

## L40: A Scenario to Motivate Matrix Operations

A reconnaissance platoon is preparing to purchase two types of drones: **Type A (short-range)** and **Type B (long-range)**. Type A drones cost \$8k each, and Type B drones cost \$12k each. The S4 section must buy exactly **10 drones** with a total budget of **\$104k**. The commander's policy requires *at least as many short-range as long-range drones*.

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### Task 1 – Define and Model

- a. Define the decision variables:
- b. Write the system of equations that represents the constraints on total drones and budget:

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### Task 2 – Graph and Solve Algebraically

- a. Graph both equations on the  $xy$ -plane. Label the intercepts and the intersection point.
- b. Solve the system algebraically (substitution or elimination). Show all work and write the solution as an ordered pair  $(x, y)$ .
- c. Interpret the result in a sentence: What do the coordinates of the intersection mean for procurement?

### Task 3 – Matrix Representation and Solution

- Write the system in matrix form  $A\mathbf{x} = \mathbf{b}$ , identifying each matrix:
  - Compute the determinant of  $A$ . What does it tell you about the system?
  - Find  $A^{-1}$  and use it to solve  $\mathbf{x} = A^{-1}\mathbf{b}$ .
  - Verify that your matrix solution matches the algebraic one.
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### Task 4 – Policy Check and Reflection

- Does the solution satisfy the commander's policy  $x \geq y$ ? Explain.
  - Using your graph, shade the region representing all points that satisfy  $x \geq y$ . Where does your solution fall relative to this region?
  - If the policy must be met, what change in budget or total number of drones would restore compliance?
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### Task 5 – Matrix Multiplication and Operations

- Scaling:** If three platoons are equipped identically, compute the increase in missiles.
- Adjustment:** If two long-range drones are reallocated, compute the result.
- Optimization Focused:** Write a cost vector. How would we write minimize cost using vector notation?