



## MATHEMATICS OF FLIGHT: ATMOSPHERIC PRESSURE

*Students will have a basic understanding of math applications used in flight. This includes calculating atmospheric pressure. Students will solve a series of problems. (One in a series)*

### LESSON PLAN

#### Lesson Objectives

The students will:

- Be introduced to formulas used in flight related to navigation and aircraft performance.
- Learn to calculate the atmospheric pressure.

#### Goal

In this lesson, students will gain an understanding of common calculations performed by flight personnel.

#### Atmospheric Pressure

The early flights of the Wright brothers were typically 10 to 12 feet above the ground. By 1908, their flying machine reached an altitude of 100 feet. Today's commercial jets fly at 30,000 to 40,000 feet. At such high altitudes, the atmospheric pressure is much different. Flight personnel calculate the atmospheric pressure,  $p$ , using this formula:

$$p = \frac{-9.05 [ (\alpha/1000)^2 - 65\alpha/1000 ]}{(\alpha/1000)^2 + 40 (\alpha/1000)}$$

where  $\alpha$  is the altitude of the plane, given in feet.

#### Example:

Calculate the atmospheric pressure for this Thomas-Morse S4C Scout from World War I flying at 6,000 feet.



**Grade Level:** 9-12

#### National Mathematics Content Standards:

Number and Operations: Understand meanings of operations and how they relate to one another  
Algebra: Represent and analyze mathematical situations and structures using algebraic symbols; Use mathematical models to represent and understand quantitative relationships.

#### Technology Content Standards (from STL):

Technology and Society.,

#### Materials Required:

- Paper
- Pencil or pen
- Formula:

$$p = \frac{-9.05 [ (\alpha/1000)^2 - 65\alpha/1000 ]}{(\alpha/1000)^2 + 40 (\alpha/1000)}$$

**Example:**

Calculate the atmospheric pressure for a Thomas-Morse S4C Scout airplane from World War I flying at 6,000 feet.

$$p = \frac{-9.05 [ (\alpha/1000)^2 - 65\alpha/1000 ]}{(\alpha/1000)^2 + 40 (\alpha/1000)}$$

$$p = \frac{-9.05 [ (6000/1000)^2 - 65(6000)/1000 ]}{(6000/1000)^2 + 40 (6000/1000)}$$

$$p = \frac{-9.05 [ (6)^2 - 65(6) ]}{(6)^2 + 40 (6)}$$

$$p = \frac{-9.05 [ 36 - 390 ]}{36 + 240}$$

$$p = \frac{-9.05 [ -354 ]}{276}$$

$$p = \frac{3,203.7}{276}$$

$$p = 11.61$$

The atmospheric pressure is 11.61 pounds per square inch (11.61 lb/in<sup>2</sup>).

**Exercises 1-2:**

Calculate the atmospheric pressure for a B-17 Flying Fortress flying a mission at 30,000 feet during World War II.

Calculate the atmospheric pressure for a F-86D Sabre flying a mission at 42,200 feet during the Korean War.

### Exercise 1:

Calculate the atmospheric pressure for a B-17 Flying Fortress flying a mission at 30,000 feet during World War II.

$$p = \frac{-9.05 [ (\alpha/1000)^2 - 65\alpha/1000 ]}{(\alpha/1000)^2 + 40 (\alpha/1000)}$$

$$p = \frac{-9.05 [ (30,000/1000)^2 - 65(30,000)/1000 ]}{(30,000/1000)^2 + 40 (30,000/1000)}$$

$$p = \frac{-9.05 [ (30)^2 - 65(30) ]}{(30)^2 + 40 (30)}$$

$$p = \frac{-9.05 [ 900 - 1950 ]}{900 + 1,200}$$

$$p = \frac{-9.05 [ - 1,050 ]}{2,100}$$

$$p = \frac{9,502.5}{2,100}$$

$$p = 4.53$$

The atmospheric pressure is 4.53 pounds per square inch (4.53 lb/in<sup>2</sup>).



## Exercise 2:

Calculate the atmospheric pressure for a F-86D Sabre flying a mission at 42,200 feet during the Korean War.

$$p = \frac{-9.05 [ (\alpha/1000)^2 - 65\alpha/1000 ]}{(\alpha/1000)^2 + 40 (\alpha/1000)}$$

$$p = \frac{-9.05 [ (42,200/1000)^2 - 65(42,200)/1000 ]}{(42,200/1000)^2 + 40 (42,000/1000)}$$

$$p = \frac{-9.05 [ (42.2)^2 - 65(42.2) ]}{(42.2)^2 + 40 (42.2)}$$

$$p = \frac{-9.05 [ 1,780.84 - 2,743 ]}{1,780.84 + 1,688}$$

$$p = \frac{-9.05 [ - 962.16 ]}{3,468.84}$$

$$p = \frac{8707.55}{3,468.84}$$

$$p = 2.51$$

The atmospheric pressure is 2.51 pounds per square inch (2.51 lb/in<sup>2</sup>).



**See student worksheet and presentation**

**Examples are from the collection of the National Museum of the U.S. Air Force**

**Resources:**

National Museum of the United States Air Force

- <http://www.nationalmuseum.af.mil/factsheets/factsheet.asp?id=271>
- <http://www.nationalmuseum.af.mil/factsheets/factsheet.asp?id=512>
- <http://www.nationalmuseum.af.mil/factsheets/factsheet.asp?id=274>

Belcher, Diana. *Education in Flight: A Teacher's Guide to the Mathematics of Flight*. Department of the Air Force, 2007.



## MATHEMATICS OF FLIGHT: ATMOSPHERIC PRESSURE

*STUDENT WORKSHEET*

*NAME:* \_\_\_\_\_

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$$p = \frac{-9.05 [ (\alpha/1000)^2 - 65\alpha/1000 ]}{(\alpha/1000)^2 + 40 (\alpha/1000)}$$

**Exercise 1:**

Calculate the atmospheric pressure for a B-17 Flying Fortress flying a mission at 30,000 feet during World War II.

**Exercise 2:**

Calculate the atmospheric pressure for a F-86D Sabre flying a mission at 42,200 feet during the Korean War.