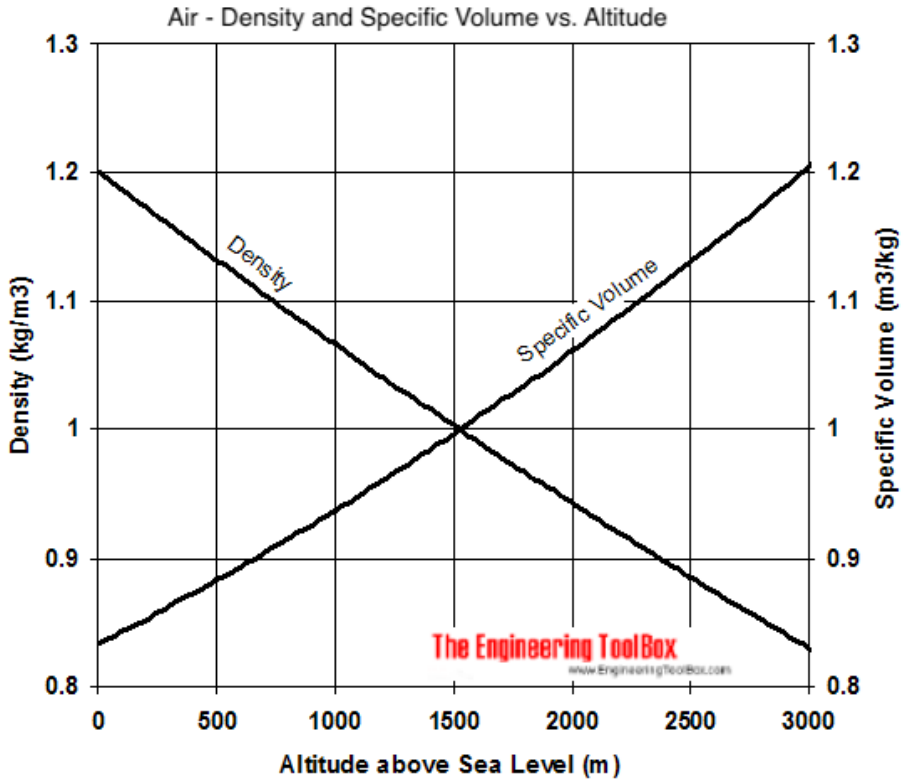
Performance of electrical equipment on high altitude

Air density, i.e. air pressure, decreases with increasing altitude. It changes with variations in atmospheric pressure, temperature, and humidity. Air gets thinner (less dense) as we go higher, dramatically decreasing from around **1.2250 kg/m³ at sea level to near vacuum at space**, resulting in lower dielectric strength and aircraft performance significantly. Major factors are altitude (less air mass), temperature (warmer air is less dense), and pressure (decreases with height). Insulating materials, such as cables, transformers, and capacitors, experience increased stress and exhibit a higher risk of failure, potentially leading to short circuits or equipment damage. The International Standard Atmosphere (ISA) for reference, showing density dropping rapidly initially and then more gradually at extreme altitudes, with steep drops in the lower troposphere and slower changes in the upper atmosphere.

When the altitude increases, the air density decreases. It affects the cooling efficiency of electrical equipment. Cooling systems, such as fans and heat sinks, rely on air circulation to dissipate heat generated during operation. **Less dissipation of heat creates failure of electrical gadget.**



Credit: engineering tool box .com

a) Density versus altitude

- **Sea Level (0m):** Density ~1.225 kg/m³; Pressure ~14.7 psi.

- **~1,800m (6,000 ft):** Density ~1.02 kg/m³; Pressure ~11.7psi.
- **~3,000m (10,000 ft):** Density ~0.90 kg/m³; Pressure ~9.96psi.
- **The standard air density at an altitude of 11,000 meters is approximately 0.364 kg/m³.**

b) Temperature versus altitude -

- Temperature generally decreases with height in the Troposphere (lowest layer) due to less solar heating from below.
- The tropopause (where the decrease stops) and stratopause (where the rise stops), with typical data showing ~15°C at sea level dropping to ~-56.5°C at 11km (tropopause)

Standard Atmosphere

- **Sea Level (0 km):** 15°C (59°F)
- **11 km (Tropopause):** -56.5°C
- **20 km:** -56.5°C (Stratosphere, stable temp)
- **50 km (Stratopause):** Around -15°C (Mesosphere begins)
- This profile shows the non-linear, layered nature of atmospheric heating, distinct from the simple cooling with height you'd experience climbing a mountain.