

You might have seen pictures of a space shuttle launch, perhaps on television or in a newspaper. You may have even seen a launch in person. The space shuttle is the first reusable aircraft ever to fly in space.

NASA began planning the space shuttle in the 1960s. They decided to use aluminum to build the main body of the space shuttle. Other metals might hold up better to the high temperatures that the space shuttle would encounter on its voyages. But aluminum is much lighter than those other metals. Using aluminum, NASA could build the body without the shuttle becoming too heavy.

The NASA scientists faced many challenges as they built the shuttle. For example, as it took off, the space shuttle would be exposed to temperatures much higher than the point at which aluminum changes from solid to liquid, or **melts**. NASA engineers had to find a way to protect the shuttle's aluminum from melting. The solution was to cover the space shuttle with heat-resistant tiles.

Another problem that NASA engineers had to solve was caused by freezing. *Freezing* is the change of state from liquid to solid. A substance can freeze if it experiences very low temperatures. Some of the fuel used by the space shuttle is extremely cold—colder than ice. Water droplets that form on the fuel tank could freeze and form ice. The ice could then break off and damage the space shuttle. One solution was to install a heater that would prevent the water from freezing.

In looking at the space shuttle, you may have also noticed that it sits on a big orange tank. This tank contains the liquid fuels used to place the space shuttle into orbit. The liquid fuels are oxygen and hydrogen. On Earth, oxygen and hydrogen are normally gases. However, a gas can be changed into a liquid by removing heat from it. Changing a gas into a liquid is called *condensation*. Condensation is what happens when water droplets form on the space shuttle's fuel tank.



If removing heat causes condensation, what happens if you add heat? If you add heat to a liquid, it can turn into a gas. This is called *evaporation*. Evaporation is partially responsible for

the most impressive thing about a space shuttle launch—the huge cloud you see as the rocket fires. When the liquid fuels are mixed, water forms. This water is released by the rocket as water vapor, the gas form of water. As the water vapor hits the cool air, it quickly condenses back into tiny water droplets. These droplets form the exhaust cloud you see as the shuttle rises into the atmosphere.

Process	Heat	Change
Melting	Added	Solid → liquid
Freezing	Removed	Liquid → solid
Condensing	Removed	Gas → liquid
Evaporating	Added	Liquid → gas