Advanced Engineering Systems and Design Name: _____

Activity 5.1.6 Lift, Stall & VTOL Period: _____

_____

Part I – Core Concepts

1. How does air density change as altitude increases?

2. What happens to lift when air density decreases?

3. According to the lift equation:

$L = ½ \rho v^2 A C_L$

How can a plane compensate for lower air density?

4. Why does drag decrease at higher altitude?

Part II – The Jet Stream

5. What is the jet stream?

6. How does a tailwind affect an airplane's ground speed?

7. How does a headwind affect fuel use?

Part III – The Tradeoff

8. Complete the table:

Factor	Low Altitude	High Altitude
Lift		
Drag		
Required Speed		
Fuel Efficiency		
Wind Effects		

9. Why is flight altitude considered a tradeoff?

Part IV – Real-World Reasoning

10. Why do commercial airplanes typically fly between 30,000–40,000 ft?

11. Why don't airplanes simply fly as high as possible?

Part V – Scenario 1 (Tailwind)

A plane is flying from New York to Los Angeles.

At 38,000 ft:

- Jet stream provides a 120 mph tailwind
- Lower air density
- Lower drag

At 15,000 ft:

- Higher air density
- More lift
- Higher drag
- No jet stream

12. Which altitude would you choose? Why?

Part VI – Scenario 2 (Headwind)

A plane is flying west and encounters a strong jet stream headwind at high altitude.

Option A: Stay high and face headwind
Option B: Fly lower and avoid the jet stream

13. Which option would you choose? Explain.

14. What additional information would help make this decision?

Part VII – Thinking

15. If velocity doubles, how does lift change?

16. Why does velocity have a stronger effect on lift than air density?

17. Explain why pilots are solving an “optimization problem” when choosing altitude.