



## Math-Based Decisions in Air Traffic Control

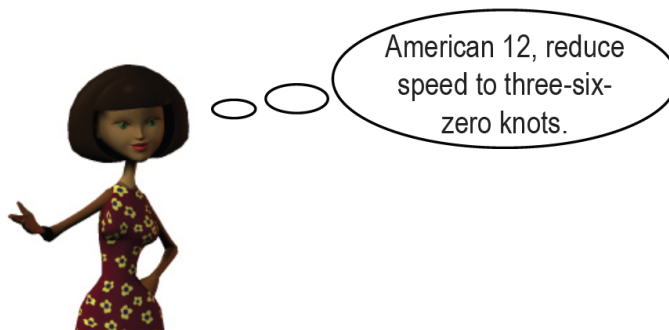
### Student Workbook F

## Appendix II

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

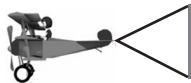


Simulator at: <https://atcsim.nasa.gov/simulator/sim2/sector33.html>



Investigator: \_\_\_\_\_

An Airspace Systems  
Program Product

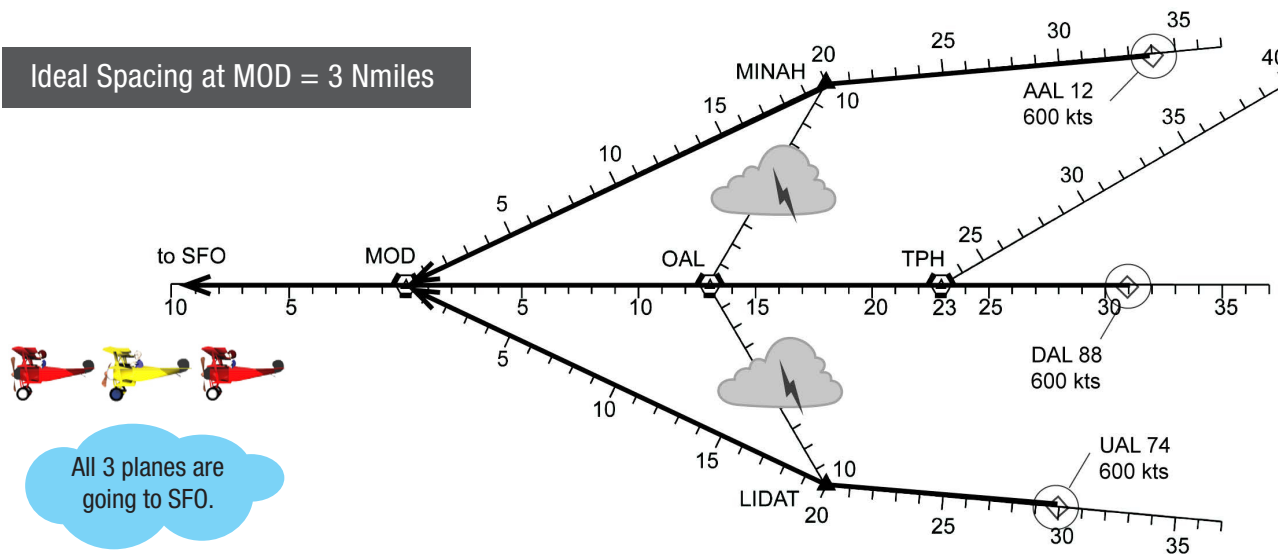


# Problem 3-3



Investigator: \_\_\_\_\_

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	<input type="text"/>	<input type="text"/>	<input type="text"/>
Arrival Order	<input type="text"/>	<input type="text"/>	<input type="text"/>

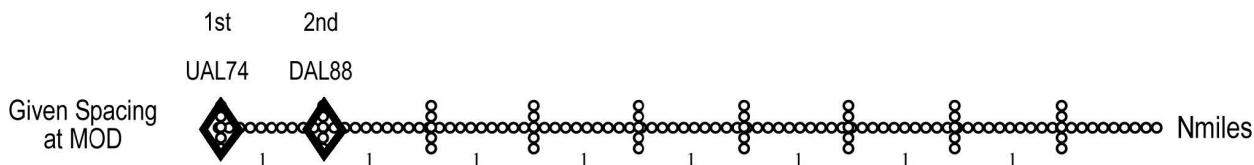
It helps to picture the arrival order and spacing at MOD!

- 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.

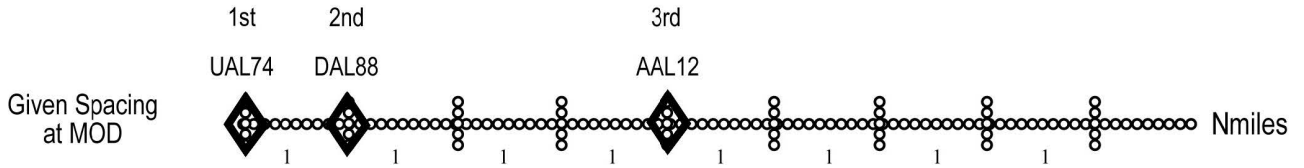


2

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



Continue to Next Page



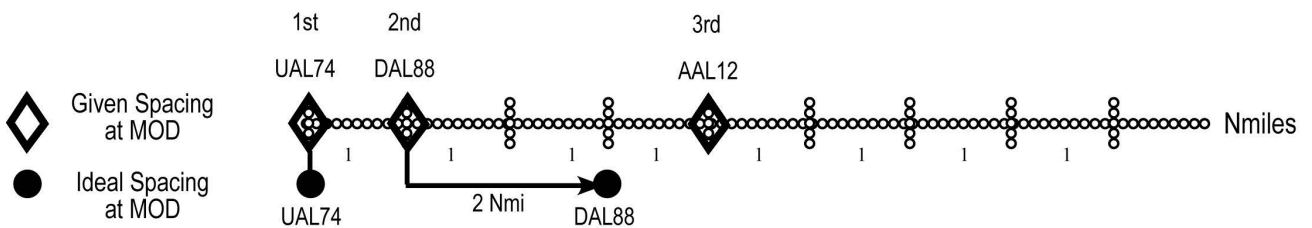
- Next we determine the additional spacing needed to get Ideal Spacing at MOD.

3

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

- 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.)  nautical miles

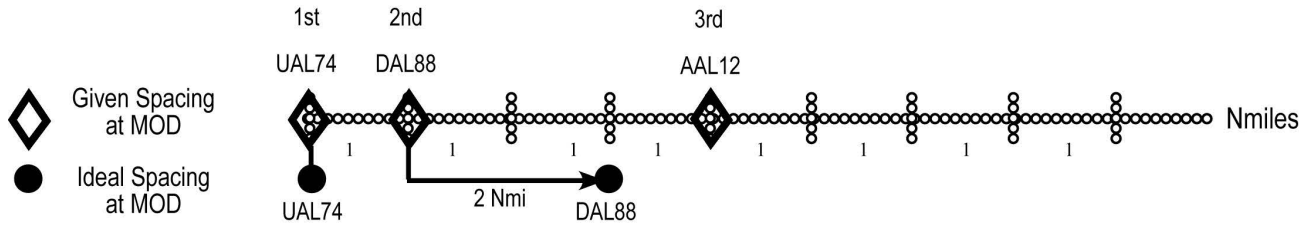
5

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?  knots What will the new speed be?  knots

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

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?  Yes  No

540 kts = 9 Nmi/Min

DAL88, I'll speed you back up as soon as you get Ideal Spacing!



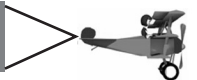
Roger! I don't want to fall further behind.

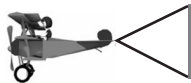
9 Now what speed changes will you make for the third plane, AAL12? Fill in the table.

	Additional Spacing	New Speed	Time Until Ideal Spacing	At or Before MOD?
AAL12	<input type="text"/> Nmi	<input type="text"/> Kts	<input type="text"/> Mins	<input type="checkbox"/> Yes <input type="checkbox"/> No

If Yes, congratulations!

End of Worksheet



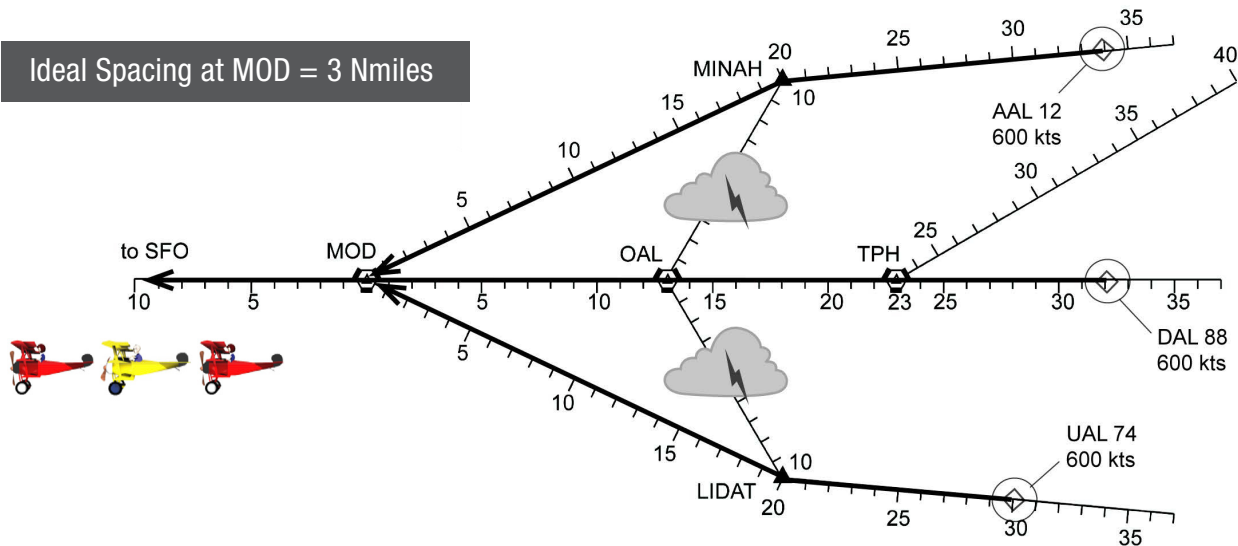


# Problem 3-4



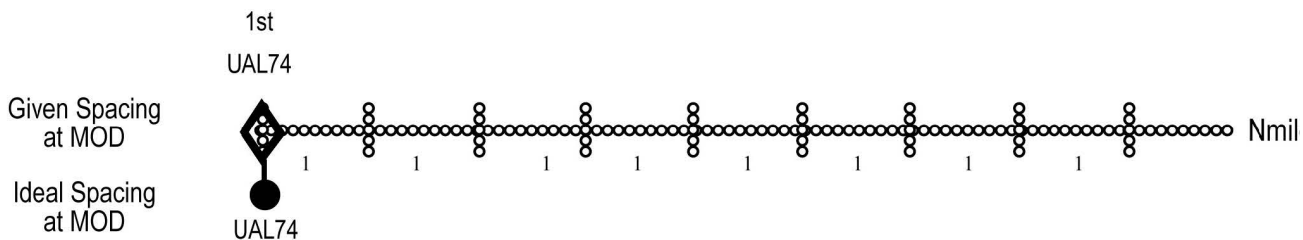
Investigator: \_\_\_\_\_

Ideal Spacing at MOD = 3 Nmiles



1

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



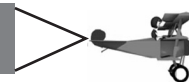
2

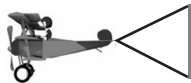
What speed changes will you make to get Ideal Spacing at MOD? Fill in the table.

Order	Call Sign	Additional Spacing	New Speed	Time Until Ideal Spacing	At or Before MOD?
2nd	<input type="text"/>	<input type="text"/> Nmi	<input type="text"/> Kts	<input type="text"/> Mins	<input type="checkbox"/> Yes <input type="checkbox"/> No
3rd	<input type="text"/>	<input type="text"/> Nmi	<input type="text"/> Kts	<input type="text"/> Mins	<input type="checkbox"/> Yes <input type="checkbox"/> No

If Yes, congratulations!

End of Worksheet



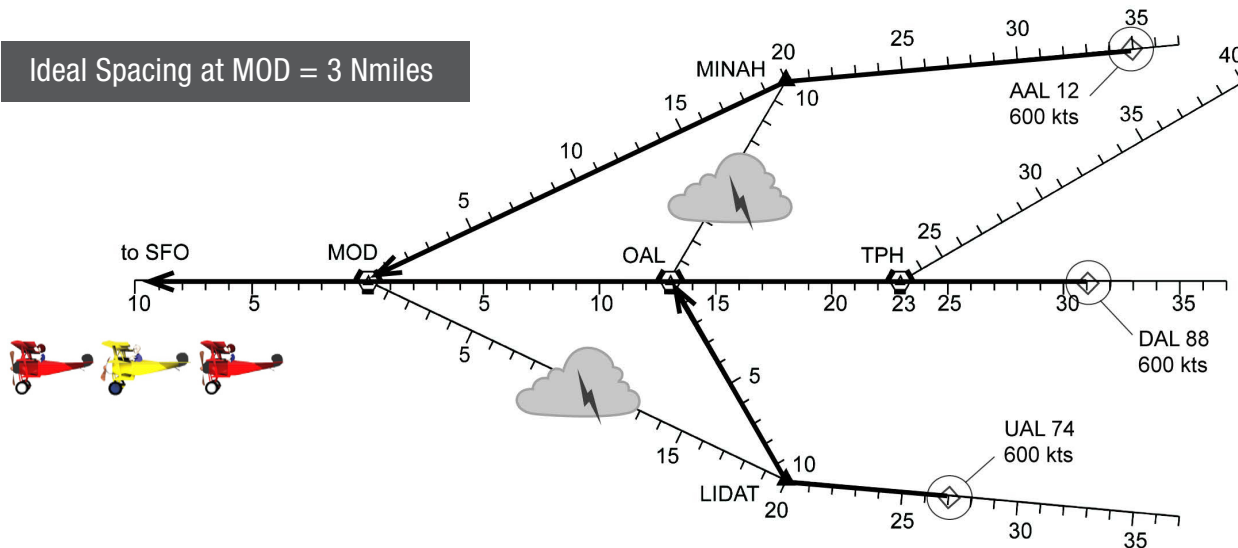


# Problem 3-5



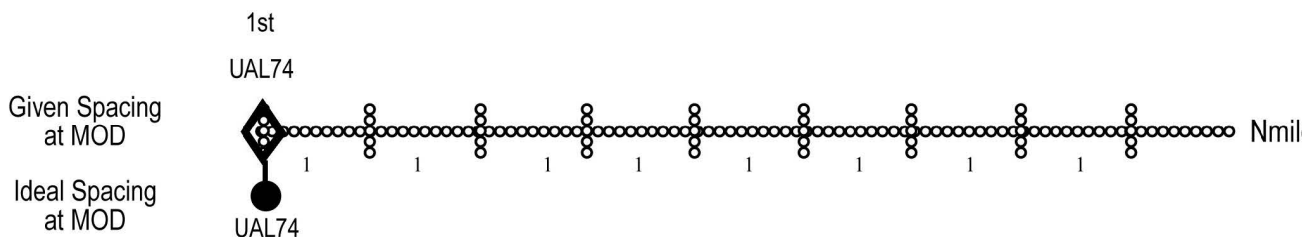
Investigator: \_\_\_\_\_

Ideal Spacing at MOD = 3 Nmiles



1

First, plot each plane's given spacing at MOD with a  $\diamond$ . Then plot the Ideal Spacing with a  $\bullet$ . 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	<input type="text"/>	<input type="text"/> Nmi	<input type="text"/> Kts	<input type="text"/> Mins	<input type="checkbox"/> Yes <input type="checkbox"/> No
3rd	<input type="text"/>	<input type="text"/> Nmi	<input type="text"/> Kts	<input type="text"/> Mins	<input type="checkbox"/> Yes <input type="checkbox"/> No

3

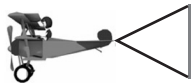
At the new speeds, will UAL74 and DAL88 have at least minimum spacing (2 Nmi) at **OAL**?  Yes  No

4

If No, how will you redo your speed changes?

\_\_\_\_\_  
\_\_\_\_\_

End of Worksheet

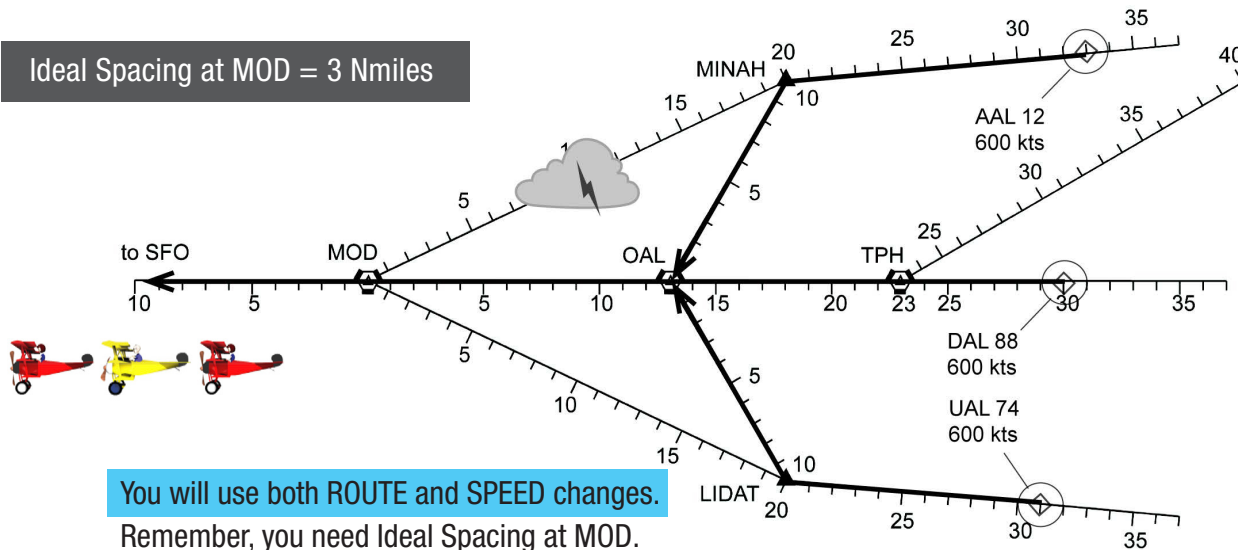


# Problem 3-6



Investigator: \_\_\_\_\_

Ideal Spacing at MOD = 3 Nmiles

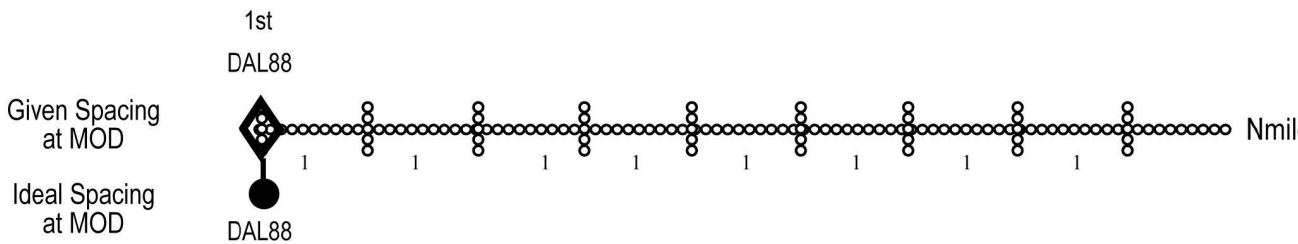


You will use both ROUTE and SPEED changes.

Remember, you need Ideal Spacing at MOD.

1

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



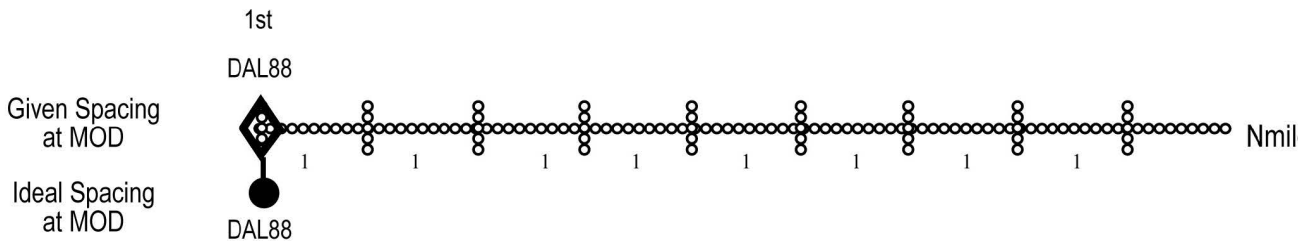
2

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

Changes: Route:  Speed:  knots

3

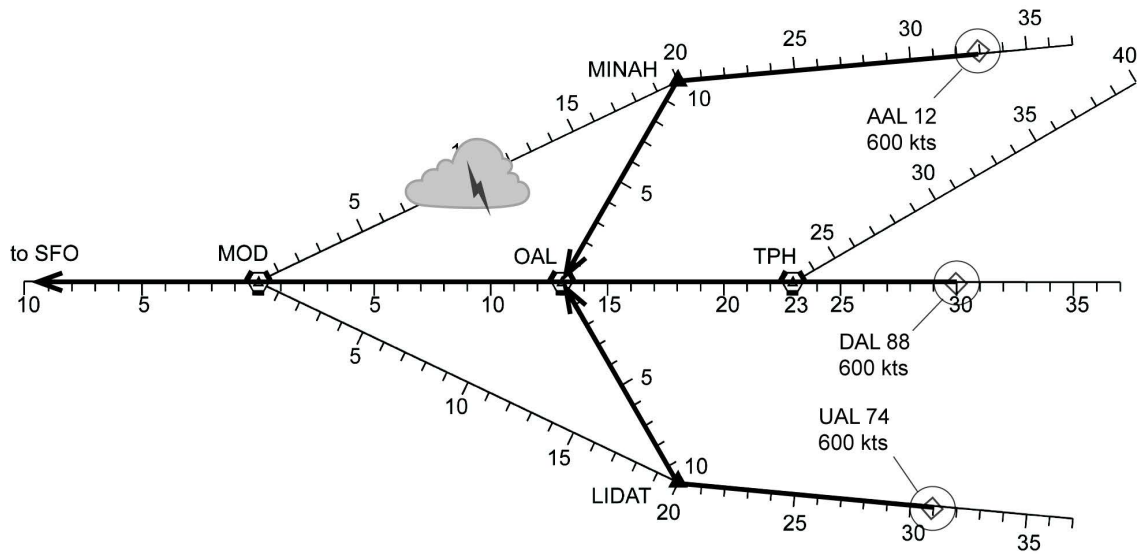
At the new speeds, will UAL74 and DAL88 have at least minimum spacing (2 Nmi) at OAL?



4

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

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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:  Speed:  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?  minutes

7

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

8

If No, how will you redo your route or speed changes? \_\_\_\_\_  
 \_\_\_\_\_

You are now cleared for takeoff!



End of Worksheet

