



# Alternative Piston Engine Aviation Fuels to Reduce Lead Emissions

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AP Research: STEM  
Thousand Oaks High School



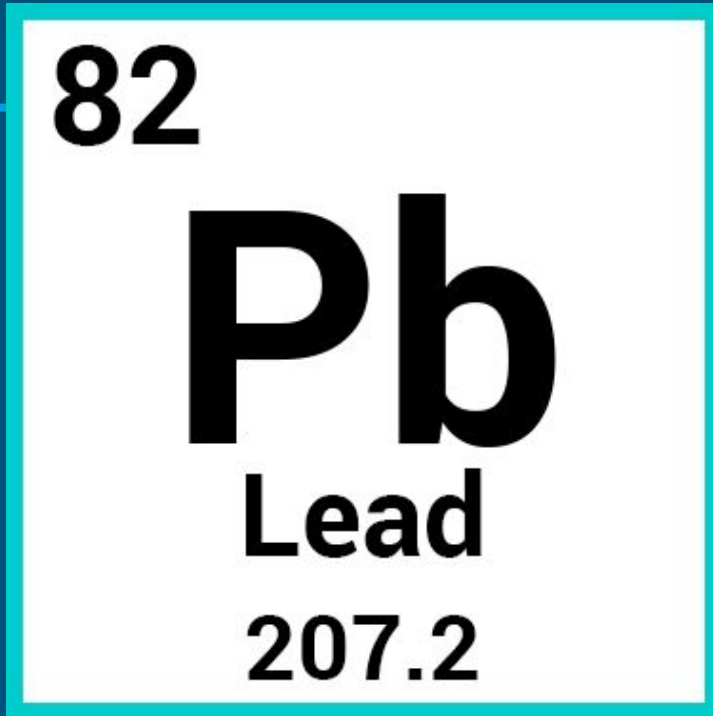


Figure 1. Lead's periodic square

- Lead is a toxic metal
- Started use in fuels during 1920s
- Increases fuel antiknock quality

- Antiknock quality: A fuel's ability to resist detonation
  - Measured as octane
- Detonation: The fuel inside an engine's cylinder explodes instead of burns
  - Damages engine

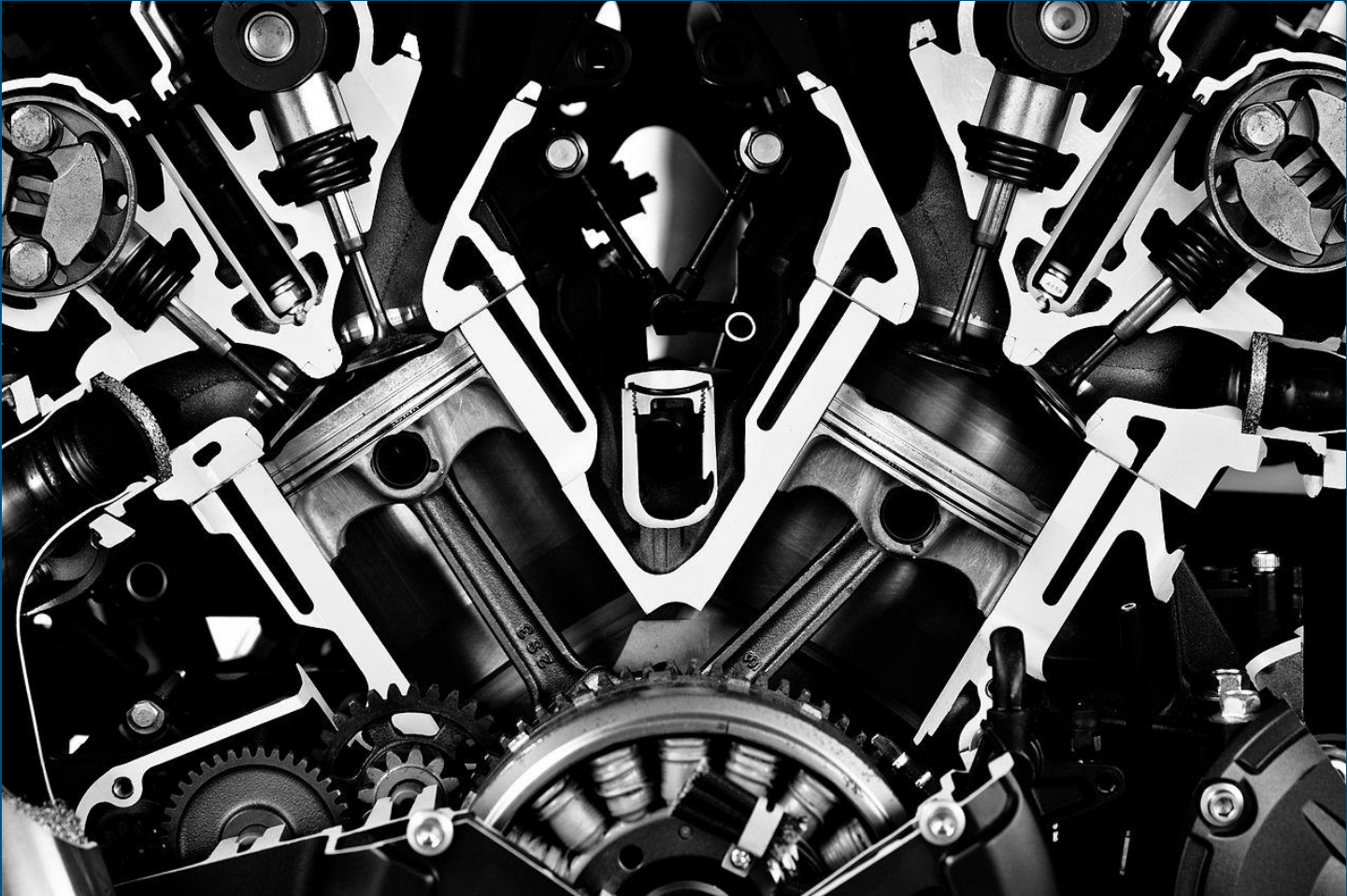
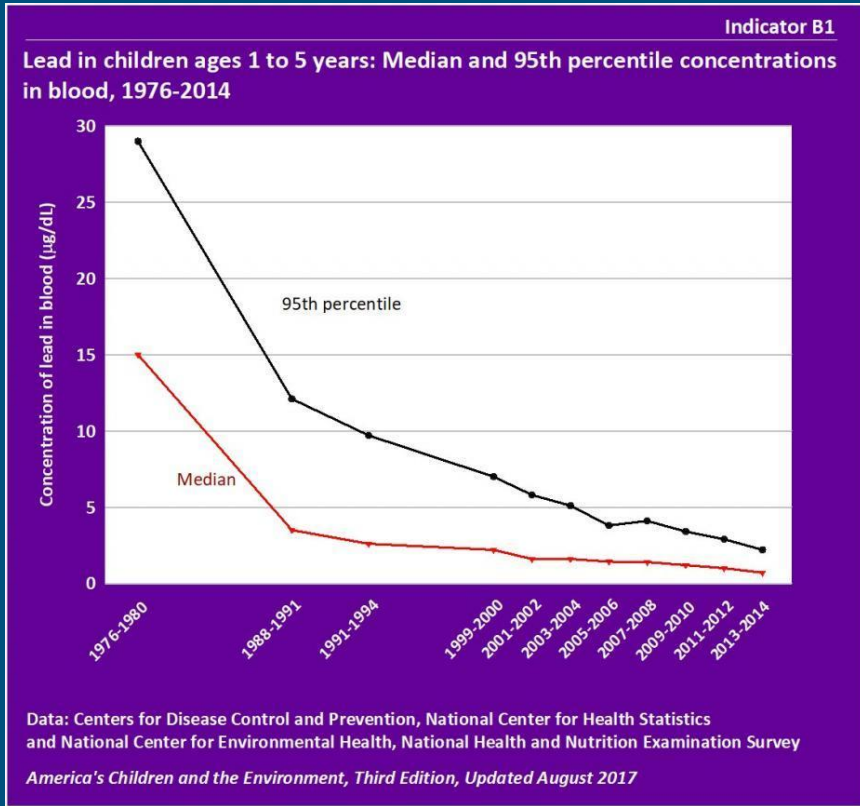


Figure 2. Cutaway of two engine cylinders

# Effects of lead

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- Reduced IQ
- Slowed physical growth
- Impaired hearing
- etc...



- 1996: lead banned in automotive gasoline
- Leaded aviation fuel still permitted

Figure 3. Chart showing the decrease in lead concentration in children's blood since 1976



Figure 4. Three piston engine aircraft flying in formation

- 100LL fuel used (Avgas)
- 50% of lead emissions from aviation
- Blood lead levels 4.4% higher in children living within 500 m of an active airport

# Purpose

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Identify a possible fuel alternative to Avgas that does not contain lead and has an equal or better octane rating



# Research Question

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Which fuel alternative to Avgas provides the best octane rating, without any lead emissions?

# Hypothesis

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- Alternative hypothesis: There are alternative non-lead fuels that provide equivalent performance to Avgas.
- Null hypothesis: There are no alternative non-lead fuels that provide equivalent performance to Avgas.

# Methods: Systematic Literature Review

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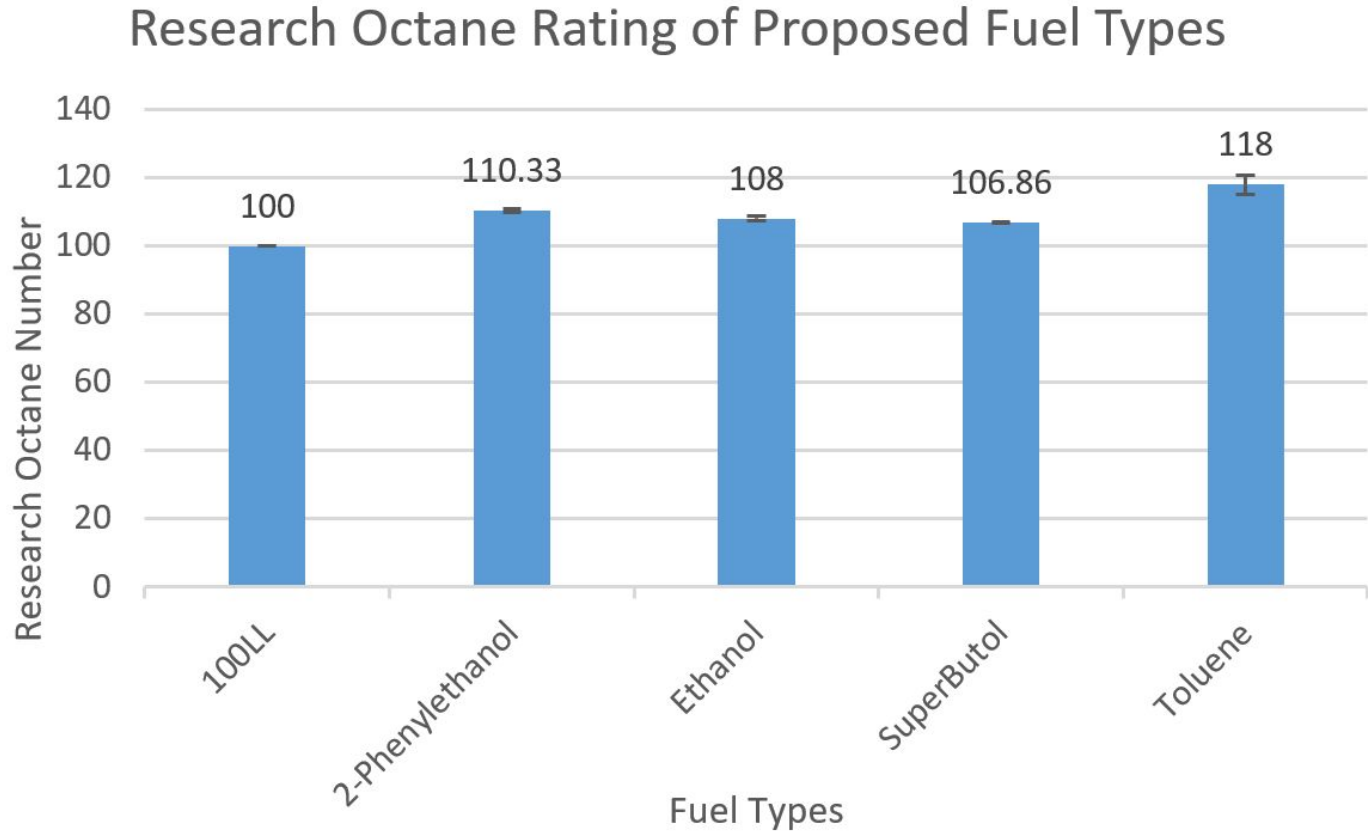
- Peer reviewed articles utilized
- JSTOR, ScienceDirect, Open Science Directory, EBSCOHost, and Science Archive were useful databases
- Search terms: RON, Octane, Fuel, Knock, Anti-knock

# Fuels Studied

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- 2-Phenylethanol
- Ethanol
- SuperButol
- Toluene

# Results



# Discussion

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- All alternative fuels have a high enough octane rating to replace Avgas
- Toluene has the highest octane rating

# Conclusion

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Toluene and 2-Phenylethanol have the highest octane ratings and are the best candidates to replace Avgas

# Further work

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- Field testing
- Harmful fuel characteristics
- Account for fuel cost



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