Aircraft vs. Spacecraft

Q: What are differences between an aircraft and spacecraft?
A: Aircraft fly through air and spacecraft fly in space.
In space, there is no air, so a spacecraft cannot be designed the same as an aircraft. There won't be drag or lift, so planes cannot fly. A spacecraft will need to rely on thrust to manuever safely. Also, spacecraft have to carry their own air along in the form of oxidizer, since there is no air to make the engines work. That's why jet engines can't work in space, so rocket engines must be used instead.

Design differences between an aircraft and a spacecraft:

Lift	Aircrafts generate thrust	Rocket boosters and three main engines that burn oxygen and hydrogen
After Lift-Off		The fuel tanks detach from the shuttle, attached to two parachutes to land safely to the ground.
Essential materials needed to survive during the flight	Usually nothing is required, except for snacks and drinks, while on board a plane	All the food, oxygen, water, toiletries needed for the duration of the trip, are stored on the space shuttle
Re-entry into the Earths atmosphere	Not necessary	The shuttle is moving so fast, large amounts of heat are generated from the friction of the air molecules against the shuttle exterior. There are reinforced carbon wings, high temperature surface insulation tiles on the fuselage and around the windows and low temperature white tiles on the remainder of the space ship.

Landing	The plane creates more drag than thrust and allows for gravity to take over.	Since the shuttle "dropped" its fuel tanks during the trip out of the Earths atmosphere, it does not have any fuel to fly it. This means the shuttle is a large glider and lands without the assitance of fuel and must maneuver itself using the flaps, ailerons, rudder and elevators.

Hypersonic Vehicles (Space Shuttles)

WHAT HAPPENS TO VEHICLES AT HYPERSONIC SPEEDS?

A vehicle designed to fly at **hypersonic** speed (more than five times the speed of sound) or to reenter the atmosphere must be able to withstand searing heat due to friction and shock waves. Special materials must be used to protect it and insulate the people and instruments on board from the heat.

WHAT HAPPENS TO AIR AT HIGH SPEEDS?

A fast-moving vehicle compresses the air in front of it, causing the air's temperature to rise.

Combined with friction, this heat becomes tremendous at extremely high speeds. The Apollo 11 spacecraft reentered the atmosphere traveling about 11 kilometers (7 miles) per *second*. The air just in front of it made a fireball hotter than the surface of the Sun!

HOW DO ASTRONAUTS SURVIVE THE HEAT OF REENTRY?

Insulating materials, like the tiles on the Space Shuttle, shield a spacecraft from the heat of reentry. A spacecraft's shape also plays a role. Besides slowing the vehicle by creating drag, a blunt shape helps to maintain an insulating cushion of air between the spacecraft and the shock wave it creates.

Another way to protect a vehicle from reentry heating is by using an **ablation shield**, like those on the Mercury, Gemini, and Apollo spacecraft. These shields were covered with a material that burned off (**ablated**) at extremely high temperatures and dissipated the heat. Unlike the tiles on the Shuttle, ablation shields can only be used once.

Space Shuttle tiles are made of a lightweight, ceramic material. They are used on the Shuttle to insulate the vehicle from the searing heat of reentry.

Did You Know?

Meteors are bits of rock or dust that fall into Earth's atmosphere at high speed. The heat of entry causes their surfaces to ablate, or burn away, causing the streaks of light commonly known as "shooting stars." Most of them burn up entirely; those few that reach the ground are called meteorites. A real meteorite can be found in the Mars section of the Museum's Exploring the Planets gallery.

Shaped for Space

HOW DOES SPACE AFFECT STRUCTURE?

If a spacecraft flies only in space and not through an atmosphere, it does not have to deal with drag. Its shape and configuration can be sprawling and irregular. Instruments can be placed at the end of long booms; broad solar panels can be deployed to gather energy from the Sun.

Keeping weight down is important, because of the high energy and cost needed to send even small amounts of mass into space. If manned, a spacecraft must have enough shielding to protect its occupants from such hazards as micrometeoroids and solar radiation.

Worksheet 1 Name: ______________________

Aircraft vs. Spacecraft

We know from just looking at pictures that airplanes look different than rockets. But, there are some particular differences between the working principles of a jet airplane and a rocket.

We have learned that the shape of an airplane's wing is essential in creating lift. The airplane rises in the air when lift is created by the pressure differences between the top and the bottom surfaces of an airplane wing. We have also learned that the propellers on a plane cut through the air and thrust is created to get a forward motion. These propellers are attached to an engine motor that continuously turns and spins. The engine takes in oxygen that is in the air and uses it to ignite and burn the engine's fuel. The gas is ejected towards the rear at high velocity, and the plane propels forward in the sky, within the earth's atmosphere.

We can see most airplanes that fly overhead, but spacecraft fly much higher. Spacecraft fly outside the earth's atmosphere into space. So, what happens in space, where there is no air? Lift cannot be created in space with wings and a propeller. Different scientific principles apply to spacecraft in order for lift off and propulsion to happen. A rocket must carry both its oxygen and its fuel. The rocket burns the fuel and the oxygen together. Hot gases roar out of the rocket's tail end, as the rocket ejects them at a very high velocity backward in order to get lift off and to propel itself upward. This action of hot gas being forced down toward the ground makes the rocket move in the opposite direction – up! As the rocket rises through the air, its thrust must be greater than the other forces acting on the rocket, such as its weight and the resistance of air which causes drag.