Laws of Thermodynamics: Zereth Law

Heat flows from hot objects to cold objects until they have the same temperature.

Laws of Thermodynamics: First Law

Conservation of Energy:
All energy entering a system must be conserved

Q = ΔU + W
LAWS OF THERMODYNAMICS: FIRST LAW

Example: A Internal Energy & Work Performed

\[ Q = \Delta U + W \]

Example: A Internal Energy & No Work Performed

\[ Q = \Delta U \]

IN

HEAT: Q

\[ \Delta U: KE \uparrow \Rightarrow T \uparrow \]

OUT

WORK: W

\[ Q = \Delta U + W \]

REAL ENGINES

Internal Combustion Engine: 4-stroke Otto cycle

Step 1: Intake of gas-air mixture from the carburetor

- Engine pulls piston out of cylinder
- Low pressure in cylinder
- Atmospheric pressure pushes fuel air mixture into cylinder
- Engine does work on gases during this stroke

Step 2: Compression of the air-gas mixture

- Engine pushes piston into cylinder
- High pressure and temperature in cylinder
- Engine does work on gases during this stroke
Internal Combustion Engine: 4-stroke Otto cycle

Step 3: Ignition and Expansion of the air-gas mixture

- Mixture burns to form hot gases
- Gases push piston out of cylinder
- As gas expands, pressure and temperature is lowered
- Gas does work on engine during this stroke

Step 4: Exhaust of waste gas

- Engine pushes piston back into cylinder
- Pressure inside pushes burnt gas out of cylinder
- As gas expands, pressure and temperature is lowered
- Engine does work on gas during this stroke
ENGINE EFFICIENCY

- Increase compression ratio => Get more work out of engine
- Limit to compression ratio: knocking - spontaneous ignition of fuel/air mixture before the engine is ready to extract work
- High compression ratio cars use premium gasoline. Higher octane ignites at higher temperatures
- On most normal cars, premium gas is a waste of money

LAWS OF THERMODYNAMICS: Diesel Engines

- Uses compression to ignite fuel
  - squeezes air to high pressure and temperature (compression ratio of ~ 20:1 compared with 8:1 - 12:1)
  - injects fuel air in between compression and power strokes
  - fuel ignites spontaneously
- High compression allows for high efficiency
Test Your Understanding

• How does the burned gas do more work on the piston during the power stroke than the piston does on the unburned fuel-air mixture during the compression stroke?
• Why is a car more likely to knock on a hot day than a cold day?
• High compression ratio cars use premium gasoline. Higher octane ignites at higher temperatures
• On most normal cars, premium gas is a waste of money

Main Points from Today’s Lecture

• Engines
  You should understand that some of the heat (that flows from hot objects to cold objects) can be used to do work. Any device that does this is called a heat engine. You should have a basic understanding of the strokes of a car engine.