This experiment quantified the effect of ambient air pressure on rocket motor performance and tested whether the experimentally measured differences in performance agreed with the differences predicted by applying the thrust equation, a commonly accepted mathematical model.

Force was recorded as a function of time for ten samples each of the Estes D11-P, Estes A10-PT, and Quest D5-0P rocket motors at two different ambient pressures (77.88 kPa and 101.04 kPa) using a force plate (total of 60 trials). The different ambient pressures were achieved by testing at different altitudes (10 m and 2255 m above sea level). The thrust equation was integrated to obtain impulse. The predicted difference in impulse between the two air pressures then depended on throat area, difference in air pressure, and duration of the burn. The predicted difference in impulse was computed for each engine model. The change in specific impulse with a change in air pressure was computed as the predicted difference in impulse divided by the mass of the fuel burned at higher pressure.

As expected, the measured thrust, impulse, and specific impulse were higher at a lower air pressure. However, the model’s prediction that the increase in thrust would be directly proportional to the decrease in air pressure was not supported. The difference in impulse for only one of three predictions (Estes D11-P), and the difference in specific impulse for a different one of three predictions (Estes A10-PT) were within the uncertainties of the predicted values.