LineUp With Math™

Math-Based Decisions in Air Traffic Control

Student Workbook A

- **Introduction to Real Air Traffic Control**
  - **Units**
  - **Sector Disply**
  - **Sector Information**
  - **Spacing Information**

Investigator: _____

An Airspace Systems Program Product

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Understand Sector Information

Investigator: _____

Understand Units

Distance:

Travel on land is measured in Statute Miles - commonly called "miles"

Travel in the air and on the sea is measured in **Nautical Miles (Nmiles)**. A nautical mile is a little *longer* than a statute mile.

> ### 1 nautical mile = 1.15 statute miles

Speed:

Speed on land is measured in Miles per Hour (mph).

Speed in the air and on the sea is measured in Nautical Miles per Hour - commonly called **"knots" (Kts)**.

> ### 1 "knot" = 1 nautical mile per hour

Just as a Nautical mile is a little *longer* than a Statute Mile, 1 knot (nautical mile per hour) is a little *faster* than 1 mile per hour.
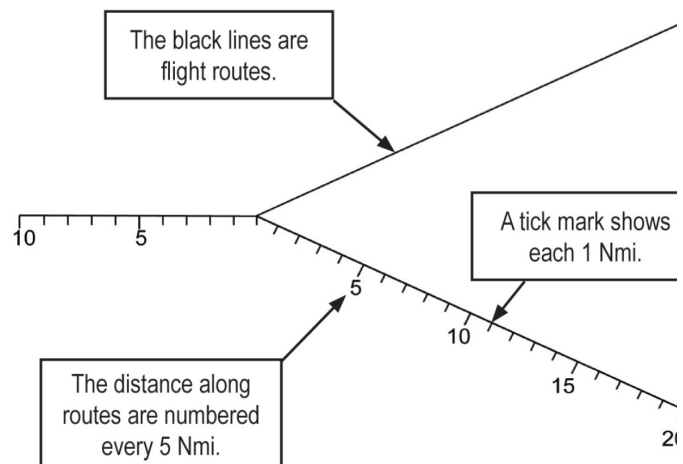
━━ Understand the Sector Display ━━

A **Sector** is the air space above a specific geographical section of the country.
Each sector has 2 air traffic controllers. They are responsible for the safe and efficient flight of all aircraft in that sector.

A sector is composed of many interconnected **Routes**. Routes are invisible pathways in the sky.

When you look at an air traffic problem display, you will see:

- Lines to show the routes
- Numbers at each 5 nautical mile distance
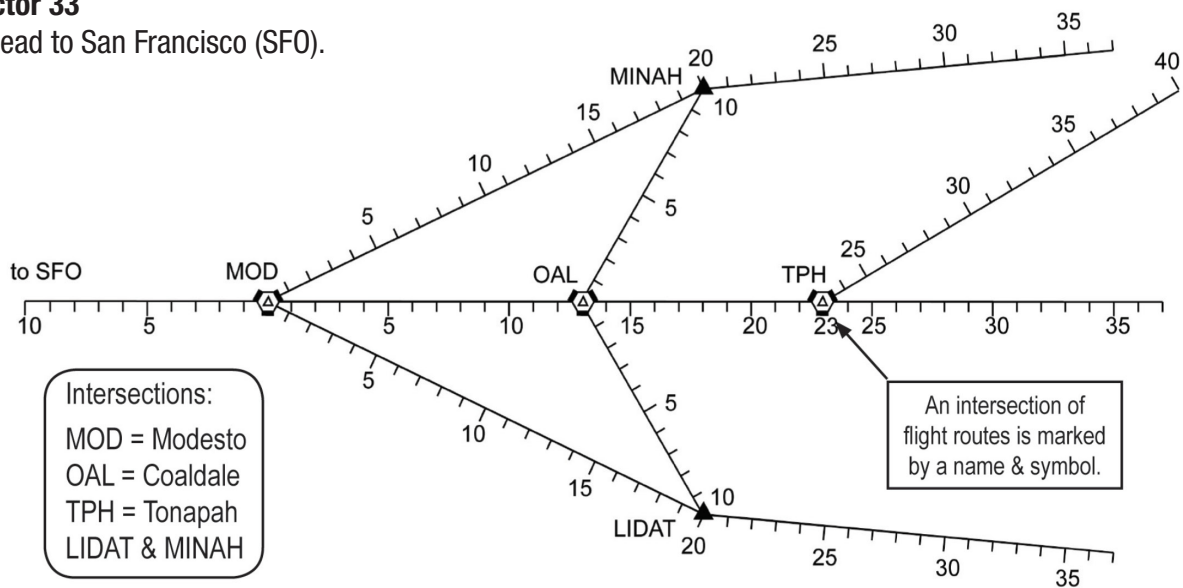- Tick marks at each 1 nautical mile distance

The black lines are flight routes.

A tick mark shows each 1 Nmi.

The distance along routes are numbered every 5 Nmi.

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- This is **Sector 33**
- All routes lead to San Francisco (SFO).

Intersections:

MOD = Modesto
OAL = Coaldale
TPH = Tonapah
LIDAT & MINAH

An intersection of
flight routes is marked
by a name & symbol.

- Sector 33 is a real sector in northern California. But we've used different distances.
- Sector 33 controllers merge traffic onto a single route to MOD.

It is important that you understand the distances between intersections.

1 Circle the intersections at MOD and MINAH.

2 What is the direct distance from:

	MINAH	TPH	LIDAT
To MOD?	☐ Nmi	☐ Nmi	☐ Nmi
To OAL?	☐ Nmi	☐ Nmi	☐ Nmi

3 How far is it from MINAH to OAL to MOD? ☐ nautical miles

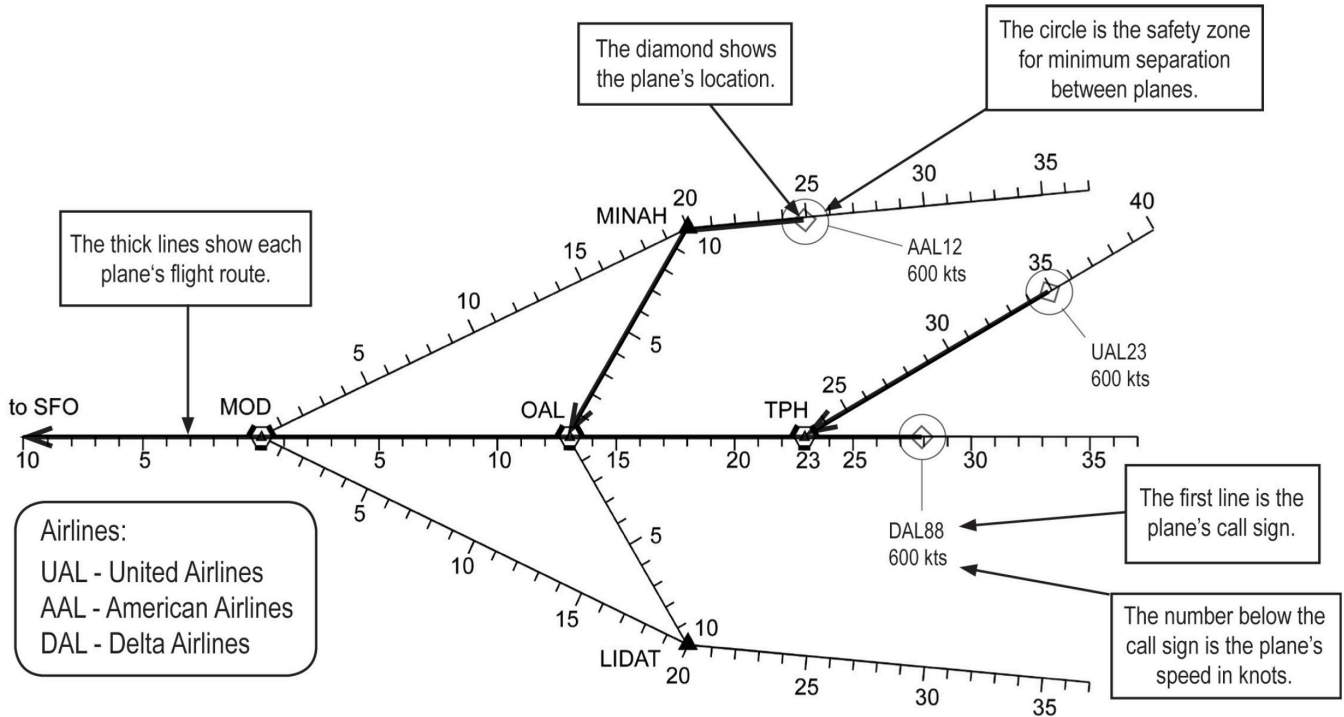**4** How far is it from MINAH to MOD directly? ☐ nautical miles

5 How much shorter is it to go from MINAH to MOD directly rather than by way of OAL? ☐ nautical miles

6 How much further is it to go from LIDAT to MOD by way of OAL rather than directly? ☐ nautical miles

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- Information for each plane, including it's position, is shown on the sector display.

The diamond shows the plane's location.

The circle is the safety zone for minimum separation between planes.

The thick lines show each plane's flight route.

MINAH

AAL12
600 kts

UAL23
600 kts

to SFO   MOD   OAL   TPH

DAL88
600 kts

The first line is the plane's call sign.

The number below the call sign is the plane's speed in knots.

LIDAT

Airlines:

UAL - United Airlines
AAL - American Airlines
DAL - Delta Airlines

7 Circle the diamond for the Delta Airlines flight on the sector display.

8 What is the speed of the Delta Airlines flight? [   ] knots

A **Flight Plan** is a plane's route of travel from intersection, including speed (knots) and altitude. In our case, the altitude will be the same for all planes.

9 Locate flight AAL12 and write the intersections (in order) for its flight plan to San Francisco (SFO):

To: [   ]   Then To: [   ]   Then To: [   ]

10 What is the length of the flight route of AAL12 from it's current position to MOD? [   ] nautical miles

11 What is the length of the flight route of UAL23 from its current position to MOD? [   ] nautical miles

Understand Airplane Spacing Requirements

Investigator: _____

The **Objective** of air traffic control is to *safely* and *efficiently* move planes to their destinations.

Safety - Minimum Separation

To be **safe**, planes must **always** be kept far enough apart that collisions and near-misses *NEVER* happen.

- The Federal Aviation Administration has established the least distance allowed between planes. This is called the **Minimum Separation**.

You will use   Minimum Separation = 2 nautical miles

- On air traffic control displays, this minimum separation is shown by a "safety circle" around the plane symbol. The circle radius is 1 nautical mile.

- When two circles just touch, the distance between the plane is 1 nautical mile + 1 nautical mile = 2 nautical miles, the minimum separation.
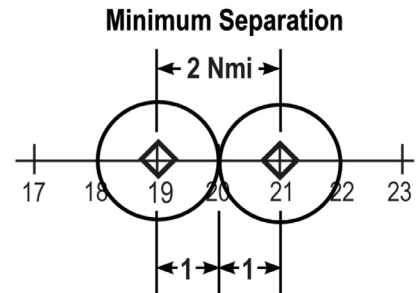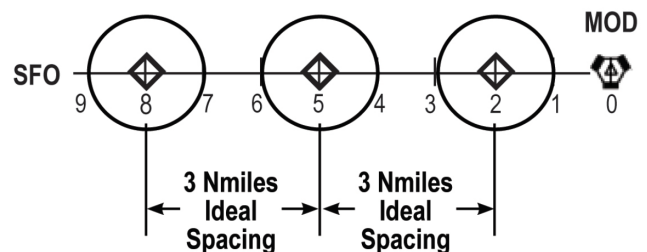

Efficiency - Ideal Spacing

- At SFO, planes arrive from Sector 33 and from other sectors.
  So, at MOD the Sector 33 controllers must leave more than 2 nautical miles to let planes from other sectors merge after MOD.

- This greater spacing is referred to as **Ideal Spacing**.

  Ideal Spacing at MOD = 3 nautical miles

- You must aim for Ideal Spacing at MOD.
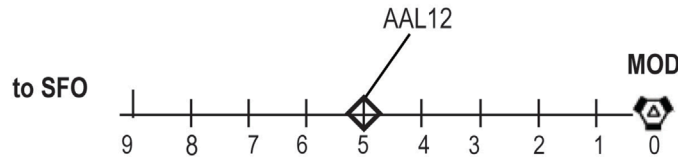 Everywhere else you need at least Minimum Separation.

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1   What is the <u>Minimum</u> Separation requirement?   ☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5   nautical miles

2   What is <u>Ideal</u> Spacing?   ☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5   nautical miles

3   On the plot below, AAL12 is flying from MOD to SFO. Using the Minimum Separation, draw a "safety circle" around the flight symbol for this flight.

4   UAL74 is **following** AAL12 to SFO. On the route, draw a diamond to show UAL74 at the <u>Minimum</u> Separation.

5   Draw a "safety circle" around the diamond for UAL74.

6   DAL88 is **ahead** of AAL12 to SFO. On the route, draw a diamond and a safety circle to show DAL88 at the <u>Ideal</u> Spacing.

7   In each Diagram, check all boxes that are **true**.