Royal Robotics

Lesson Plan – Pneumatics/hydraulics

Definition: Pneumatics is the use of air pressure or vacuum to cause mechanical motion. Hydraulics is the use of a fluid, usually water or oil, under pressure to cause mechanical motion.

Concepts & Principles:

First – principles for both air and fluids are nearly similar. We are primarily going to address this lesson to pneumatics, but these concepts equally apply to hydraulics (unless otherwise noted).

Air is a gas and takes up space (blow up balloon) . Air can exert pressure on objects. (use balloon to pick up cup-blow up inside to grip- and blow a cup around-let go of neck aimed at cup) Air can be compressed into a smaller space, but it wants to expand back into its normal area, this creates a pushing force like a spring (let go of balloon to shoot balloon like a rocket). This force can be harnessed to do work using a pneumatic system.

One difference between pneumatics and hydraulics is that it is more difficult to put fluids under pressure –hydraulic systems require a much higher pressure than pneumatic systems. The more molecules in a given area. (show states of matter chart) the harder it is to compress. Gasses have fewer molecules in a given area, Fluids have more while Solids have the most. The 'space' between molecules allows easier compression. (weight on foam vs. styrofoam)

SAFETY ALERT! air under pressure can be DANGEROUS! It can exert a great deal of force which if it strikes you can hurt and cause serious damage. Excess pressure in a system can cause parts to explode creating shrapnel. Students should always follow safety procedures when working with pneumatics and make sure systems include safety features.

Pressure Formula:

To figure out how much force a pneumatic system is applying there is a mathematical formula: (formula poster 1)

Force = Pressure x Area

Force (measured in pounds) = Pressure (measured in pounds per square inch) x Area (measured in square inches).

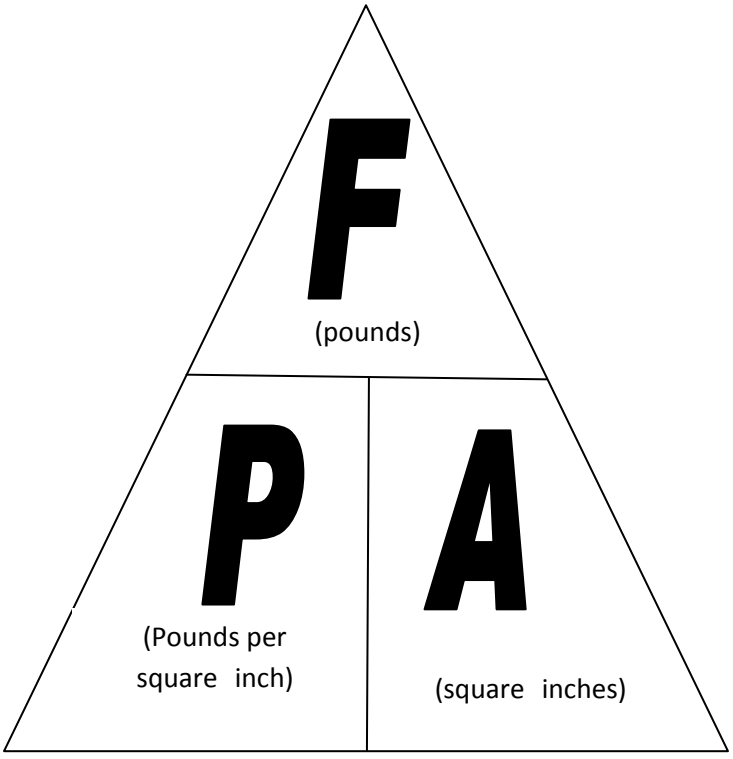
(formula poster2) Essentially what this means is that you get more force by either increasing pressure or area.

You can also invert formula to find Pressure:

Pressure = Force / Area

or Area:

Area = Force/Pressure



When you know the pressure your system is using and the volumes of the holding tank and the actuator cylinders you can figure out how many cycles you can run a system before it needs to reload and how much mechanical force you are producing.

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Control of pressure:

To achieve full potential of a pneumatic system you must have control of the air pressure.

First this means that you have a closed system. Any leaks and the pressure will drop and there will be insufficient power. (have volunteer try to blow up balloon with a hole).

Second, you need to regulate pressure after the compressor and after the air reservoirs. This provides both safe use and enough power. By regulating the pressure from the compressor to the reservoir you can be sure that you have enough pressure available to do the work without overloading the air tank. By regulating between the air tank and the rest of the system you can be sure that the proper amount of air is released to the system to run the actuators.

Pneumatic system: (show parts from kit)

Pneumatics systems have three main components:

1. Compressor: This is a pump that brings in air from around it and compresses that air, increasing pressure.
2. Air Tanks: These are usually strong hollow cylinders that store the compressed air until needed.
3. Actuators: This is the part that transfers the air pressure into mechanical motion. The most common is an air cylinder that uses air to push and pull a rod in a back and forth or in/out motion. There are also actuators that can create a turning or rotary motion.

All other components are for moving the air safely between these three main compenents:

1. Pressure regulators and gauges: These sense and show how much pressure is in the system and can send signals to the compressor or to a valve to release/increase pressure.
2. Valves and switches: Valves open and close the various paths and parts to allow air flow as needed. Valves can be one way or have multiple paths. Valves can be controlled manually or electrically with switches. Some valves are called “relief valves’ which are a safety feature, they release pressure from the system if it gets too high.
3. Tubing and fittings: tubing provides the path for airflow. Fittings, such as T’s, Y’s and couplers can split or join paths.

Supplies: balloons, paper cups, foam/styrofoam & weight, pneumatic kit, poster set