This pair 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. It shows part of the exhaust plume cloud ejected by the shuttle engines as they were ignited. This vapor plume is created when the exhaust gases from the rocket engines interact with the Sound Suppression Water System (SSWS).

The bottom image was taken at 11:29:14.0 a.m. EDT, and the top image was obtained at 11:29:15.0 a.m. EDT. The length of the space shuttle is 37 meters from its pointed top end to the base of its rocket nozzles.

The speed of the SSWS plume can be estimated from the clues in the two images.

Problem 1 - What is the scale of each image in meters/millimeter?

Problem 2 - How far did the SSWS plume travel in the time interval between the two images?

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

Problem 4 - Assuming that you could survive the noise of the rocket motors, would you be able to out-run the SSWS plume if you ran as fast as Olympic sprinter Usain Bolt in the 2008, 100-meter race whose time was 9.7 seconds?

Problem 1 - What is the scale of each image in meters/millimeter?
Answer: The shuttle measures about 12 millimeters so the scale is 37 meters/12 mm = **3 meters/mm**.

Problem 2 - How far did the SSWS plume travel in the time interval between the two images?
Answer: Students can measure the distance from the tip of the plume to the right-hand edge of the image to get 14mm (top) and 33mm (bottom) for a difference of 19 mm. Multiplying by the scale of 3 m/mm we get **57 meters**.

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

Answer: The time between the two images is 1 second, then

A) 57 meters/1 sec = **57 m/sec**.
B) 57 m/s x (1 km/1000 m) x (3600 s/1 hr) = **205 km/hr**.
C) 205 km/hr x 0.62 miles / 1 km) = **127 mph**.

Problem 4 - Assuming that you could survive the noise of the rocket motors, would you be able to out-run the SSWS plume if you ran as fast as Olympic sprinter Usain Bolt in the 2008, 100-meter race whose time was 9.7 seconds?

Answer: Usains speed was 100 meters/9.7 sec = 10.3 meters/sec which is <u>much slower</u> than the 57 m/sec plume speed.