LineUp With Math™

Math-Based Decisions in Air Traffic Control for Grades 5–9

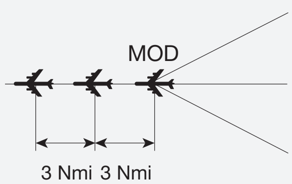
Problem Set F

Resolving 3-Plane Traffic Conflicts by Changing Speed

Teacher Guide with Answer Sheets

Three planes on merging routes are:
-- different distances from the intersection,
-- traveling at the same speed.
Alternate routes are not available.

Overview of Problem Set F



Estimated class time: 1.5 to 2 hours

In this Problem Set, students will determine whether three planes traveling on different merging routes will line up with proper spacing at MOD (the last intersection before the planes leave the airspace sector). If the spacing is not adequate, students will change the speed of one or more planes to achieve the proper spacing at MOD. In the final problem, students will make both speed and route changes to achieve proper spacing at MOD.

The planes are traveling at the same altitude and the same constant (fixed) speeds.

This is the most challenging of the *LineUp With Math*™ Problem Sets.

This Problem Set also includes an optimal solution time for each Simulator problem. A "target time" is posted on the Simulator screen. This target time is the minimum required for the last plane to reach the intersection at MOD. An on-screen clock keeps track of the flight time for a student's solution.

Each problem can be explored with the interactive Air Traffic Control (ATC) Simulator. Four of the problems can be more closely examined with Student Workbook F (print-based). The Workbook provides a structured learning environment for exploring the problems with paper-and-pencil worksheets that introduce students to pertinent air traffic control concepts as well as problem analysis and solution methods.

Objectives

Each plane is traveling at 600 knots, the maximum speed allowed. So to resolve a spacing conflict, students must reduce plane speeds.

Students will:

- Analyze a sector diagram to identify spacing conflicts among three planes, each traveling at the same speed.
- Resolve spacing conflicts by changing the speed of one or more planes.
- Resolve spacing conflicts by changing the speed or the speed and route of one or more planes.

Prerequisites

Before attempting the current 3-plane Problem Set, it is strongly recommended that students complete Problem Set A that introduces essential air traffic control vocabulary, units, and representations. Students should also complete Problem Sets D and E that introduce speed changes for two planes.

Materials

- ATC Simulator (web-based)
- Student Workbook E (print-based)

The materials are available on the *LineUp With Math*™ website:

http://www.smartskies.nasa.gov/lineup

A separate student website gives students easy access to the Simulator only (and not to the answers and solutions provided on the teacher website):

https://atcsim.nasa.gov/simulator/sim2/sector33.html

ATC Simulator

A complete description of the ATC Simulator is contained in the Educator Guide for LineUp With Math™.

For a simulator quick start guide and an animated tutorial, visit the LineUp With Math™ *website.*

Interactive Air Traffic Control Simulator

Students can explore Problem Set F with the interactive ATC Simulator. Each problem features 3-plane conflicts that can be resolved by speed changes or by route and speed changes.

The Simulator problems for Problem Set F are:

3-3*; 3-4*; 3-5*; 3-6*; 3-8, 3-9; 3-10; 3-11; 3-12

Problems with an asterisk (*) are supported by worksheets in Student Workbook E.

An optimal solution time ("target time") is displayed on the screen for each Simulator problem. This target is the minimum time required for the last plane to reach the intersection at MOD. An on-screen clock keeps track of the flight time for a student's solution.

For a complete set of answers and solutions to all Problem Set F Simulator problems, see Appendix I of this document.

For a discussion of the key points associated with the first four Simulator problems, see the worksheet notes in the following Student Workbook section.

Student Workbook

It is recommended that you have a copy of Student Workbook F open while you read these notes.

The worksheet title is the same as the associated Simulator problem.

The Student Workbook consists of four worksheets, one for each of the four featured Simulator problems listed below.

Simulator Problem	Worksheet Title
3-3*	Problem 3-3
3-4*	Problem 3-4
3-5*	Problem 3-5
3-5*	Problem 3-6

Each problem features a spacing conflict with different starting conditions. After the first worksheet, the students will require less guidance and structure, and the subsequent worksheets reflect this.

For a complete set of answers to each worksheet, see Appendix II of this document.

For each worksheet, they key points are briefly described as follows.

Worksheet: *Problem 3-3*

*In the sector diagram, each route flows only **towards** MOD. E.g., a plane may fly from MINAH to OAL, but cannot fly from OAL to MINAH.*

- On a number line, students plot the relative spacing of each plane at MOD to help picture the arrival order of the planes at MOD, their relative spacing, and any spacing violations.
- To identify spacing conflicts, students begin by considering the first and second planes to arrive at MOD. Students determine that the second plane needs 2 additional nautical miles of spacing to achieve Ideal Spacing.
- Next, students identify conflicts between the second plane (with its **new** spacing) and the third plane to arrive at MOD. Students determine that the third plane needs 2 additional nautical miles of spacing to achieve Ideal Spacing.
- To achieve Ideal Spacing at MOD between the first and second planes, students slow the second plane. A 60-knot speed decrease achieves the 2-nautical mile additional spacing in 2 minutes. It takes the first plane 3 minutes (30 nautical miles at 600 knots) to arrive at MOD. In a similar manner, students achieve Ideal Spacing between the second and third planes.

Worksheet: *Problem 3-4*

- Students use the same problem-solving approach as in Problem 3-3. Minimal structure is provided to lead students to the solution.
- Students first identify spacing conflicts between the first and second planes to arrive at MOD. Then students use the **new** spacing of the second plane to identify the spacing conflict between the second and third planes.

Worksheet: *Problem 3-5*

- As in Problem 3-3 and Problem 3-4, students first identify spacing conflicts at MOD and resolve these conflicts to achieve Ideal Spacing (3 nautical miles) at MOD.
- In this problem, unlike Problem 3-3 and Problem 3-4, two planes (UAL74 and DAL88) pass through OAL on their way to MOD. Students must determine whether their resolution of the MOD spacing conflict violates the Minimum Separation requirement (2 nautical miles) at OAL.
- At the given starting distances (UAL74 is 17 nautical miles from OAL and DAL88 is 18 nautical miles from OAL) and starting speeds, there will be only 1 nautical mile of spacing between the planes at OAL. This does not meet the Minimum Separation requirement (2 nautical miles). However, after the 60-knot speed reduction for DAL88 (introduced to achieve Ideal Spacing at MOD), DAL88 will achieve an additional 1 nautical mile of spacing in 10 nautical miles. So Minimum Separation is achieved before OAL.

Worksheet: *Problem 3-6*

- This is the first problem to require students to make a route change and a speed change to achieve Ideal Spacing at MOD.
- In this problem, the original positions of two planes, DAL88 (30 nautical miles from MOD) and UAL74 (34 nautical miles from MOD), will give 4 nautical miles spacing at MOD. This is more than the Ideal Spacing (3 nautical miles). To achieve Ideal Spacing exactly (for efficiency purposes), students can reroute UAL74 and make a speed reduction.
- With the new route, UAL74 is 31 nautical miles from MOD, so an additional 2 nautical miles of spacing are required at MOD. Students can slow UAL74 by 60 knots to achieve the 2 nautical mile additional spacing in 2 minutes. Then, to maintain Ideal Spacing and not fall further behind, students can return UAL74 to 600 knots after 2 minutes.
- With the route change and the speed change, UAL74 now has 3 nautical miles of spacing with respect to each of the other two planes.

Answer Sheets

For a set of answers and solutions to all Simulator problems, visit the LineUp with Math™ website.

Answer sheets for each of the Problem Set F Simulator problems can be found in Appendix I of this document.

Answer sheets for each worksheet in Student Workbook F can be found in Appendix II of this document.

LineUp With Math™

APPENDIX 1

Air Traffic Control Simulator

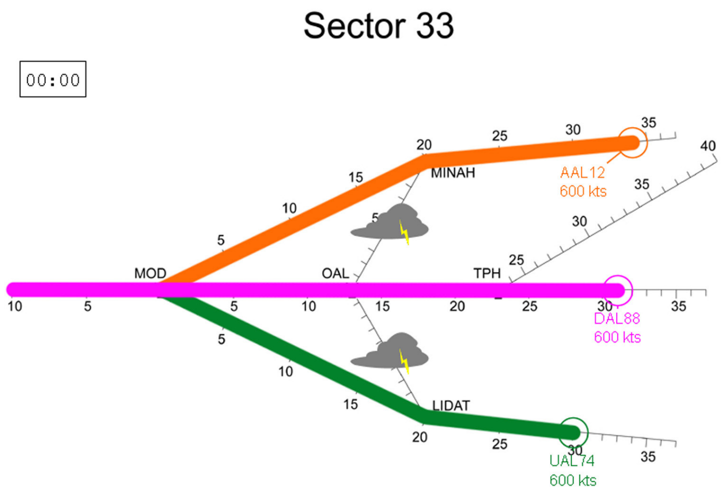
Simulator Solutions for Problem Set F

3-3*, 3-4*, 3-5*, 3-6*
3-8, 3-9, 3-10, 3-11, 3-12

Problems with an asterisk (*) are supported by worksheets in Student Workbook F

Problem 3-3 Solution

Starting Conditions:



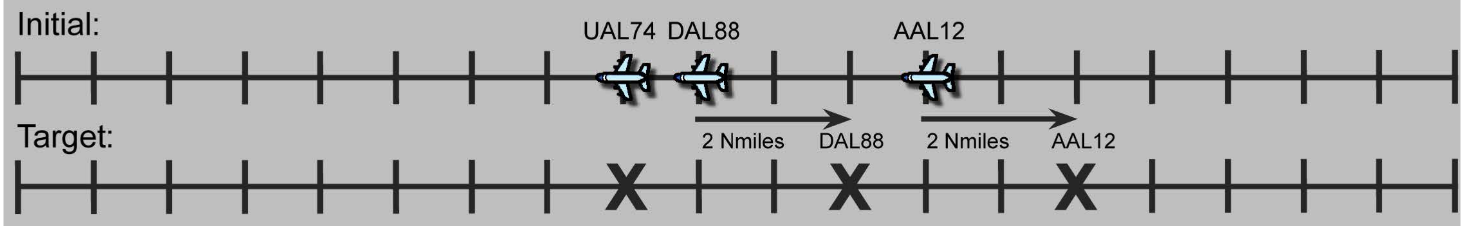
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	34	600
DAL88	TPH	OAL	MOD	31	600
UAL74	LIDAT		MOD	30	600

- Route from **MINAH** to **OAL is closed**.
- Route from **LIDAT** to **OAL is closed**.
- Ideal spacing at **MOD** is 3 nautical miles.

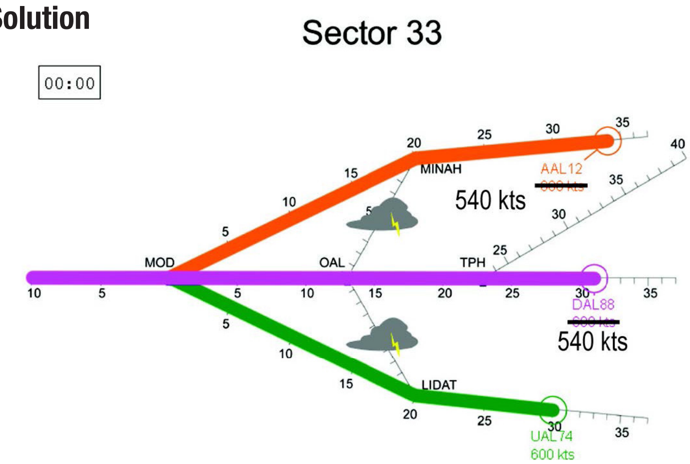
Analysis:

- **<u>Conflict</u>: DAL88** will arrive at MOD **1 nautical mile** behind UAL74.
- **Weather** prevents **UAL74 <u>and</u> AAL12** from rerouting.
- **DAL88** can slow down to fall back 2 nautical miles. **AAL12** will then need to slow down to fall back 2 nautical miles.

Project Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	UAL74	30	
2nd	DAL88	31	1
3rd	AAL12	34	3



Solution



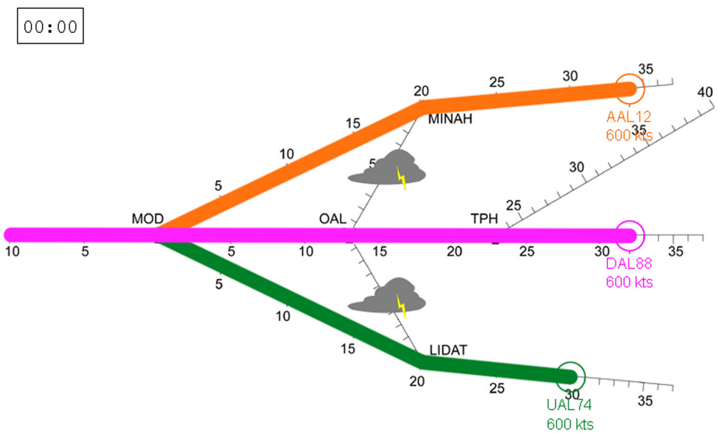
- **AAL12** - Slow down to 540 knots for 2 minutes to fall back 2 nautical miles. Then speed up to 600 knots.
- **DAL88** - Slow down to 540 knots for 2 minutes to fall back 2 nautical miles. Then speed up to 600 knots.

- **Target Time** - 3 minutes and 36 seconds.

Problem 3-4 Solution

Starting Conditions:

Sector 33



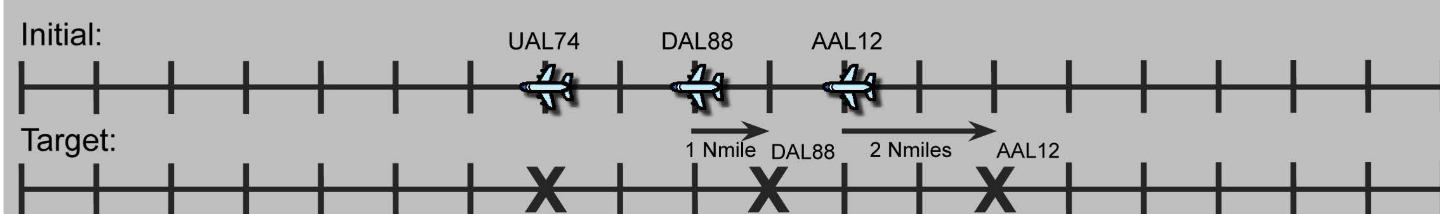
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	34	600
DAL88	TPH	OAL	MOD	32	600
UAL74	LIDAT		MOD	30	600

- Route from **LIDAT** to **OAL is closed**.
- Route from **MINAH** to **OAL is closed**.
- Ideal spacing at **MOD** is 3 nautical miles.

Analysis:

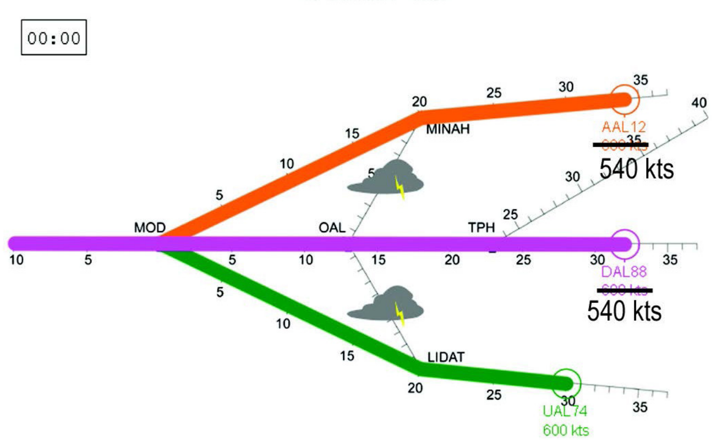
- **UAL74 AND DAL88** will arrive at MOD 2 nautical miles apart. **AAL12 AND DAL88** will arrive at MOD 2 nautical miles apart.
- **Weather** prevents **UAL74 AND AAL12** from rerouting.
- **DAL88 AND AAL12** both need to slow down to fall back 1 and 2 nautical miles, respectively.

Project Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	UAL74	30	
2nd	DAL88	32	2
3rd	AAL12	34	2



Solution

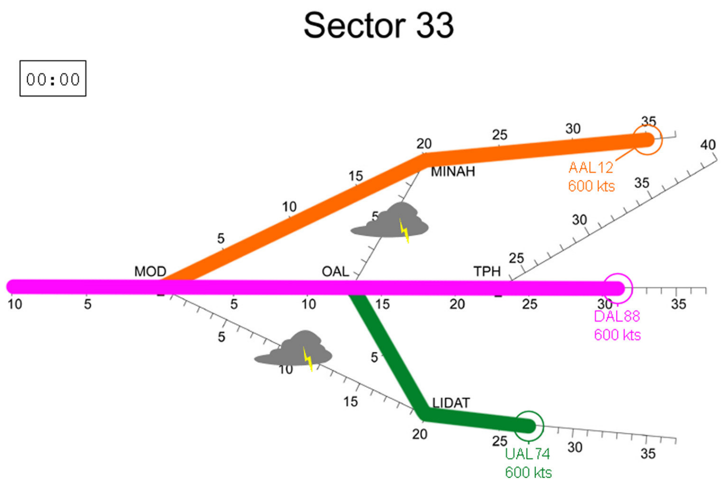
Sector 33



- **DAL88** - Slow down to 540 knots for 1 minute to fall back 1 nautical mile. Then speed up to 600 knots.
- **AAL12** - Slow down to 540 knots for 2 minutes to fall back 2 nautical miles. Then speed up to 600 knots.
- **Target Time** - 3 minutes and 36 seconds.

Problem 3-5 Solution

Starting Conditions:



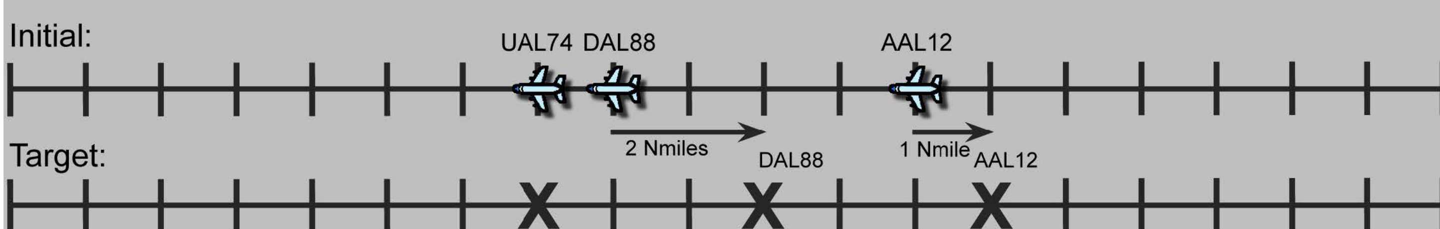
Plane	From	Through	To	Distance	Speed
AAL12	MINAH		MOD	35	600
DAL88	TPH	OAL	MOD	31	600
UAL74	LIDAT	OAL	MOD	30	600

- Route from **MINAH** to **OAL is closed.**
- Route from **LIDAT** to **MOD is closed.**
- Ideal spacing at **MOD** is 3 nautical miles.

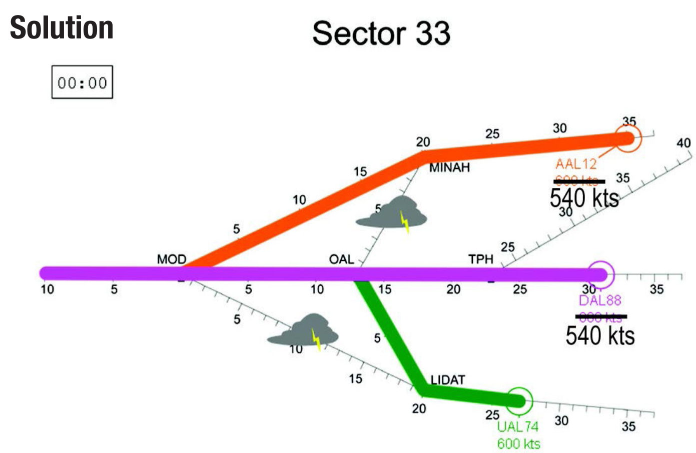
Analysis:

- <u>**Conflict**</u>**: DAL88** will arrive at OAL **1 nautical mile** behind **UAL74.**
- **Weather** prevents **AAL12** <u>**AND**</u> **UAL74** from rerouting.
- **DAL88** needs to slow down to fall back 2 nautical miles (at least 1 nautical mile before OAL).
- **AAL12** needs to slow to fall back 1 nautical mile before **OAL.**

Project Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	UAL74	30	
2nd	DAL88	31	1
3rd	AAL12	35	4



Solution



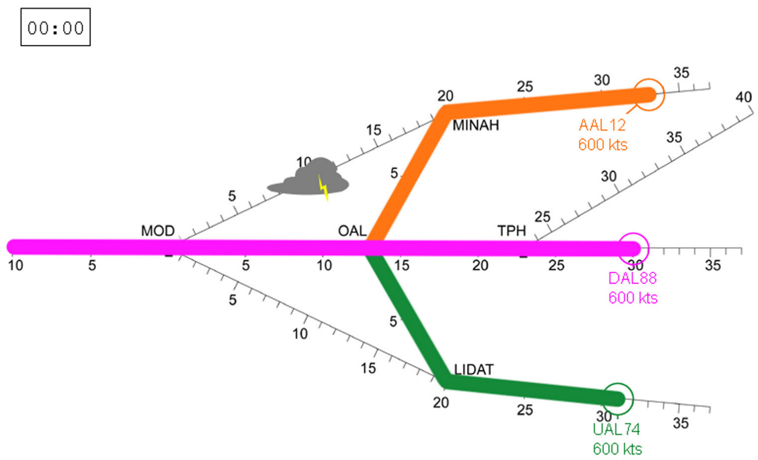
- **DAL88** - Slow down to 540 knots for 2 minutes to fall back 2 nautical mils. Then speed up to 600 knots.
- **AAL12** - Slow down to 540 knots for 1 minute to fall back 1 nautical mile before OAL. Then speed up to 600 knots.
- **Target Time** - 3 minutes and 36 seconds.

Problem 3-6

Solution

Starting Conditions:

Sector 33



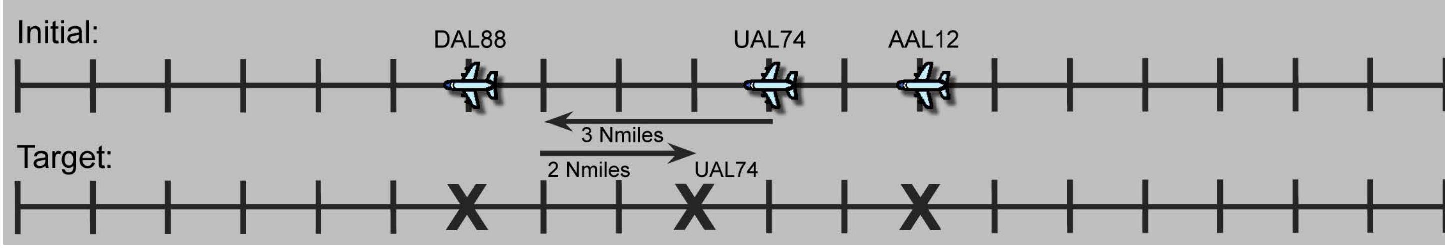
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	36	600
DAL88	TPH	OAL	MOD	30	600
UAL74	LIDAT	OAL	MOD	34	600

- Route from **MINAH** to **MOD is closed**.
- Ideal spacing at **MOD** is 3 nautical miles.

Analysis:

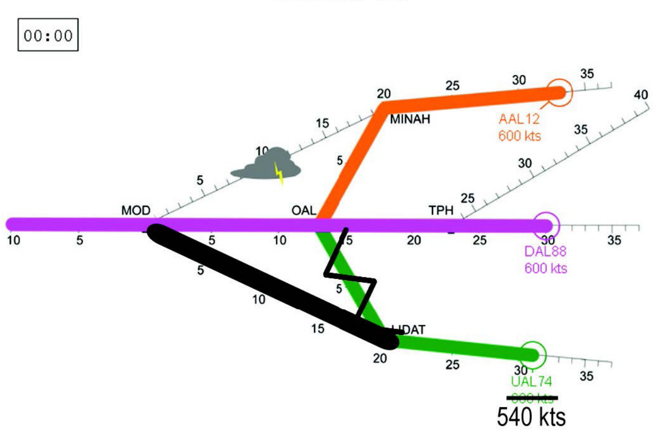
- **AAL12** will arrive at OAL **2 nautical miles** behind UAL74.
- **Weather** prevents **AAL12** from rerouting.
- **UAL74** can take the shortcut to shorten its travel distance by 3 nautical miles and then can slow down to fall back 2 nautical miles.

Project Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	DAL88	30	
			4
2nd	UAL74	34	
			2
3rd	AAL12	36	



Solution

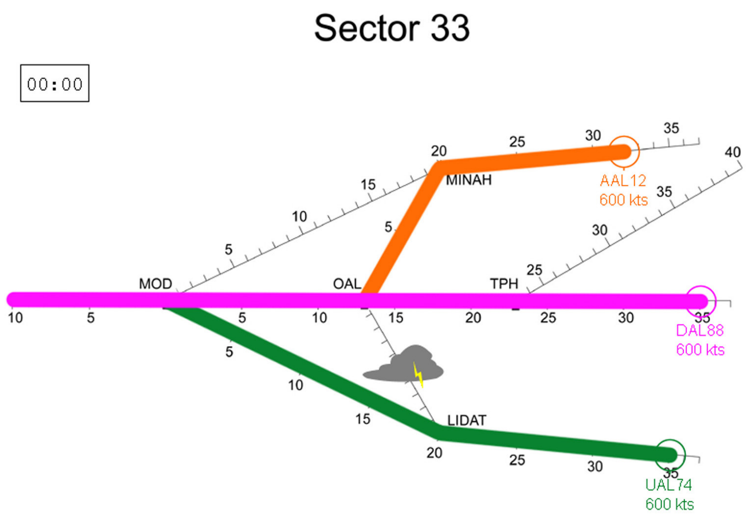
Sector 33



- **UAL74** - Slow down to MOD to move forward 3 nautical miles and then slow down to 540 knots for 2 minutes to fall back 2 nautical miles. Then speed up to 600 knots.
- **Target Time** - 3 minutes and 36 seconds.

Problem 3-8 Solution

Starting Conditions:



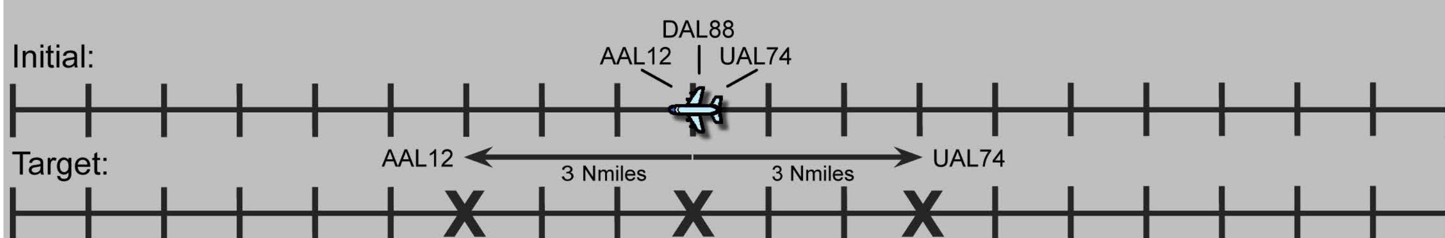
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	35	600
DAL88	TPH	OAL	MOD	35	600
UAL74	LIDAT		MOD	35	600

- Route from **LIDAT** to **OAL is closed**.
- Ideal spacing at **MOD** is 3 nautical miles.

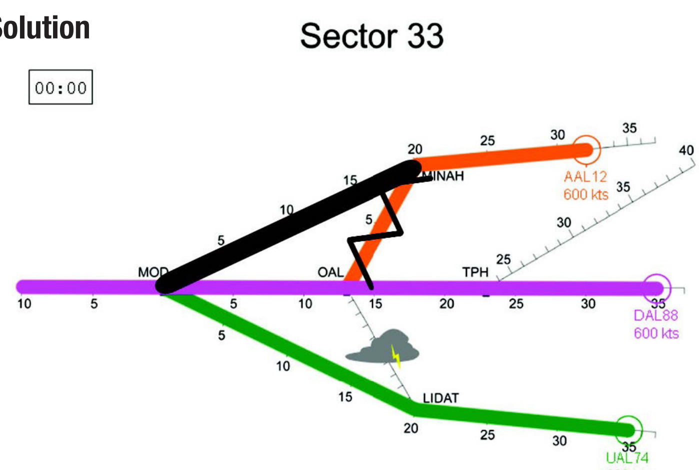
Analysis:

- **Conflict: AAL12, UAL74, AND DAL88** will arrive at MOD at the same time.
- Weather prevents **UAL74** from rerouting.
- **AAL12** can take the shortcut to shorten its travel distance by 3 nautical miles. **UAL74** can slow down to fall back 3 nautical miles.

Project Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	35	0
1st	DAL88	35	0
1st	UAL74	35	



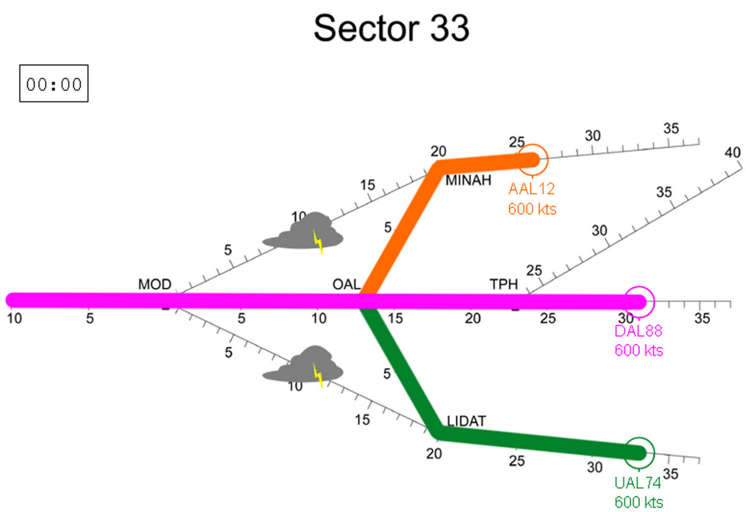
Solution



- **AAL12** - Reroute direct to MOD to move forward 3 nautical miles.
- **UAL74** - Slow down to 540 knots for 3 minutes to lose 3 nautical miles. Then speed up to 600 knots.
- **Target Time** - 3 minutes and 48 seconds.

Problem 3-9 Solution

Starting Conditions:



Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	29	600
DAL88	TPH	OAL	MOD	31	600
UAL74	LIDAT	OAL	MOD	36	600

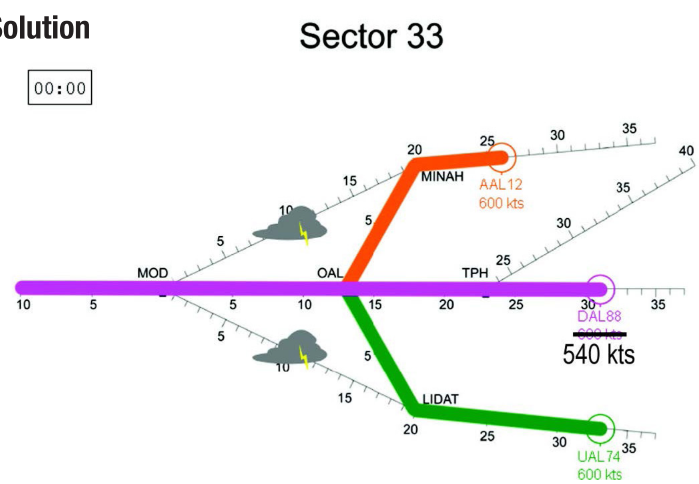
- Route from **MINAH** to **MOD is closed**.
- Ideal spacing at **MOD** is 3 nautical miles.

Analysis:

- **DAL88** will arrive at OAL **2 nautial mile** behind **AAL12**. **UAL74** will be 5 nautical miles behind **DAL88**.
- **Weather** prevents **UAL74 <u>AND</u> AAL12** from rerouting.
- **DAL88** can slow down to fall back 1 nautical mile.

Project Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	29	
2nd	DAL88	31	2
3rd	UAL74	36	5

Solution



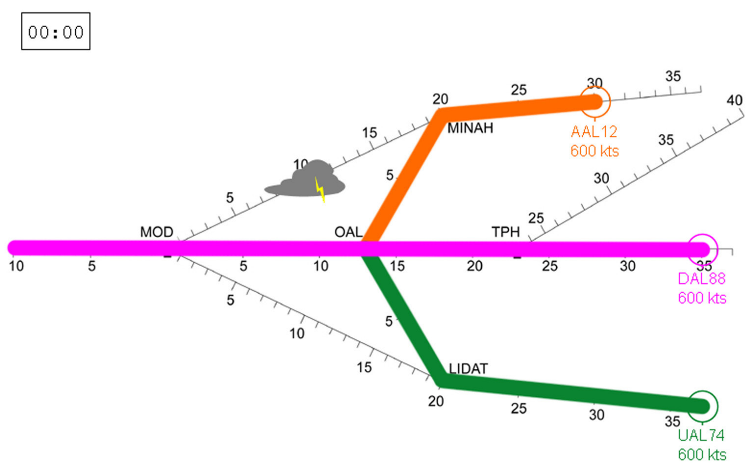
- **DAL88** - Slow down to 540 knots for 1 minute to fall back 1 nautical miles. Then speed up to 600 knots.
- **UAL74** - Spacing is 4 nautical miles. This is greater than 3 nautical miles Ideal Spacing.
- **Target Time** - 3 minutes and 36 seconds.

Problem 3-10

Solution

Starting Conditions:

Sector 33



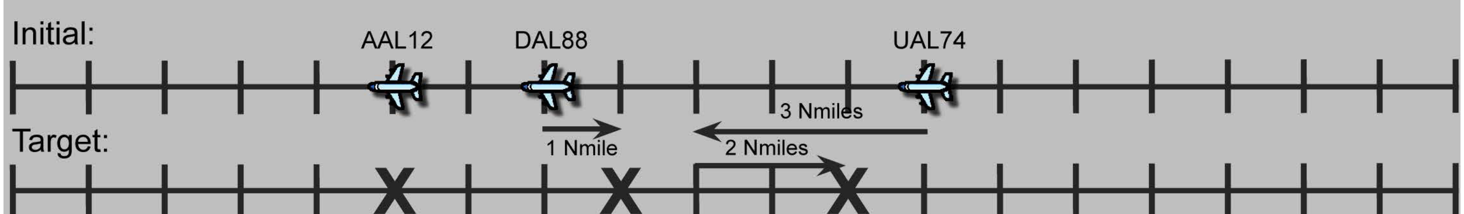
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	33	600
DAL88	TPH	OAL	MOD	35	600
UAL74	LIDAT	OAL	MOD	40	600

- Route from **MINAH** to **OAL is closed**.
- Ideal spacing at **MOD** is 3 nautical miles.

Analysis:

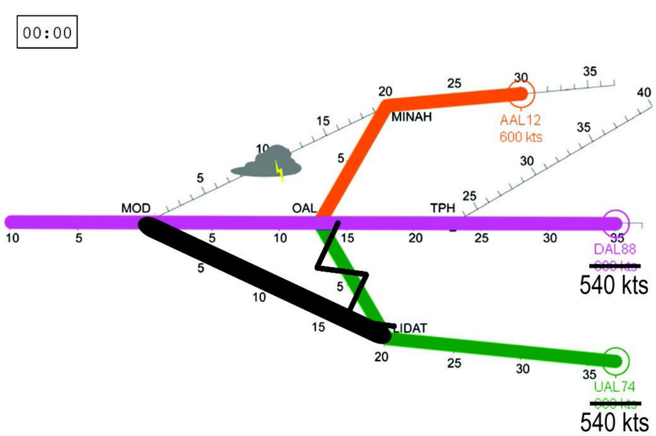
- **DAL88** will arrive at OAL 2 nautical miles behind **AAL12**
  UAL74 will be 5 nautical miles behind.
- **Weather** prevents **AAL12** from rerouting.
- **DAL88** can slow down to fall back 1 nautical mile. **UAL74** can take the shortcut to shorten its travel distance by 3 nautial miles and slow down to fall back 2 nautical miles.

Project Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	33	
2nd	DAL88	35	2
3rd	UAL74	40	5



Solution

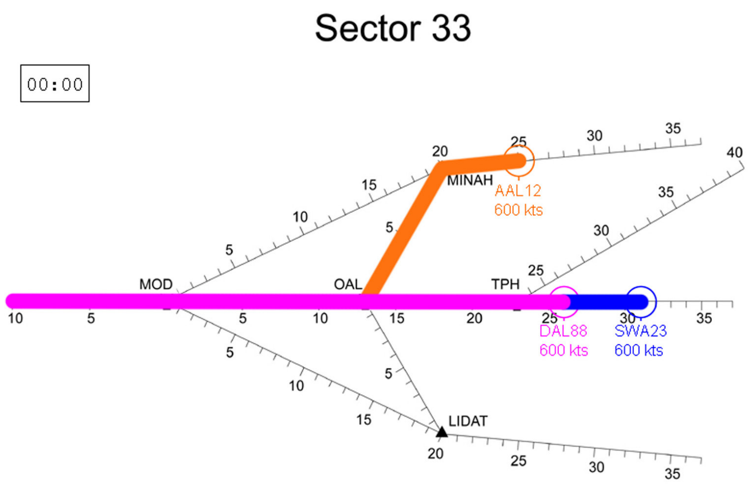
Sector 33



- **DAL88** - Slow down to 540 knots for 1 minute to fall back 1 nautical mile. Then speed up to 600 knots.
- UAL74 - Reroute direct to MOD to move up 3 nautical miles. Slow down to 540 knots for 2 minutes to fall back 2 nautical miles. Then speed up to 600 knots.
- **Target Time** - 3 minutes and 36 seconds.

Problem 3-11 Solution

Starting Conditions:



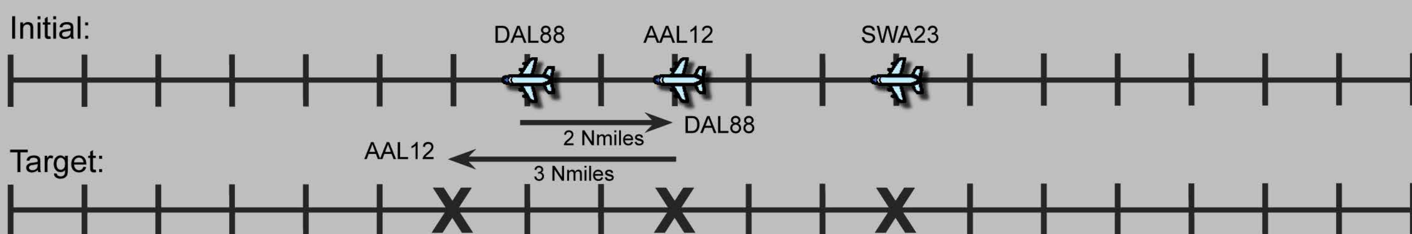
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	28	600
DAL88	TPH	OAL	MOD	26	600
SWA23	TPH	OAL	MOD	31	600

- Ideal spacing at **MOD** is 3 nautical miles.

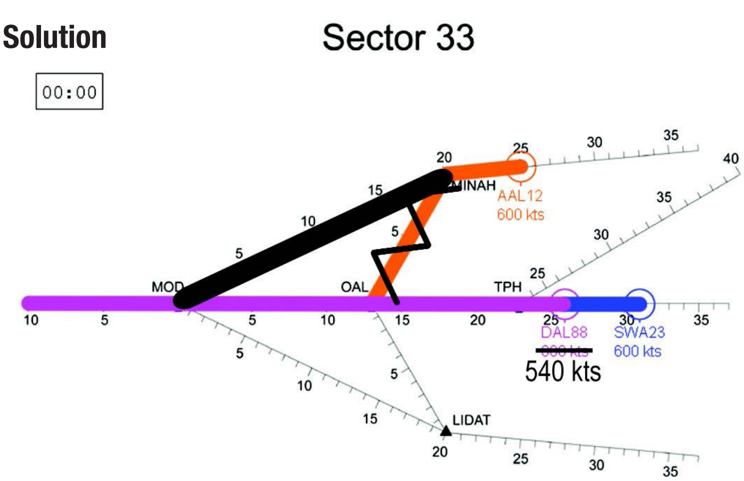
Analysis:

- **DAL88** will arrive at OAL **2 nautical miles** behind **AAL12**. **UAL74** will be 5 nautical miles behind.
- **Weather** prevents **AAL12** from rerouting.
- **DAL88** can slow down to fall back 1 nautical mile. **UAL74** can take the shortcut to shorten its travel distance by 3 nautical miles and slow down to fall back 2 nautical miles.

Project Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	DAL88	26	
			2
2nd	AAL12	28	
			3
3rd	SWA23	31	



Solution

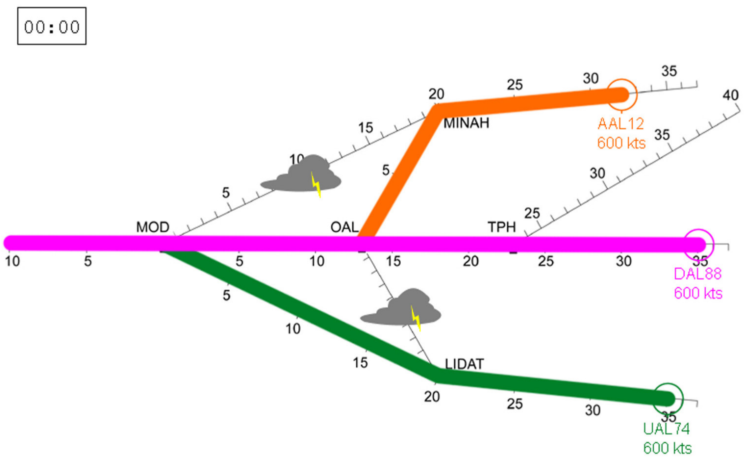


- **AAL12** - Reroute AAL12 direct to MOD to move forward by 3 nautical miles.
- DAL88 - Slow down to 540 knots for 2 minutes to fall back 2 nautical miles. Then speed up to 600 knots.
- **Target Time** - 3 minutes and 6 seconds.

Problem 3-12 Solution

Starting Conditions:

Sector 33



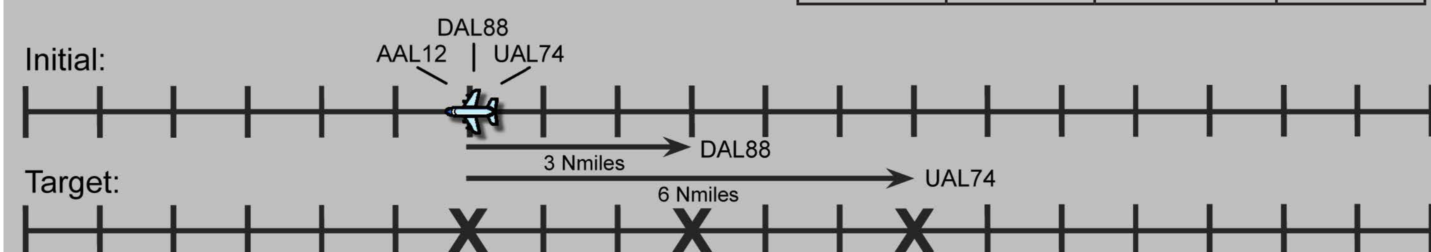
Plane	From	Through	To	Distance	Speed
AAL12	MINAH	OAL	MOD	35	600
DAL88	TPH	OAL	MOD	35	600
UAL74	LIDAT		MOD	35	600

- Route from **LIDAT** to **OAL is closed**.
- Route from **MINAL** to **MOD is closed**.
- Ideal spacing at **MOD** is 3 nautical miles.

Analysis:

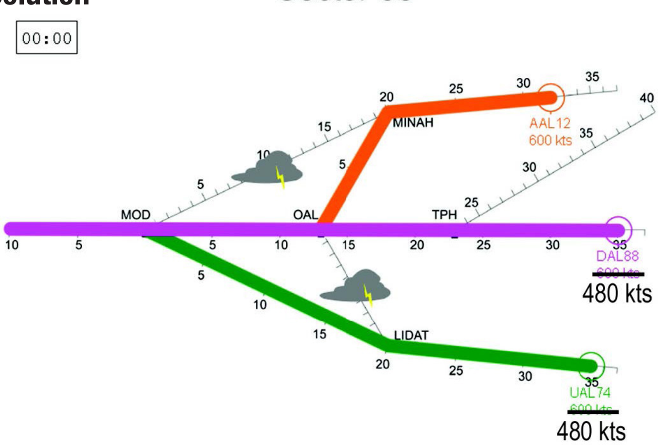
- **<u>Conflict</u>: AAL12, UAL74, <u>AND</u> DAL88** will arrive at MOD at the same time.
- **Weather** prevents **UAL74 <u>AND</u> AAL12** from rerouting.
- One plane must slow down to lose 3 nautical miles and one plane must slow down to lose 6 nautical miles.

Project Arrival	Plane	Distance Along Flight Plan	Initial Spacing
1st	AAL12	35	
1st	DAL88	35	0
1st	UAL74	35	0



Solution

Sector 33



- **UAL74** - Slow down to 480 knots for 3 minutes to fall back 6 nautical miles (at 5 nautical miles from MOD). Then speed up to 600 knots.
- **DAL88** - Slow down to 480 knots for 1.5 minutes to fall back 3 nautical miles (at 2 nautical miles from OAL) before a possible conflict at OAL. Then speed up to 600 knots.
- **Target Time** - 4 minutes and 6 seconds.

LineUp With Math™

Math-Based Decisions in Air Traffic Control

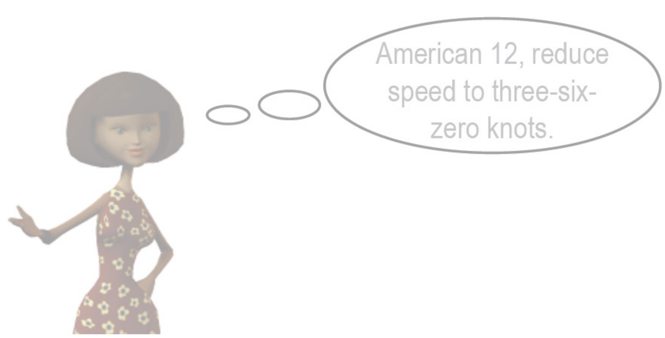
Student Workbook F

Appendix II

Workbook Answers

- Resolving Air Traffic Conflicts by Changing Speed
  - 3 planes, each at the same starting speed.
  - Student Problems 3-3, 3-4, 3-5, 3-5.

- Simulator at: atcsim.nasa.gov



Investigator: ______________________

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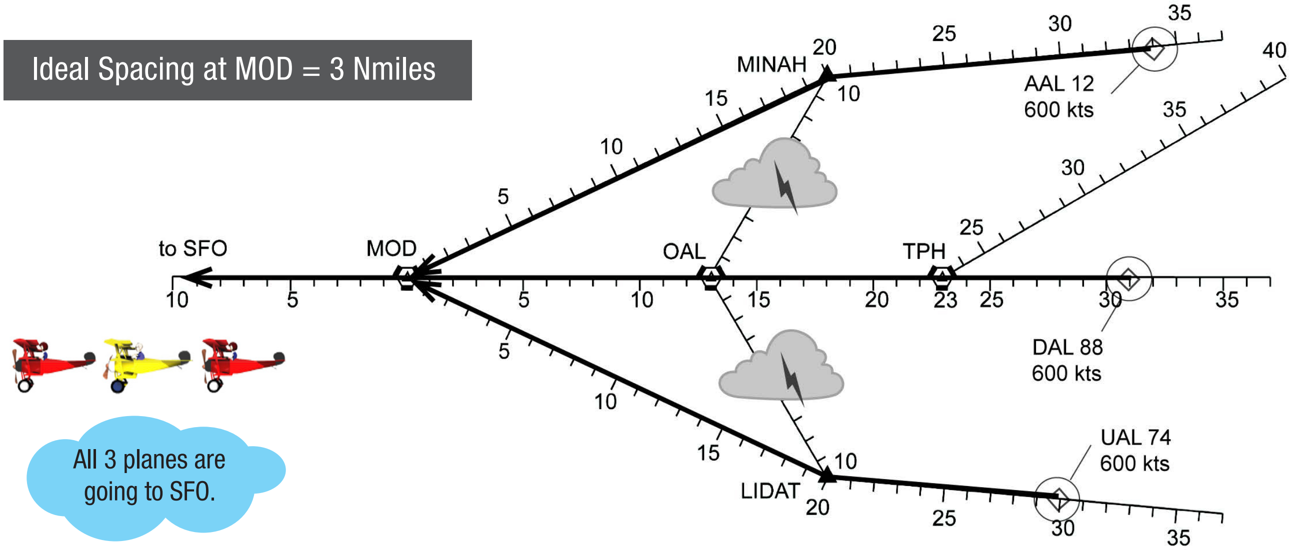
Ideal Spacing at MOD = 3 Nmiles



- If we need to change spacing, we must change speed. The alternate routes are closed.

1 To find the arrival order of the 3 planes at MOD, fill in the table.

Plane	AAL12	DAL88	UAL74
Distance to MOD, Nmi	34	31	30
Arrival Order	3rd	2nd	1st

It helps to picture the arrival order and spacing at MOD!

- To picture the arrival order and spacing of each plane, we use a number line.
- We start with the first plane to arrive and work back to the last plane.

2 Use a ◇ to show the order and spacing for the 3rd plane. Label your ◇ with "AAL12".

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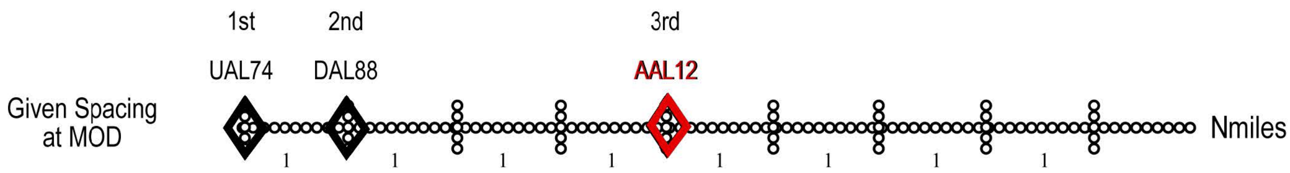
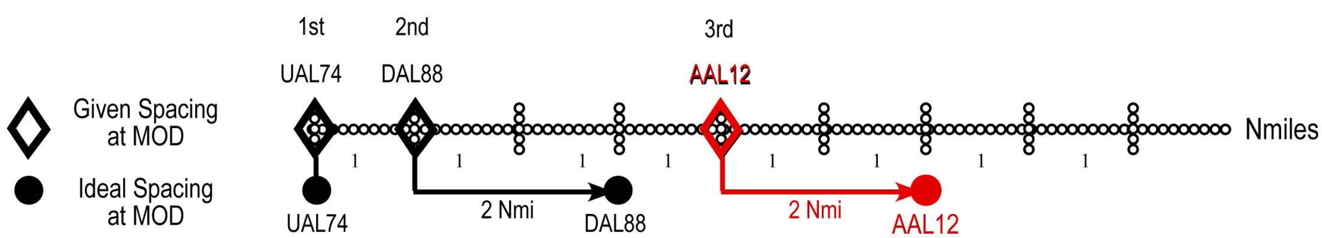


- Next we determine the additional spacing needed to get Ideal Spacing at MOD.

3 To get Ideal Spacing between the first and second plane, how much additional spacing do you need? **2** nautical miles

- We use an arrow to show the additional spacing needed for the 2nd plane.

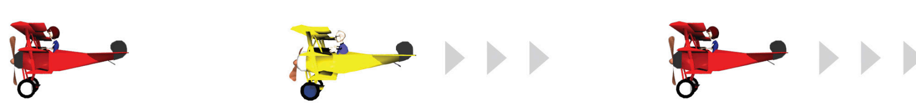
  We picture the new spacing with a ● at the end of the arrow. We label the ● with the plane's call sign.



4 Now, how much additional spacing do you need between the second and third plane to get Ideal Spacing? (Be sure to use the NEW position of the second plane.) **2** nautical miles

5 Use an arrow to show the additional spacing for the third plane (AAL12).

Put a ● at the end of the arrow to show the new spacing. Label the ● with "AAL12".



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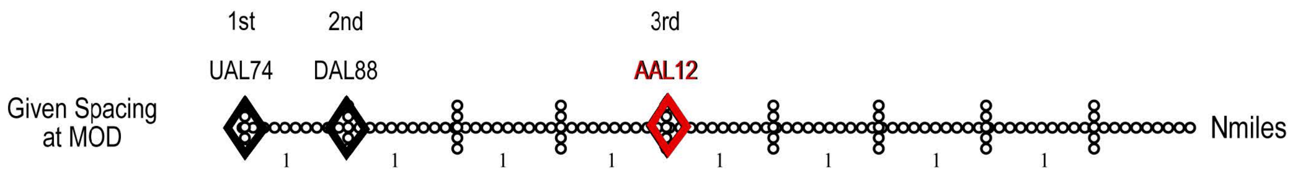


- Now that you know the additional spacing you need, what speed changes will you make? Begin with the second plane (DAL88).

6 How much will you slow the DAL88 speed? **60** knots What will the new speed be? **540** knots

7 How many minutes will it take to get the additional spacing? **2** minutes

2 Nmi needed ÷ 1 Nmi/min = 2 mins

A 60-knot difference in speed will cause a 1 Nmile difference in spacing **each minute**.

8 Will you get the additional spacing needed before MOD? **X** Yes ☐ No

540 kts = 9 Nmi/Min

$$T_{MOD\ for\ DAL88} = 31\ Nmi \div 9\ Nmi/min \approx 3.4\ mins > 2\ mins$$

9 Now what speed changes will you make for the third plane, AAL12? Fill in the table.

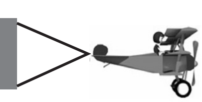
	Additional Spacing	New Speed	Time Until Ideal Spacing	At or Before MOD?
AAL12	**34** Nmi	**540** Kts	**31** Mins	**X** Yes ☐ No

2 Nmi needed ÷ 1 Nmi/min difference = 2 mins

$$T_{MOD\ for\ AAL12} = 34\ Nmi \div 9\ Nmi/min \approx 3.8\ mins > 2\ mins$$

If Yes, congratulations!

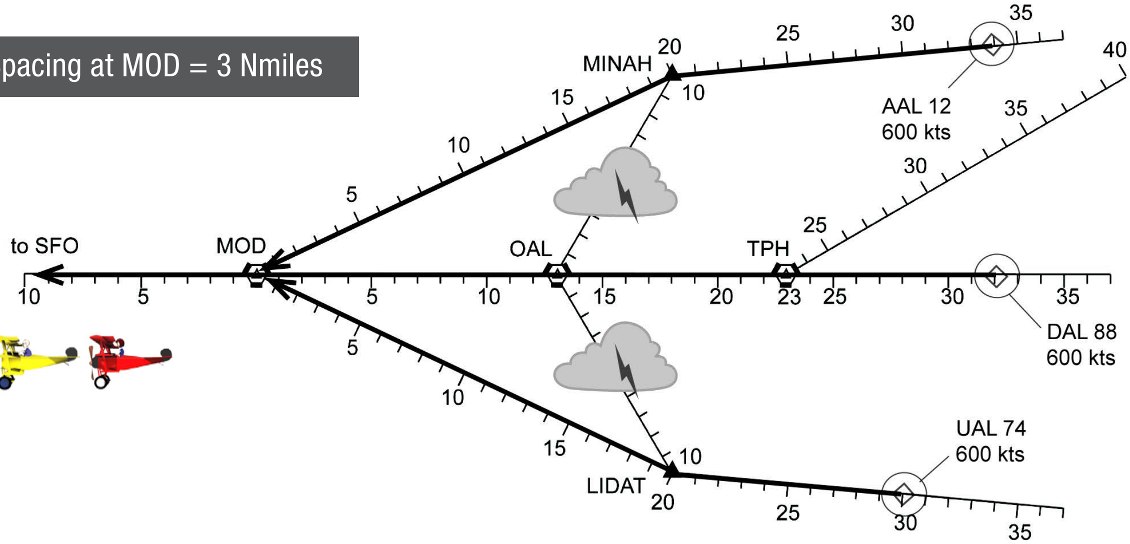
End of Worksheet



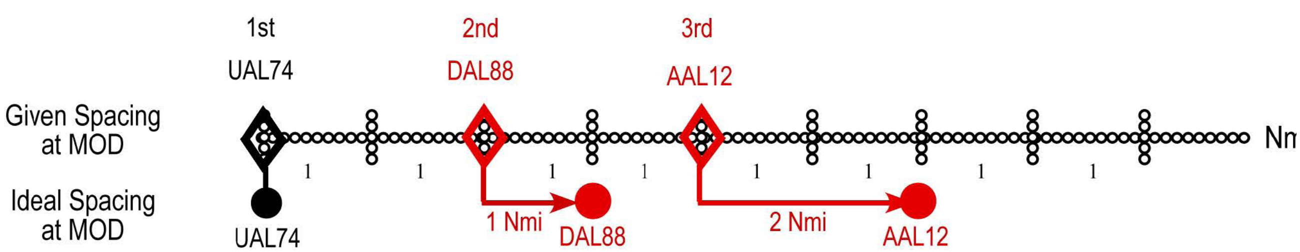
Problem 3-4

Investigator: ______________________

Ideal Spacing at MOD = 3 Nmiles



1 First, plot each plane's given spacing at MOD with a ◊. Then plot the Ideal Spacing with a ●. Label each symbol with the plane's call sign. Use an arrow to show the additional spacing needed.



2 What speed changes will you make to get Ideal Spacing at MOD? Fill in the table.

Order	Call Sign	**Additional** Spacing	New Speed	Time Until Ideal Spacing	At or Before MOD?
2nd	*DAL88*	*1* Nmi	*540* Kts	*1* Mins	X Yes ☐ No
3rd	*AAL12*	*2* Nmi	*540* Kts	*2* Mins	X Yes ☐ No

DAL88: T_{MOD} ***= 34 Nmi ÷ 9 Nmi/min ≈ 3.6 mins > 1 min***

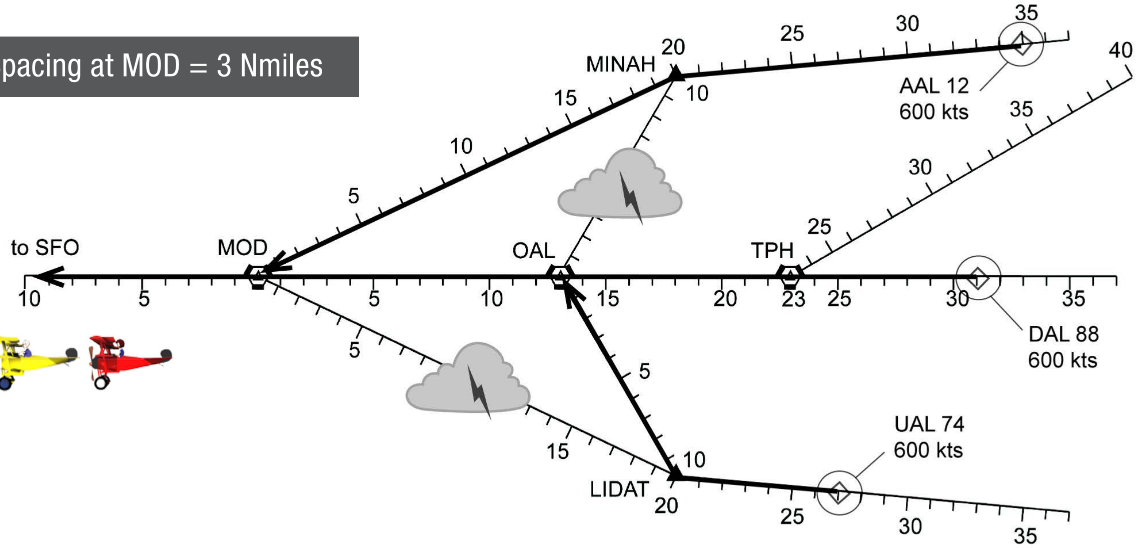
AAL12: T_{MOD} ***= 34 Nmi ÷ 9 Nmi/min ≈ 3.8 mins > 2 mins***

If Yes, congratulations!

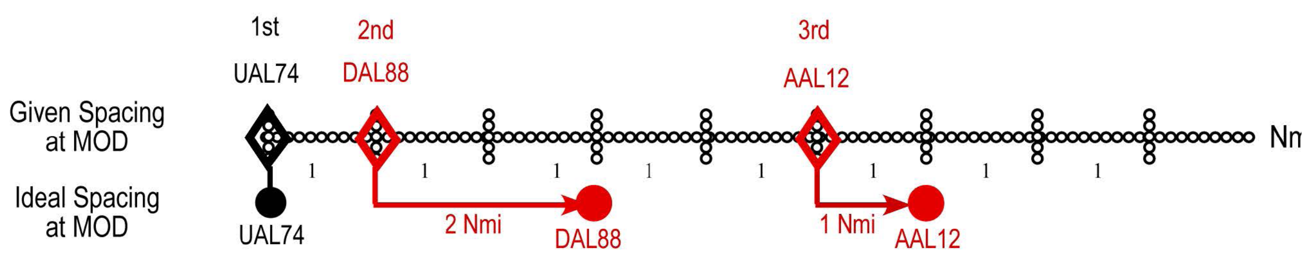
End of Worksheet

Investigator: ______________________

Ideal Spacing at MOD = 3 Nmiles



1 First, plot each plane's given spacing at MOD with a ◊. Then plot the Ideal Spacing with a ●. Label each symbol with the plane's call sign. Use an arrow to show the additional spacing needed.



2 What speed changes will you make to get Ideal Spacing at MOD? Fill in the table.

Order	Call Sign	**Additional** Spacing	New Speed	Time Until Ideal Spacing	At or Before MOD?
2nd	***DAL88***	***2*** Nmi	***540*** Kts	***2*** Mins	**X** Yes ☐ No
3rd	***AAL12***	***1*** Nmi	***540*** Kts	***1*** Mins	**X** Yes ☐ No

3 At the new speeds, will UAL74 and DAL88 have at least minimum spacing (2 Nmi) at **OAL**? **X** Yes ☐ No

$T_{OAL\ for\ UAL74}$ = 17 Nmi ÷ 10 Nmi/min = 1.7 mins

1 Nmi headstart + 1 Nmi/min • 1.7 mins = 1 + 1.7 = 2.7 Nmi > 2 Nmi

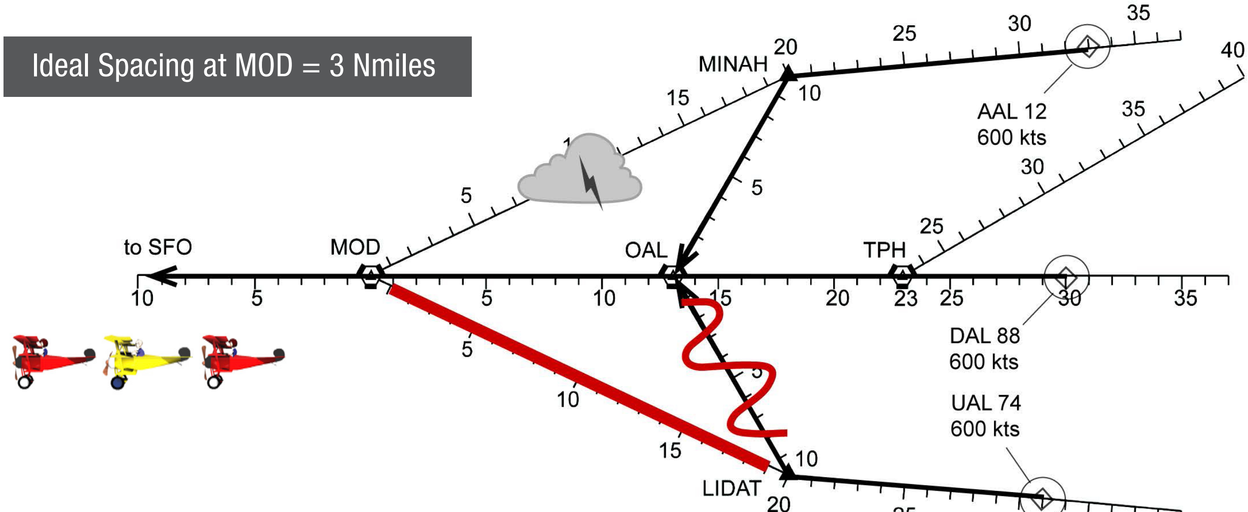
4 If No, how will you redo your speed changes?

Not needed.

End of Worksheet

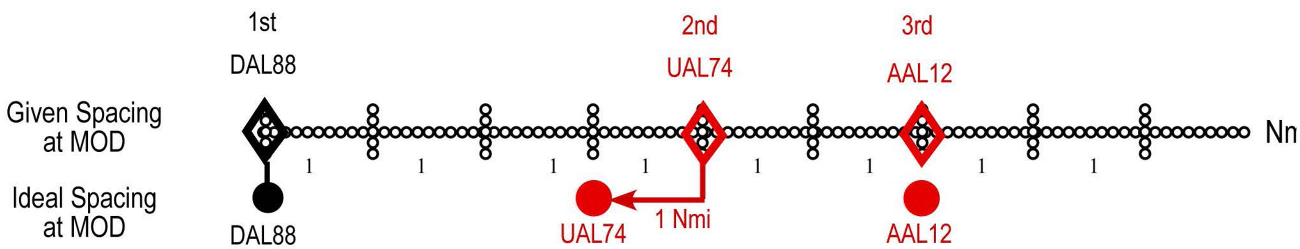
Investigator: ______________________

Ideal Spacing at MOD = 3 Nmiles



Remember, you need Ideal Spacing at MOD.

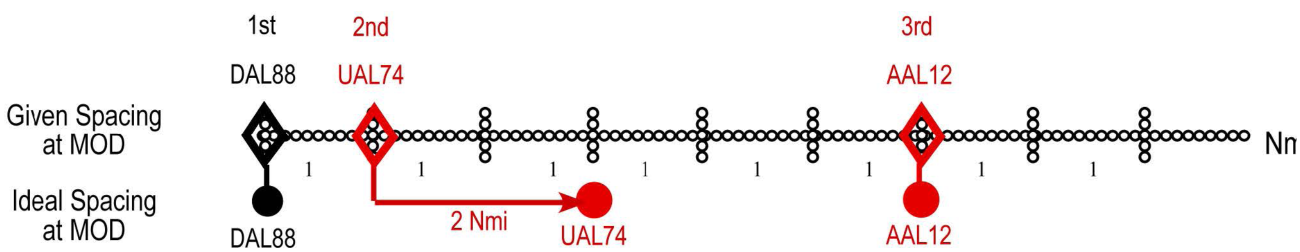
1 First, plot each plane's given spacing at MOD with a ◊. Then plot the Ideal Spacing with a ●. Label each symbol with the plane's call sign. Use an arrow to show the additional spacing needed.



2 For the second plane, what route change and speed change will give Ideal Spacing at MOD?

Changes: Route: ***Direct to MOD*** Speed: ***540*** knots

3 At the new speeds, will UAL74 and DAL88 have at least minimum spacing (2 Nmi) at **OAL**?



4 For the speed change, after how many minutes will you speed up the plane to 600 knots to maintain ideal separation at MOD? ***2*** minutes

2 Nmi needed ÷ 1 Nmi difference = 2 mins

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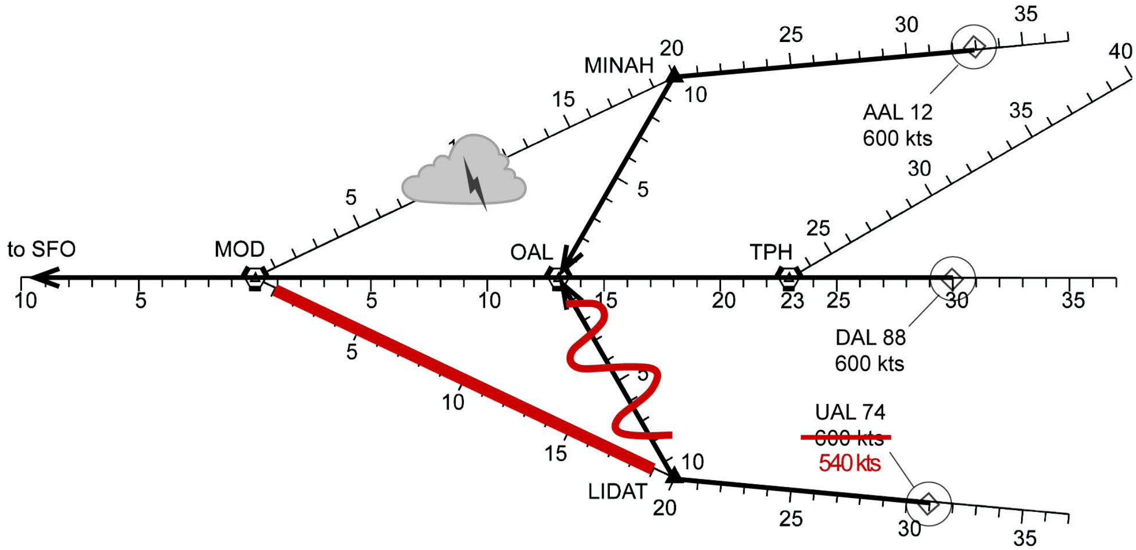

CAUTION **Be sure to mark the route and speed changes you have made on the above sector plot.**

5 For the third plane, describe your changes (if any) to get Ideal Spacing at MOD.

Changes: Route: ***AAL12: None*** Speed: ***None*** knots

6 If you changed speed, after how many minutes will you speed up the plane to 600 knots to maintain ideal separation at MOD? ***N/A*** minutes

7 With your new speeds, will AA12 and DAL88 have at least the 2 nautical mile **Minimum** Separation at **OAL**? [ ] No [X] Yes

At OAL: (23-17) Nmi = 6 Nmi

8 If No, how will you redo your route or speed changes? ***Not needed.***

End of Worksheet