This sequence of images shows the historic launch of the Space Shuttle Atlantis (STS-135) on July 8, 2011 at 11:29 a.m. EDT, from launch pad 39A at the NASA Cape Canaveral Space Center.

From bottom to top, the image times are 11:29:12.0, 11:29:12.5, and 11:29:13.0. The length of the space shuttle is 37 meters from its pointed top end to the base of its rocket nozzles.

A rocket moves forward by throwing mass out its rocket engines as fast as possible. It does NOT move forward by 'pushing against' the ground as a popular misconception might suggest.

By ejecting thousands of pounds of gas every second, a rocket motor produces the thrust needed to lift a payload and move it in the opposite direction to its exhaust.

The plume of gas is ejected at high speed from the Shuttle main engines and makes a right-angle turn as it is vented horizontally across the gantry platform. The vented gas seen in the sequence to the left is the plume created by the Sound Supression Water System (SSWS).

Problem 1 - Using a millimeter ruler, what is the scale of each image in meters/mm?

Problem 2 - How far did the leading edge of the SSWS plume travel between the top and bottom images?

Problem 3 - What was the speed of the SSWS plume in A) meters/sec? B) kilometers/hr? C) miles/hr?

Problem 1 - Using a millimeter ruler, what is the scale of each image in meters/mm?

Answer: The Shuttle measures about 13 millimeters in length on an ordinary reproduction of this 8.5 x 11-inch page, so the scale is **2.8 meters/mm**.

Problem 2 - How far did the leading edge of the SSWS plume travel between the top and bottom images?

Answer: For example, students might measure the distance from the tip of the cloud and the left-edge of the image. Top Image = 5 mm. Bottom image = 15 mm ,so the distance traveled is 10 millimeters or from the scale factor, 10 x 2.8 = **28 meters**.

Problem 3 - What was the speed of the SSWS plume in A) meters/sec? B) kilometers/hr? C) miles/hr?

Answer: A) The time difference between the top and bottom images is 11:29:13.0 - 11:29:12.0 = 1 second. The average speed would be 28 meters/1 sec = **28 meters/sec.**

B) 28 meters/sec x (1 km/1000 meters) x (3600 sec / 1 hr) = **100 km/hr**.

C) 100 km/hr x (0.62 miles / 1 km) = **62 miles per hour**.