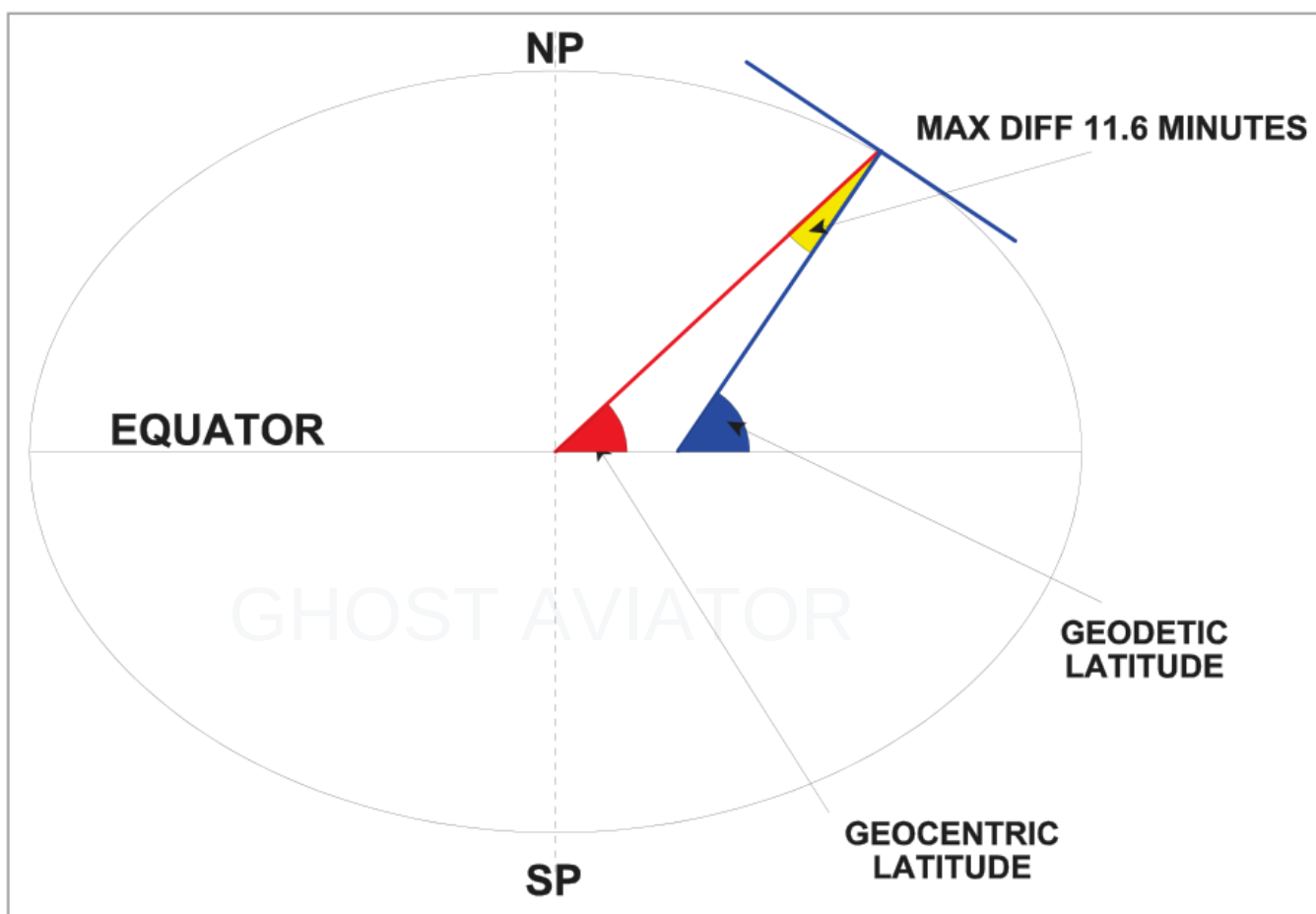


Figure 14 — Case 6 — Antipodal points: Greenwich ($51^{\circ}30'N$ $000^{\circ}00'E$) and Antipodes Island ($51^{\circ}30'S$ $180^{\circ}00'E/W$) — diametrically opposite on the Earth

Example: Greenwich ($51^{\circ}30'N$ $000^{\circ}00'E$) to Antipodes Island ($51^{\circ}30'S$ $180^{\circ}00'E$)

Step 1 — Antipodal check: Equal latitudes N & S, longitudes add to 180° ✓

Step 2 — GC distance between any point and its antipode: always **$180^{\circ} = 10\,800\text{ NM}$**

Note: Because the points are diametrically opposite, infinitely many Great Circles connect them.

9. Mean Latitude

The **mean latitude** between two positions is their arithmetic average. It is used in departure calculations (Ch.15).

Method

- **Same hemisphere:** add both latitudes, divide by 2.
- **Different hemispheres:** find the angular span (sum), halve it, subtract from the higher latitude.

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Worked Examples

Example 1 — same hemisphere: Mean lat of $52^{\circ}17'N$ and $17^{\circ}57'N$

$$52^{\circ}17' + 17^{\circ}57' = 70^{\circ}14' \div 2 = \underline{35^{\circ}07'N}$$

Example 2 — different hemispheres: Mean lat of $35^{\circ}25'N$ and $13^{\circ}38'S$

$$\text{Total span} = 35^{\circ}25' + 13^{\circ}38' = 49^{\circ}03'. \text{ Half} = 24^{\circ}31.5'.$$

$$\text{Mean lat} = 35^{\circ}25'N - 24^{\circ}31.5' = \underline{10^{\circ}53.5'N}$$

Quick Revision Summary — Chapter 2

- GC = shortest distance; constant direction = Rhumb Line
- Rhumb Line is always nearer the **Equator** than the GC
- GC always nearer the **Pole** than the Rhumb Line
- Only lines that are both GC and Rhumb Line: **Equator and meridians**
- DIID: North East = Increasing, North West = Decreasing, South East = Decreasing, South West = Increasing
- GC direction always changes **towards the Equator**
- 1 NM = **1 852 m = 6 080 ft** (standard); Earth = **21 600 NM = 40 000 km**
- NM length: shortest at Equator (**6 048 ft**), longest at Poles (**6 108 ft**)
- Meridian+anti-meridian condition: longitudes of *opposite signs* that **sum to 180°**
- Case 3/4: GC always goes via the **nearer Pole**
- Antipodal: **10 800 NM** (always)

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Practice Questions & Detailed Answers

11 questions (many with sub-parts) • Calculation, conceptual & MCQ • Full worked solutions

Q1. What is the change of latitude between the following positions?

(a) $52^{\circ}15'N$ to $39^{\circ}35'N$ (b) $49^{\circ}35'N$ to $60^{\circ}20'S$ (c) $74^{\circ}20'S$ to $34^{\circ}30'S$ (d) $71^{\circ}20'N$ to $86^{\circ}45'N$ over the North Pole

Anchor: [§8 – Change of Latitude](#)

Part	Calculation	Answer
(a)	$52^{\circ}15' - 39^{\circ}35' = 12^{\circ}40'$ South	$12^{\circ}40'S$
(b)	$49^{\circ}35'N + 60^{\circ}20'S$ (cross Equator) = $109^{\circ}55'$ South	$109^{\circ}55'S$
(c)	$74^{\circ}20'S \rightarrow 34^{\circ}30'S$: $74^{\circ}20' - 34^{\circ}30' = 39^{\circ}50'$ North	$39^{\circ}50'N$
(d)	$71^{\circ}20'N \rightarrow \text{Pole}$: $18^{\circ}40'$ + Pole $\rightarrow 86^{\circ}45'N$: $3^{\circ}15' = 21^{\circ}55'$	$21^{\circ}55'$

Part (b) note: When crossing the Equator, add both latitudes ($49^{\circ}35' + 60^{\circ}20' = 109^{\circ}55'$).

Part (c) note: Both in Southern hemisphere — the aircraft travels northward (toward less southerly latitude). Subtract the smaller from the larger: $74^{\circ}20' - 34^{\circ}30' = 39^{\circ}50'N$.

Part (d) note: "Over the North Pole" means the route passes through $90^{\circ}N$ and continues on the opposite meridian. From $71^{\circ}20'N$ to the pole = $18^{\circ}40'$; pole to $86^{\circ}45'N = 3^{\circ}15'$. Total = $21^{\circ}55'$.

Instructor's Note: Source key verified. All four answers confirmed. No discrepancy.

Q2. What is the distance in nautical miles and kilometres from position A ($41^{\circ}25'N$) to position B ($79^{\circ}30'N$)? Both are on the same meridian.

Anchor: [§8 – Case 1](#)

Distance: **$2\ 285\ NM$ | $4\ 232\ km$**

Step 1 — Ch.lat: $79^{\circ}30' - 41^{\circ}25' = 38^{\circ}05'N$

Step 2 — NM: $(38 \times 60) + 5 =$ **$2\ 285\ NM$**

Step 3 — km: $2\ 285 \times 1.852 =$ **$4\ 232\ km$** (or $4\ 230\ km$ using the nav computer)

Instructor's Note: Source key: 2 285 NM / 4 232 km. Verified. No discrepancy.

Q3. What is the change of longitude between the following positions?

(a) $075^{\circ}40'W$ to $125^{\circ}35'W$ (b) $001^{\circ}20'E$ to $004^{\circ}20'W$ (c) $150^{\circ}40'E$ to $179^{\circ}30'E$ (d) $162^{\circ}36'W$ to $140^{\circ}42'E$

Anchor: [§8 — Change of Longitude](#)

Part	Calculation	Answer
(a)	$125^{\circ}35' - 075^{\circ}40' = 49^{\circ}55'$ West (same side)	$49^{\circ}55'W$
(b)	$001^{\circ}20' + 004^{\circ}20' = 05^{\circ}40'$ West (opposite sides)	$05^{\circ}40'W$
(c)	$179^{\circ}30' - 150^{\circ}40' = 28^{\circ}50'$ East (same side)	$28^{\circ}50'E$
(d)	$162^{\circ}36' + 140^{\circ}42' = 303^{\circ}18' \rightarrow$ shorter arc: $360^{\circ} - 303^{\circ}18' =$ $56^{\circ}42'W$	$56^{\circ}42'W$

Rule: same side $\rightarrow$ subtract; opposite sides $\rightarrow$ add. If the result exceeds 180° , take the supplement ($360^{\circ} - \text{result}$) — this is the shorter arc.

Part (d) detailed: $162^{\circ}36'W$ and $140^{\circ}42'E$ are on opposite sides, so add: $162^{\circ}36' + 140^{\circ}42' = 303^{\circ}18'$. Since $303^{\circ}18' > 180^{\circ}$, the shorter arc is $360^{\circ} - 303^{\circ}18' = 56^{\circ}42'$. Going *westward* from $162^{\circ}36'W$ by $56^{\circ}42'$ takes you through the anti-meridian to $140^{\circ}42'E$.

Instructor's Note: Source key notes "(d): Not $303^{\circ}18'$ — we want the smaller arc." Confirmed. No discrepancy.

Q4. Give the direction and the change of latitude and longitude from X to Y in each case:

(a) $50^{\circ}31'N$ $006^{\circ}30'W \rightarrow 52^{\circ}00'N$ $008^{\circ}35'W$

(b) $47^{\circ}32'N$ $002^{\circ}46'W \rightarrow 43^{\circ}56'N$ $001^{\circ}33'W$

(c) $61^{\circ}47'N$ $003^{\circ}46'W \rightarrow 62^{\circ}13'N$ $001^{\circ}36'E$

(d) $31^{\circ}27'S$ $091^{\circ}47'E \rightarrow 35^{\circ}57'N$ $096^{\circ}31'E$

(e) $51^{\circ}05'N$ $177^{\circ}42'E \rightarrow 51^{\circ}06'N$ $167^{\circ}42'W$

Anchor: [§8 — Ch.lat & Ch.long](#)

Part	Ch.lat	Ch.long
(a)	01°29'N	002°05'W
(b)	03°36'S	001°13'E
(c)	00°26'N	005°22'E
(d)	67°24'N	004°44'E
(e)	00°01'N	014°36'E

(a) Lat: $52^{\circ}00' - 50^{\circ}31' = 01^{\circ}29'N$. Long: $008^{\circ}35'W - 006^{\circ}30'W = 002^{\circ}05'W$ (going further west).

(b) Lat: $43^{\circ}56' - 47^{\circ}32' = 03^{\circ}36'S$ (going south). Long: $002^{\circ}46'W \rightarrow 001^{\circ}33'W = 001^{\circ}13'E$ (going east, less westerly).

(c) Lat: $62^{\circ}13' - 61^{\circ}47' = 00^{\circ}26'N$. Long: $003^{\circ}46'W + 001^{\circ}36'E = 005^{\circ}22'E$ (crossing prime meridian).

(d) Lat: $35^{\circ}57'N + 31^{\circ}27'S = 67^{\circ}24'N$ (cross Equator northbound). Long: $096^{\circ}31' - 091^{\circ}47' = 004^{\circ}44'E$.

(e) Lat: $51^{\circ}06' - 51^{\circ}05' = 00^{\circ}01'N$. Long: $177^{\circ}42'E \rightarrow 167^{\circ}42'W$ — going east: $177^{\circ}42'E$ to $180^{\circ} = 2^{\circ}18'$, then 180° to $167^{\circ}42'W = 12^{\circ}18'$. Total = **014°36'E** (shorter arc eastward).

Instructor's Note: All five sub-answers verified against source key. No discrepancies.

Q5. Give the shortest distance in nautical miles and kilometres between the following positions:

- (a) $52^{\circ}06'N$ $002^{\circ}32'E$ and $53^{\circ}36'N$ $002^{\circ}32'E$ (b) $04^{\circ}41'S$ $163^{\circ}36'W$ and $03^{\circ}21'N$ $163^{\circ}36'W$
(c) $62^{\circ}00'N$ $093^{\circ}00'E$ and $62^{\circ}00'N$ $087^{\circ}00'W$ (d) $00^{\circ}00'N$ $176^{\circ}00'E$ and $00^{\circ}00'N$ $173^{\circ}00'W$
(e) $43^{\circ}57'N$ $071^{\circ}37'W$ and $43^{\circ}57'S$ $108^{\circ}23'E$

Anchor: [§8 – All six cases](#)

Part	Case	NM	km
(a)	Case 1 (same meridian, same hemi)	90 NM	167 km
(b)	Case 2 (same meridian, diff hemi)	482 NM	893 km
(c)	Case 3 (merid+anti-merid, same hemi)	3 360 NM	6 223 km
(d)	Case 5 (Equator)	660 NM	1 222 km
(e)	Case 6 (Antipodal)	10 800 NM	20 000 km

- (a) Same lon $002^{\circ}32'E$. Ch.lat = $53^{\circ}36' - 52^{\circ}06' = 01^{\circ}30' = 90 \text{ NM} \times 1.852 = 167 \text{ km}$.
- (b) Same lon $163^{\circ}36'W$. Ch.lat = $04^{\circ}41' + 03^{\circ}21' = 08^{\circ}02' = 482 \text{ NM} \times 1.852 = 893 \text{ km}$.
- (c) $093^{\circ}00'E + 087^{\circ}00'W = 180^{\circ} \rightarrow$ Case 3. Both $62^{\circ}N \rightarrow$ route over N Pole. Angular = $180^{\circ} - (62^{\circ} + 62^{\circ}) = 56^{\circ} = 3\,360 \text{ NM} \times 1.852 = 6\,223 \text{ km}$.
- (d) Both on Equator $\rightarrow$ Case 5. Ch.long: $176^{\circ}E + 173^{\circ}W = 349^{\circ}$; shorter arc = $360^{\circ} - 349^{\circ} = 11^{\circ}$. At Equator: $11^{\circ} \times 60 = 660 \text{ NM} \times 1.852 = 1\,222 \text{ km}$.
- (e) $071^{\circ}37'W + 108^{\circ}23'E = 180^{\circ}$ AND equal lats N/S $\rightarrow$ Antipodal (Case 6). Distance = $180^{\circ} = 10\,800 \text{ NM} = 20\,000 \text{ km}$.

Instructor's Note: All five answers confirmed against source key. No discrepancies.

Q6. An aircraft is to fly from $72^{\circ}00'N\,002^{\circ}30'E$ to $72^{\circ}00'N\,177^{\circ}30'W$ on the shortest possible route.

(a) Give the initial True track direction. (b) Will the track direction remain the same? (c) Why/why not?

Anchor: [§8 – Case 3](#)

- (a) Initial track: **$360^{\circ}(T)$** – True North
- (b) Track changes: **No**
- (c) **Route is over the North Pole. Initial track is True North; once past the pole, the track becomes True South ($180^{\circ}T$).**

Step 1 – Identify case: $002^{\circ}30'E + 177^{\circ}30'W = 180^{\circ} \rightarrow$ meridian/anti-meridian. Both at $72^{\circ}N \rightarrow$ same hemisphere $\rightarrow$ Case 3 (route over North Pole).

Step 2 – Initial direction: From $72^{\circ}N$ heading to the North Pole = due North = **$360^{\circ}(T)$** .

Step 3 – Track consistency: As the aircraft crosses the pole, "north" flips to "south" on the Mercator representation. The track direction changes from $360^{\circ}T$ to $180^{\circ}T$ – so No, it does not remain constant.

Instructor's Note: Verified against source key. No discrepancy.

Q7. You are at position A: $54^{\circ}20'N\,002^{\circ}30'W$. Given a ch.lat of $16^{\circ}20'N$ and a ch.long of $20^{\circ}30'W$ to B, what is the position of B?

Anchor: [§8 – Ch.lat & Ch.long application](#)

Position B: 70°40'N 023°00'W

Latitude: $54^{\circ}20'N + 16^{\circ}20'N = 70^{\circ}40'N$

Longitude: $002^{\circ}30'W + 20^{\circ}30'W = 023^{\circ}00'W$

Instructor's Note: Verified. No discrepancy.

Q8. You are at position C: $36^{\circ}47'S$ $179^{\circ}21'E$. Given a ch.lat of $46^{\circ}47'N$ and a ch.long of $20^{\circ}30'E$ to D, what is the position of D?

Anchor: [§8 — Ch.lat & Ch.long application](#)

Position D: 10°00'N 160°09'W

Latitude: $36^{\circ}47'S + 46^{\circ}47'N$ (northward change crosses Equator): $46^{\circ}47' - 36^{\circ}47' = 10^{\circ}00'N$

Longitude: $179^{\circ}21'E + 20^{\circ}30'E = 199^{\circ}51'E$. Since $> 180^{\circ}$: $360^{\circ} - 199^{\circ}51' = 160^{\circ}09'W$

Instructor's Note: Verified. No discrepancy. The longitude crosses the anti-meridian — a common exam trap.

Q9. What is the position of the Rhumb Line between 2 points relative to the Great Circle if the points are:

(a) *In the Northern hemisphere* (b) *In the Southern hemisphere*

Anchor: [§2 — Rhumb Line vs GC](#)

(a) Northern hemisphere: Rhumb Line is nearer the Equator (South of the Great Circle)

(b) Southern hemisphere: Rhumb Line is nearer the Equator (North of the Great Circle)

In both hemispheres, the Rhumb Line lies nearer to the Equator, while the Great Circle bulges toward the nearer Pole. This is why the GC is the shorter path — it cuts across the "top" of the curved path rather than staying at the lower latitude.

Instructor's Note: Verified. No discrepancy.

Q10. Any Meridian Line is a:

- (a) Rhumb Line
- (b) Semi Great Circle
- (c) Rhumb Line and a semi Great Circle ✓**

Correct Answer: (c)

A meridian is simultaneously both:

- A **Rhumb Line** — it cuts all other meridians at a constant angle of 0° (it runs exactly N–S, maintaining constant direction).
- A **semi-Great Circle** — it forms one half of a Great Circle (the other half being its anti-meridian), whose plane passes through the Earth's centre.

Distractor Analysis:

- (a) Correct but incomplete — a meridian is also a semi-Great Circle.
- (b) Correct but incomplete — a meridian is also a Rhumb Line.

Instructor's Note: Source key: c. Verified. No discrepancy.

Q11. A Rhumb Line cuts all meridians at the same angle. This gives:

Anchor: [§2 — Rhumb Line definition](#)

- (a) The shortest distance between two points
- (b) A line which could never be a Great Circle track
- (c) A line of constant direction ✓**

Correct Answer: (c) — A line of constant direction

Cutting all meridians at the *same angle* is equivalent to maintaining a **constant compass direction**. This is the defining property of a Rhumb Line and the basis of traditional compass navigation.

Distractor Analysis:

- (a) Wrong — constant direction gives the longer (Rhumb Line) path, not the shortest (Great Circle).
- (b) Wrong — meridians cut all other meridians at 0° (a constant angle) AND are semi-Great Circles. So a Rhumb Line CAN be a Great Circle track.

Instructor's Note: Source key: c. Verified. No discrepancy.

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Master Reference Tables — Chapter 2

All Key Numerical Values

Parameter	Value	Section
1 NM (ICAO)	1 852 m	§5
1 NM (Standard/Admiralty)	6 080 ft	§5
1 NM (at Equator)	~6 048 ft (shortest)	§6
1 NM (International mean)	6 076.1 ft	§6
1 NM (at Poles)	~6 108 ft (longest)	§6
Earth circumference	21 600 NM = 40 000 km	§7
Equator to Pole	5 400 NM = 10 000 km	§7
1 km	3 280 ft = 0.5400 NM	§7
1 m	3.28 ft	§5
1 inch	2.54 cm	§5
1 statute mile	5 280 ft	§5
Antipodal distance	10 800 NM = 20 000 km	§8

GC Distance Cases — Quick Decision Tree

Test	Case	Method
Same longitude, both same hemi	Case 1	Ch.lat → NM
Same longitude, different hemi	Case 2	Sum lats → NM
Lons add to 180°, same hemi	Case 3	180° – sum of lats → NM
Lons add to 180°, diff hemi	Case 4	Draw diagram, route via nearer Pole
Both at Equator (lat = 0)	Case 5	Ch.long (shorter arc) → NM
Equal lats N & S, lons add to 180°	Case 6	Always 10 800 NM

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DIID Rule — GC Track Direction Change

Hemisphere + Direction	GC Track Angle
North + East (→)	Increasing
North + West (←)	Decreasing
South + East (→)	Decreasing
South + West (←)	Increasing

GC always changes direction **towards the Equator**. Mnemonic: **DIID** read from North-West clockwise.

Answer Key Summary — No 🚩 Flags

Q	Answer(s)
1	a) 12°40'S b) 109°55'S c) 39°50'N d) 21°55'
2	2 285 NM 4 232 km
3	a) 49°55'W b) 05°40'W c) 28°50'E d) 56°42'W
4	a) 01°29'N 002°05'W b) 03°36'S 001°13'E c) 00°26'N 005°22'E d) 67°24'N 004°44'E e) 00°01'N 014°36'E
5	a) 90/167 b) 482/893 c) 3 360/6 223 d) 660/1 222 e) 10 800/20 000
6	a) 360°(T) b) No c) Over N Pole, then track reverses to 180°T
7	70°40'N 023°00'W
8	10°00'N 160°09'W
9	a) Nearer Equator (S of GC) b) Nearer Equator (N of GC)
10	c
11	c

DGCA CPL/ATPL General Navigation Study Notes

Chapter 2 — Great Circles, Rhumb Lines & Directions on the Earth

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