Applied Laws

What is thermodynamics?
Thermodynamics is the study of heat/pressure energy or the behavior of gases (including air) and vapors under variations of temperature and pressure.

Explain Bernoulli’s theorem.
Bernoulli’s theorem is that the total energy in a moving fluid or gas is made up of three forms of energy:

1. Potential energy (the energy due to the position)
2. Pressure/temperature energy (the energy due to the pressure)
3. Kinetic energy (the energy due to the movement)

When considering the flow of air, the potential energy can be ignored; therefore, for practical purposes, it can be said that the kinetic energy plus the pressure/temperature energy of a smooth flow of air is always constant. Thus, if the kinetic energy is increased, the pressure/temperature energy drops proportionally, and vice versa, so as to keep the total energy constant. This is Bernoulli’s theorem.

Explain a venturi.
A venturi is a practical application of Bernoulli’s theorem, sometimes called a convergent/divergent duct.
A venturi tube has an inlet that narrows to a throat, forming a converging duct and resulting in (1) velocity increasing, pressure (static) decreasing, and (3) temperature decreasing. The outlet section is relatively longer with an increasing diameter, forming a diverging duct and resulting in (1) velocity decreasing, (2) pressure (static) increasing, and (3) temperature increasing.

![Diagram of Venturi Airflow](image)

**Figure 2.1** Venturi airflow.

For a flow of air to remain streamlined, the mass flow through a venturi must remain constant. To do this and still pass through the reduced cross section of the venturi throat, the speed of flow through the throat must be increased. In accordance with Bernoulli’s theorem, this brings about an accompanying drop in pressure and temperature. As the venturi becomes a divergent duct, the speed reduces, and thus the pressure and temperature increase.

**Piston Engines**

**What is the combustion cycle of an aeropiston engine?**

Induction, compression, combustion (expansion), and exhaust. The combustion of a piston engine occurs at a constant volume.

**What is compression ratio in a piston engine?**

Compression ratio in a piston engine is the ratio of the total volume enclosed in a cylinder with the piston at bottom dead center (BDC) to the volume remaining at the end of the compression stroke with the piston at top dead center (TDC).

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\text{Compression ratio} = \frac{\text{total volume}}{\text{clearance volume}}
\]
What produces the ignition in a piston engine?
MagnetoS are used on internal combustion engines to supply the high-
tension voltage necessary to cause an electric spark at the spark plug.

What does blue, black, and white exhaust smoke indicate?
Blue exhaust smoke indicates an oil burn in the cylinders, probably
due to broken piston rings that allow oil seepage into the combustion
chamber. Black exhaust smoke indicates carbon granules burning in
the cylinders. This occurs if the mixture is too rich, resulting in some
of the fuel not being burnt and turning into carbon granules, which are
then exhausted as black smoke. White exhaust smoke indicates a high
water content in the combustion chamber, which is exhausted as white
“steam” smoke.

What is engine torque?
Torque is a force causing rotation. In particular, torque is the force
created within an engine, which causes rotation of the rotating parts,
e.g., the crankshaft.
Torque is a measure of the load experienced, expressed in pounds per
inch or feet. A quantity of torque, or twisting moment, is involved in
the measurement of the engine brake horsepower (bhp).

Torque = force × distance (at right angles to the force)

What is a normally aspirated piston engine?
A normally aspirated engine works as a result of “the breathing of the
cylinder is due to the pressure differential below the standard sea level
14.7 lb/in².” In other words, it only uses the atmospheric air density
that is available to produce a charge in its cylinders and is not boosted
by a supercharger; therefore, the normally aspirated piston engine’s
power output is restricted by its cylinder capacity.

What are the disadvantages of a piston engine?
A piston engine suffers from three main disadvantages:
1. A lack of power output, especially with increased altitudes
2. A low produced airspeed due to propeller rpm limitations
3. Mechanical inefficiency

What is a supercharged (piston) engine?
A supercharger simply increases the air delivered to the engine cylinder
above its normally aspirated capacity by compressing the intake air,
which in turn requires more fuel to be delivered to the carburetor to maintain the correct mixture ratio, which in turn produces a greater power output (horsepower). Therefore, a supercharged engine is capable of producing a greater power output than a normally aspirated engine of the same cylinder size.

How is the (piston) engine power output increased to compensate for low atmospheric pressure?

Superchargers are used to artificially raise the engine manifold pressure to compensate for low atmospheric pressure either (1) to increase engine power output for takeoff and the initial climb (ground-boosted engine) or (2) to maintain mean sea level (MSL) engine power at high altitudes (altitude-boosted engine).

What regulates the supercharger to deliver a constant boost/manifold absolute pressure (MAP)?

The auto boost control (ABC) keeps the boost pressure/MAP constant during a climb or a descent.

How is engine power monitored?

There are two main engine power monitoring/indication systems: manifold absolute pressure (MAP) and boost pressure.

What is carburetor icing?

(See Chapter 8, “Meteorology and Weather Recognition,” page 264.)

When would you expect carburetor icing in a piston engine?

(See Chapter 9, “Flight Operations and Technique,” page 325.)

What actions should you take to prevent or remove carburetor/throttle icing in a piston engine?

(See Chapter 9, “Flight Operations and Technique,” page 325.)

Propellers

What advantages does an aircraft gain from a propeller?

The propeller provides the following advantages:

1. The propeller creates a high-energy slipstream, which has three main effects on the aircraft: