2024 VRC Reverse Engineering Online Challenge

Disassembling the Mystery Engine

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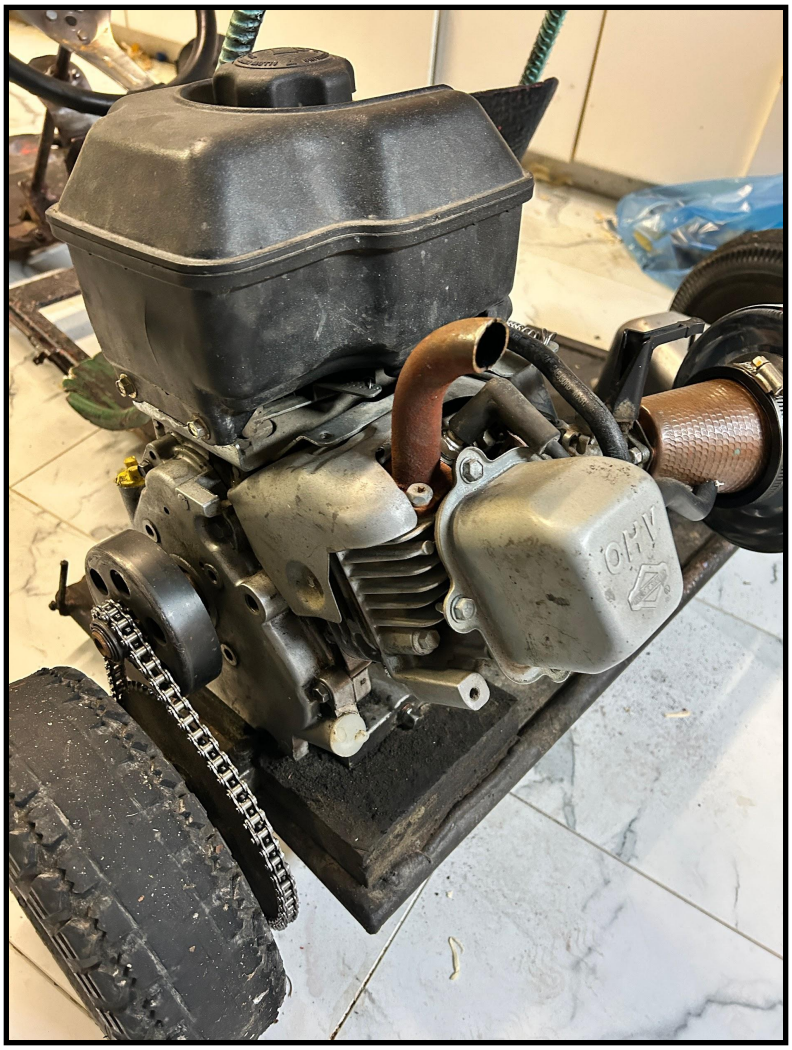

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480 Words not including table of contents, image captions, diagrams, and citations

Table of contents:

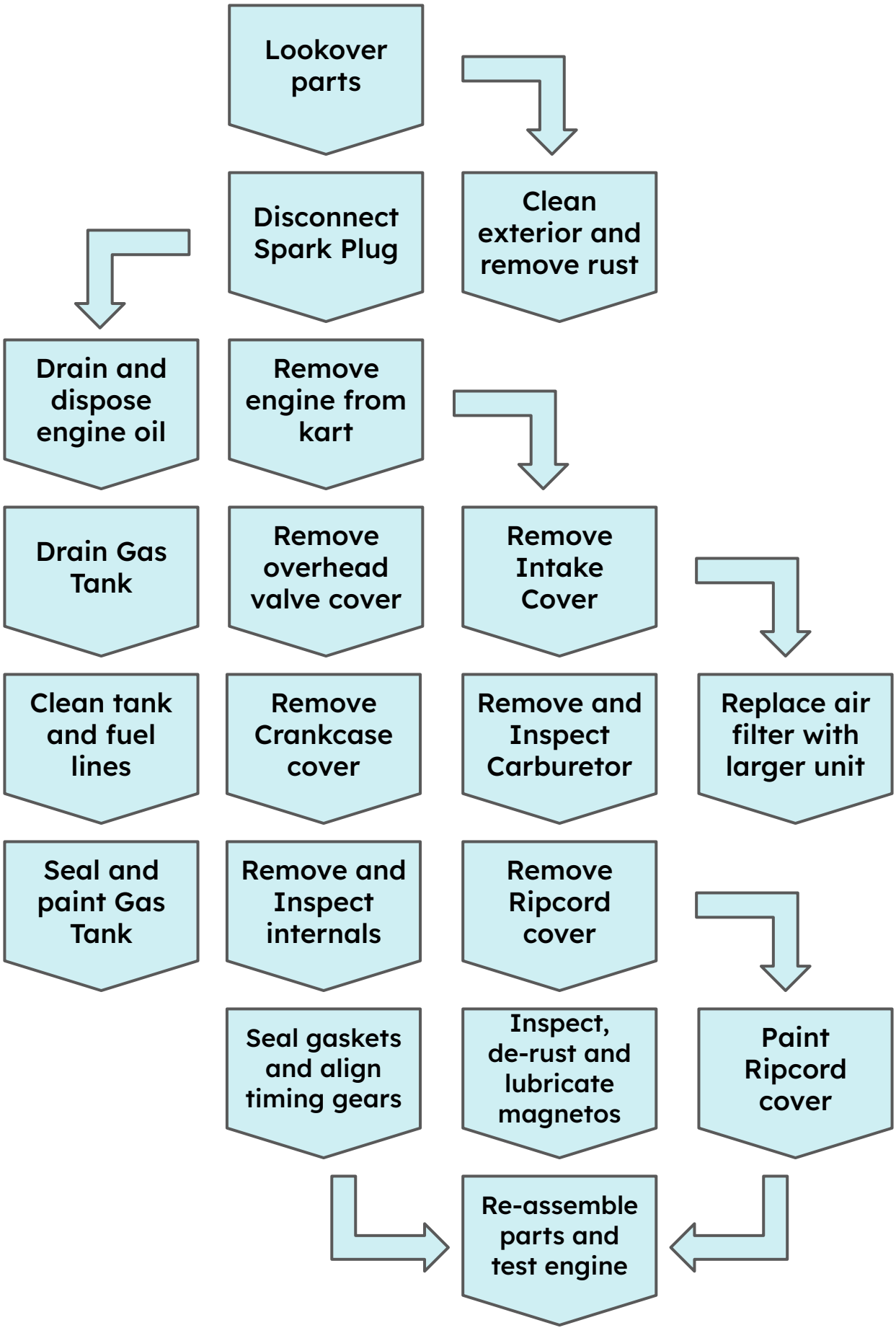
Introduction:

We recently bought a broken go-kart. Our goal for this challenge is to diagnose, then fix the issue and learn along the process to fix other problems later on.

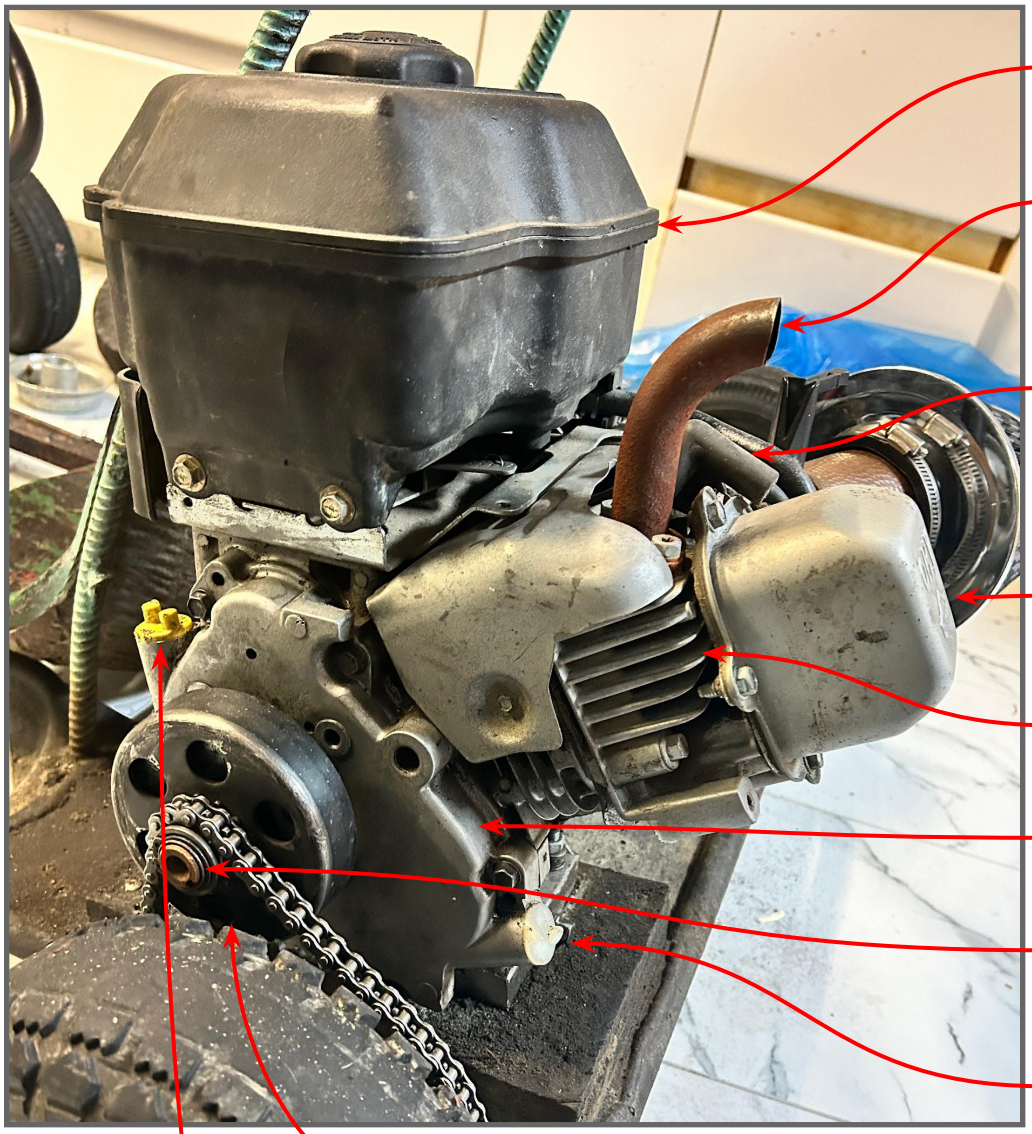
“Lunch break at PYRS Season Opener”

Our team prides ourselves on good cohesion. Being passionate about engineering means that we spend long hours on our robot but without a break, we burn out faster than our catapult motors in a skills run. We bought this project to work on as a new exciting challenge. The issue is that we don’t actually know what model the engine is. So we started investigating…

Disassembly flow chart:

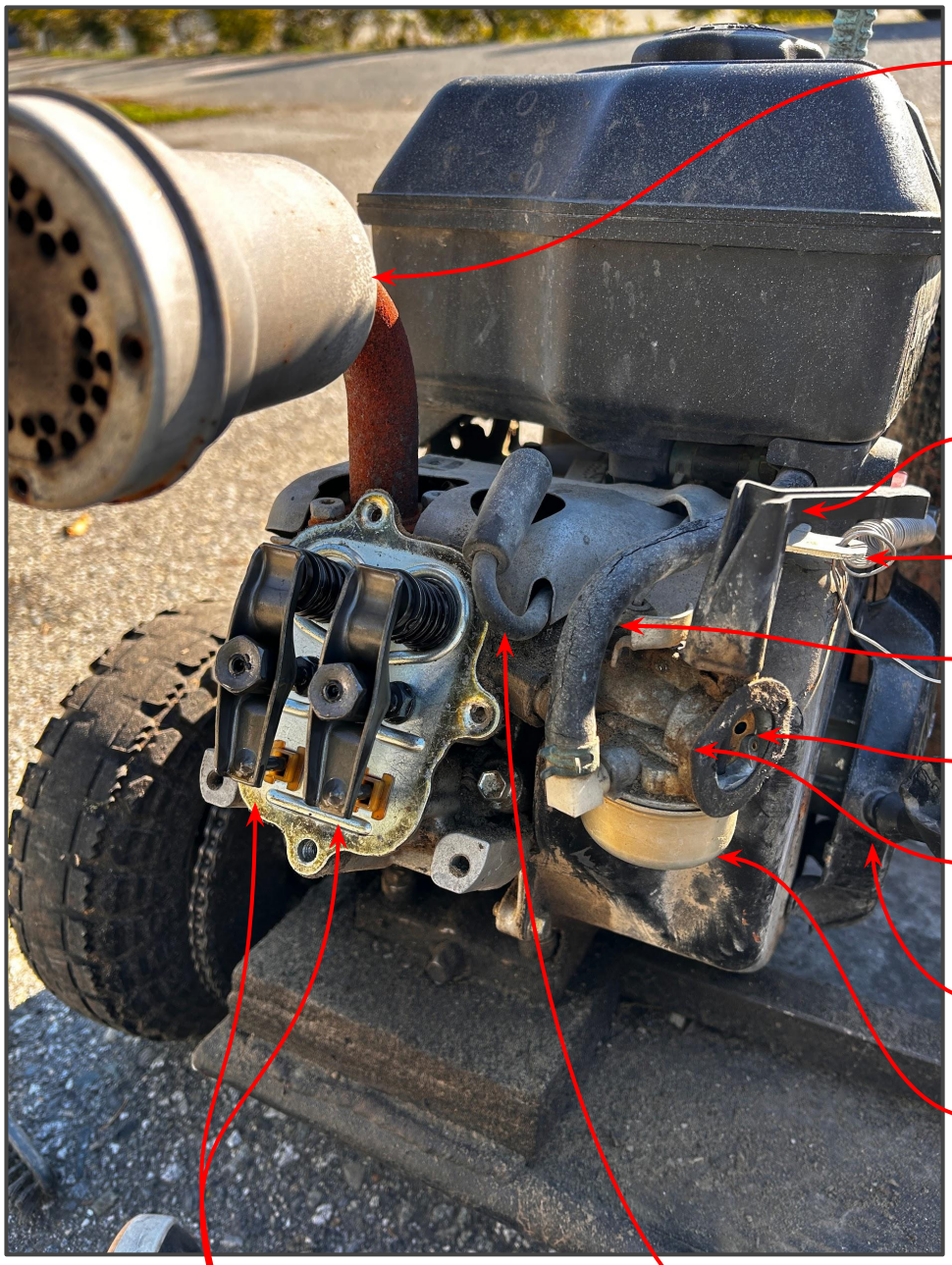


First Impressions:



We then removed the overhead-valve cover and intake

Delving deeper:



The inside was much cleaner than the outside and the oil was metal dust free which was a good sign.

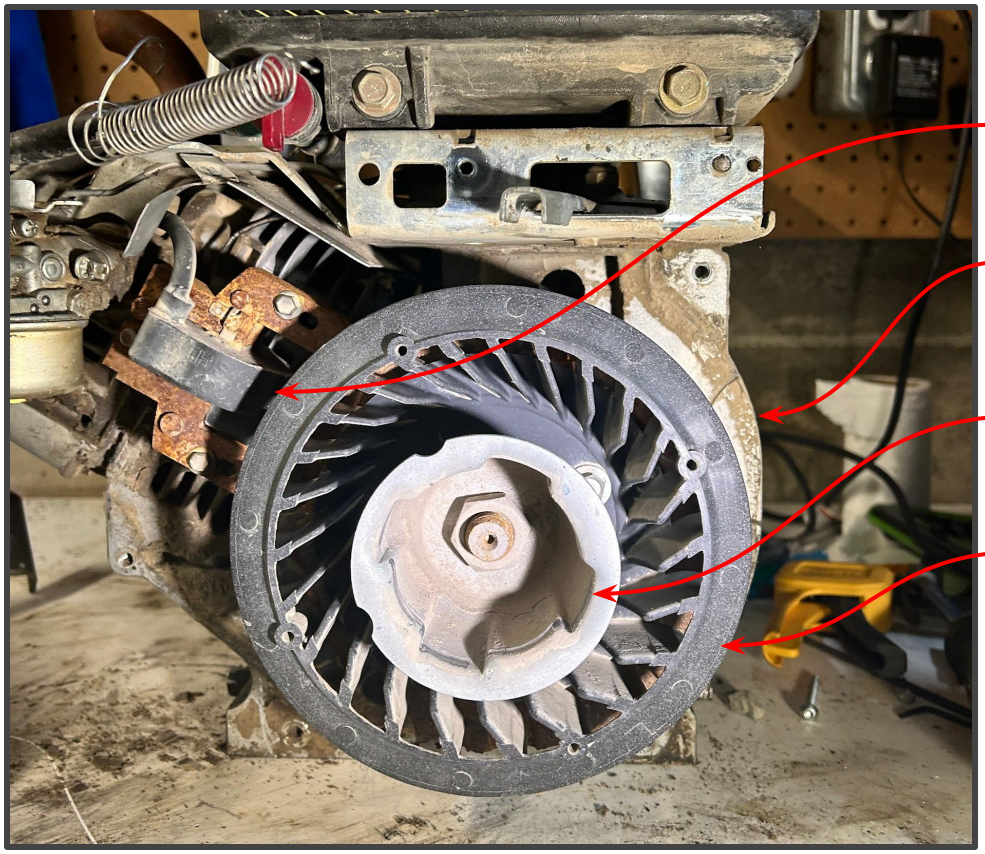
"This was after I cleaned it with a wire brush"

Disassembly and Parts:

The best way to sort the parts is to arrange them in 3 categories:

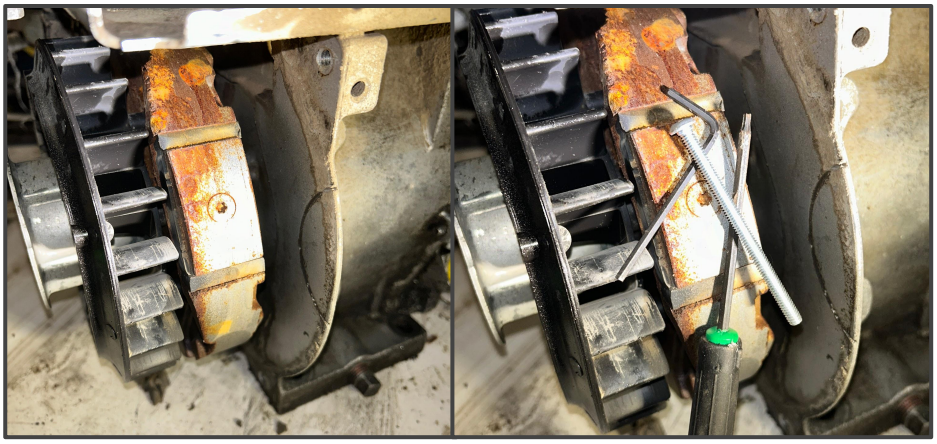
FUEL **AIR** **ELECTRONICS**

SAFETY:
Disassembly was performed in a ventilated environment.
Spark plug was disconnected and fuel drained to avoid ignition.
I also wore eye protection, gloves and a first aid kit + fire extinguisher nearby.



Pull-cord housing was removed to reveal flywheel and cooling fan

Electronics:



Magneto magnet:

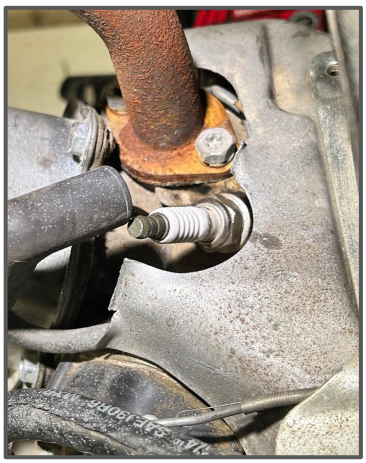
Connected to crank shaft

Purpose:
Generates electricity by passing magneto coil.

Magneto:

Connected to spark plug, has a wire coil inside.

Purpose:
Creates and sends electrical signal to spark plug.



Spark Plug:

Screwed into the top of the cylinder

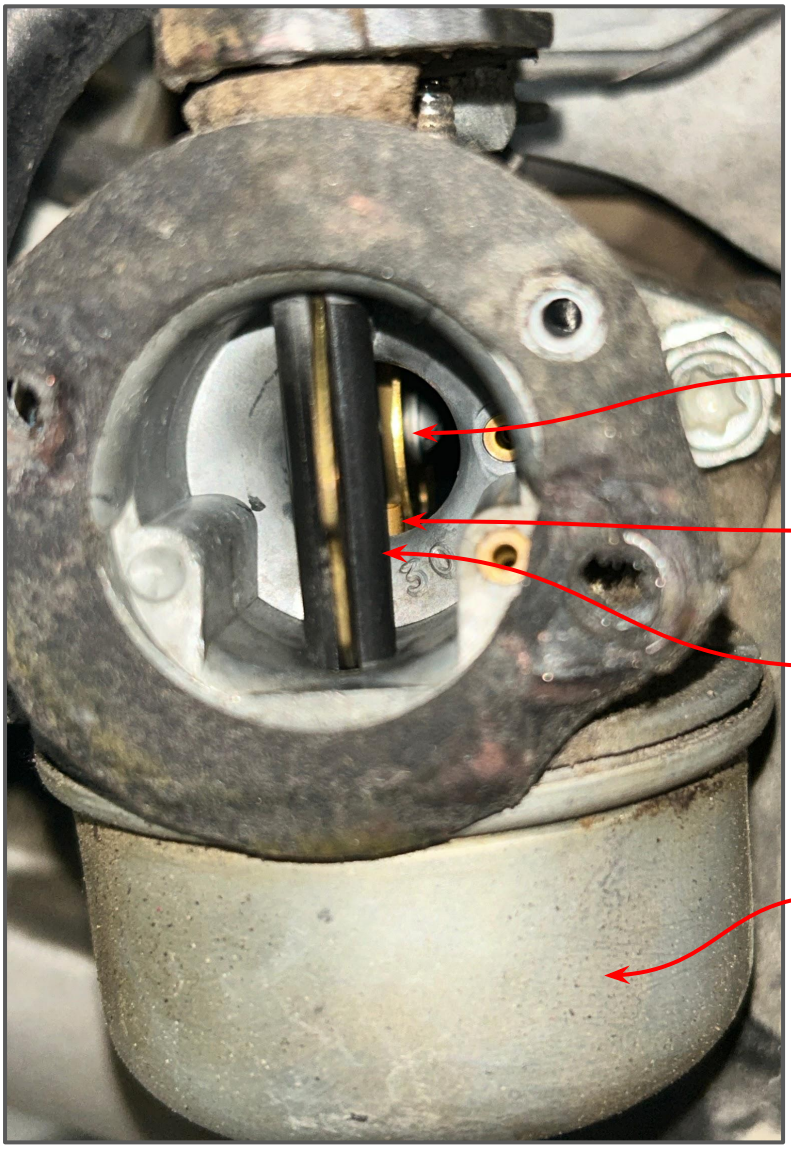
Purpose:
Spark ignites compressed fuel/air mixture in cylinder.

Ripcord:

Attached to engine case, meshes with flywheel when cord is pulled

Purpose:
Manually kickstarts 4 stroke cycle and spins magneto ring to start engine

Air:



Carburetor:

Connected to intake and valve body

Purpose:

Mixes fuel and air

Governor valve:

Closes to regulate RPM

Fuel-Jet:

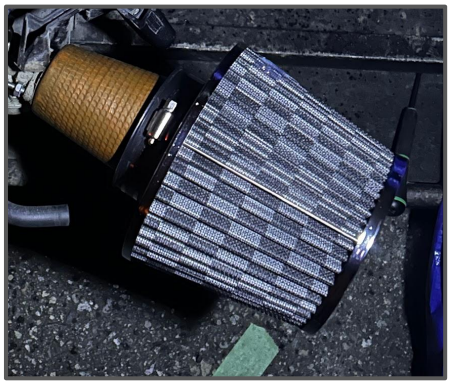
Sprays fuel into air using the venturi effect

Choke Valve:

Richens fuel/air mixture by restricting air for starting a cold engine

Carburetor Bowl:

Holds fuel for carb jet

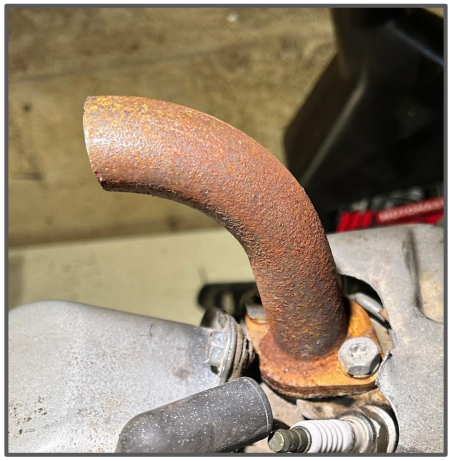


Air filter:

Air intake for carburetor and keeps internal components clean

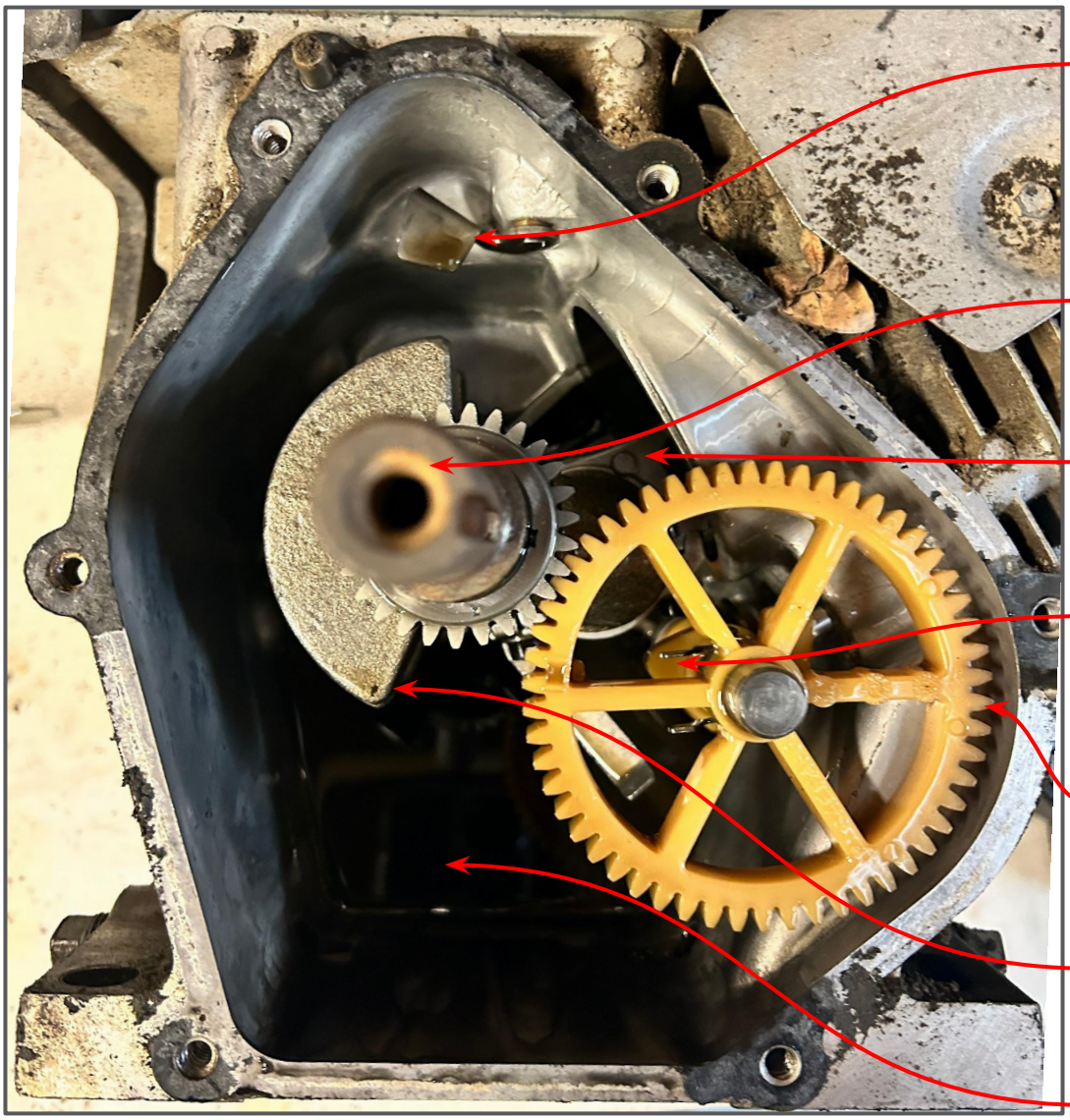
Exhaust

Exhausts burnt fuel/air mix



Fuel:

Crankcase:



Governor lever:
Regulates RPM by closing throttle, interfaces with governor gear

Crankshaft:
Main spinning shaft, connected to drivetrain

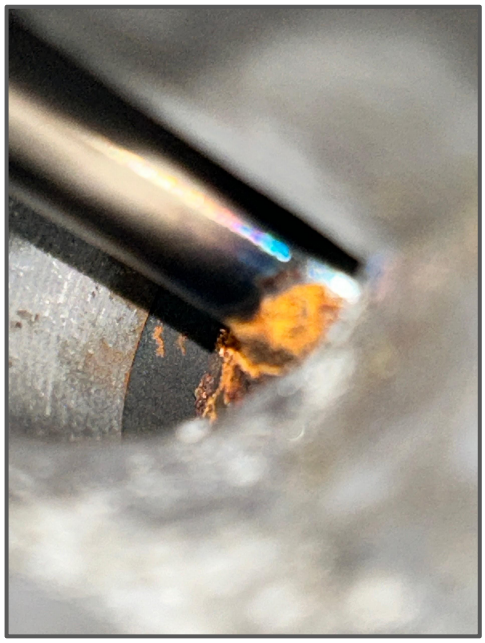
Piston:
Completes 4 strokes to produce power

Camshaft:
Ridges on shaft bump the valve bottoms to push them up, opening them

Timing-gear:
Spins camshaft

Counterweight:
Counters force of piston moving up and down

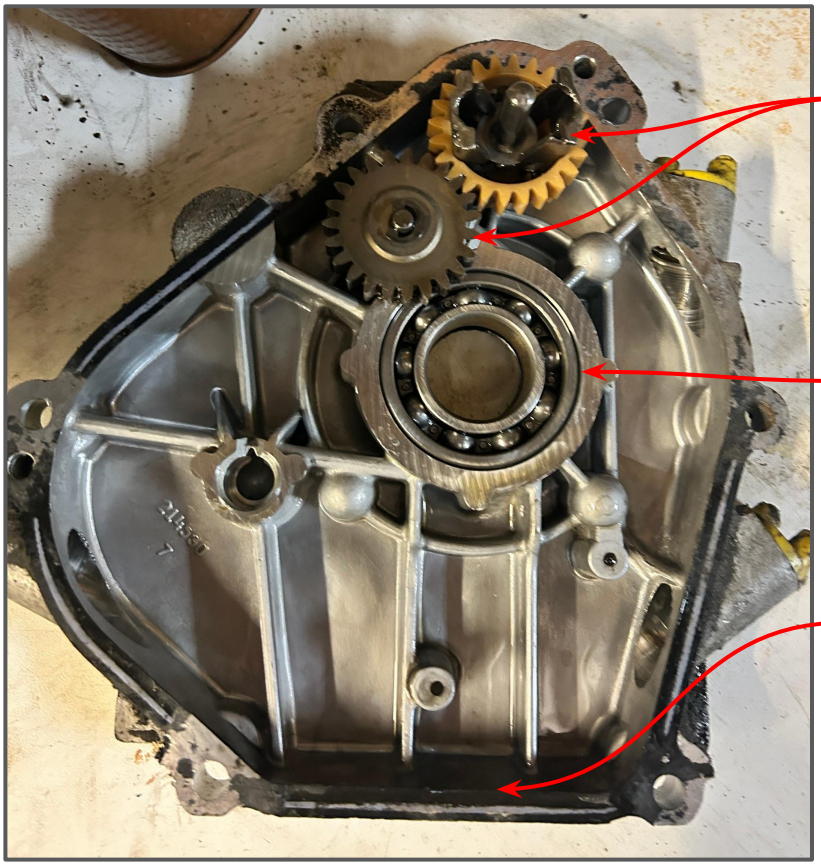
Oil:
Lubrication of all internal parts



Valves:
Opens to let fuel air mixture into the cylinder and exhaust gasses out

Fuel:

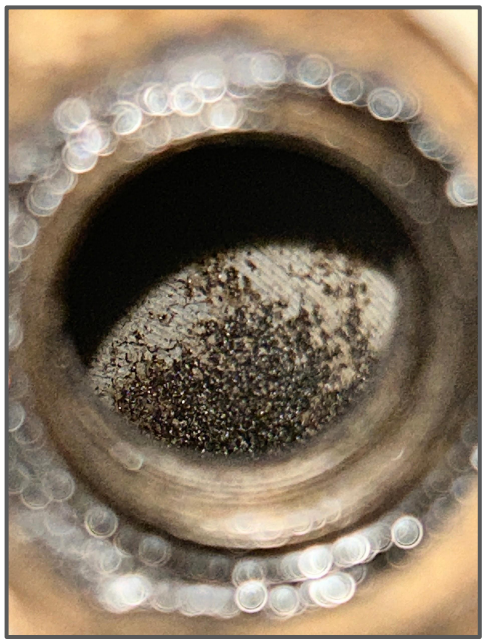
Crankcase cover:



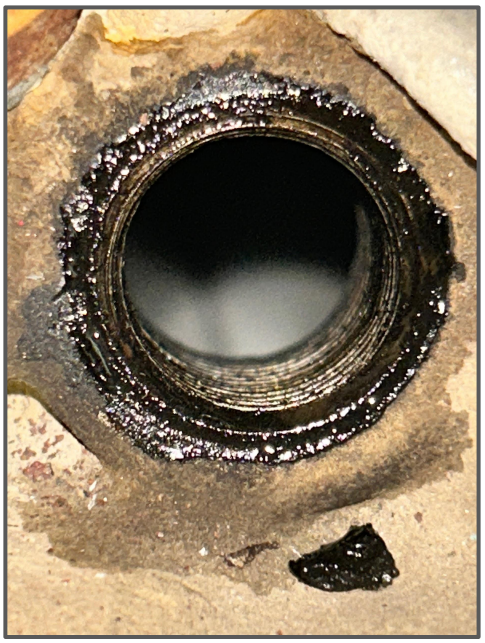
Governor:
Regulates RPM by spinning out a flywheel at high speeds to push governor lever

Crankshaft Bearings:
Holds crankshaft

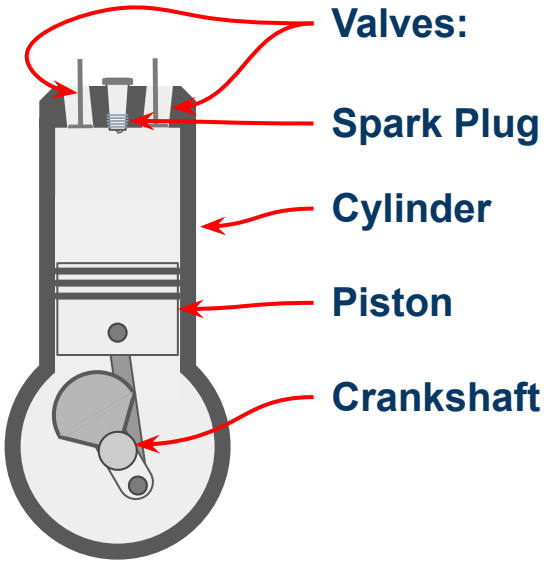
Gasket:
Seals oil inside crankcase

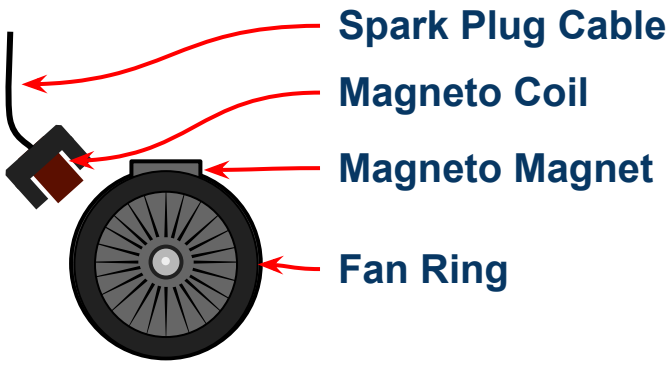


Piston at Top-Dead-Center

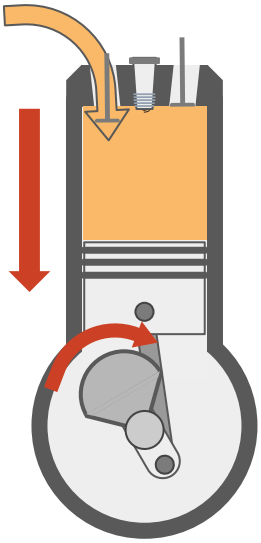


Piston at Bottom-Dead-Center

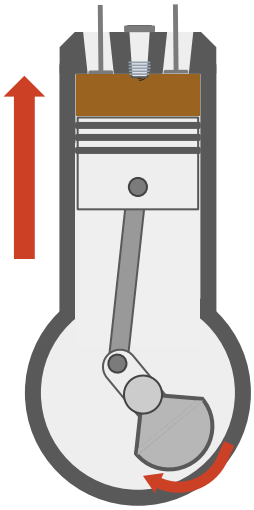




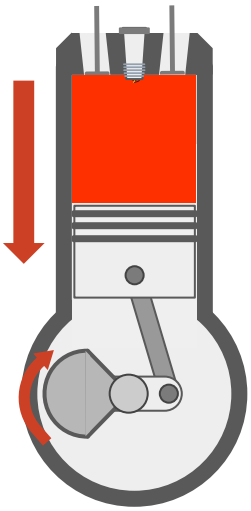
The 4 Stroke Cycle:



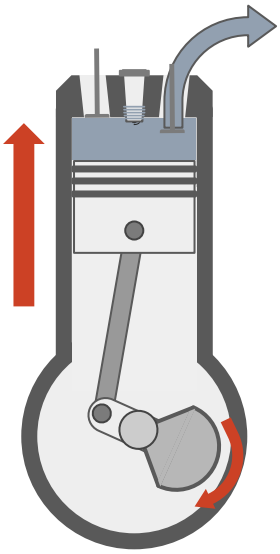
Intake:
Intake valve opens and piston pulls in mixture of fuel and air into the cylinder



Compression:
Piston goes up and compresses the fuel air mixture

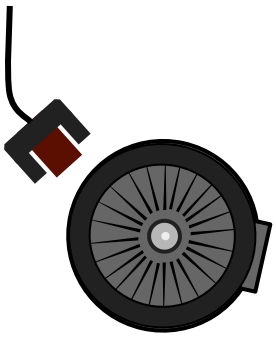


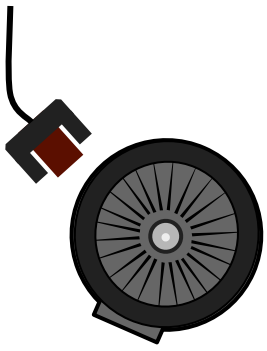
Combustion:
Also known as the power stroke, the spark plug ignites the compressed fuel air mixture

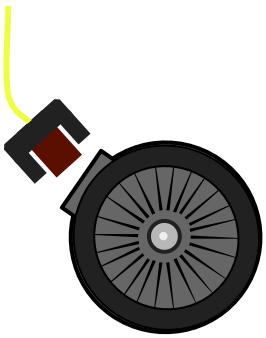


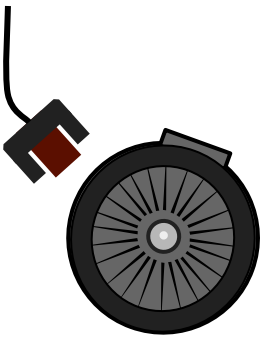
Exhaust:
Exhaust valve opens and the piston pushes out the exhaust gasses, clearing the cylinder to start the cycle again.

Magneto Positions:



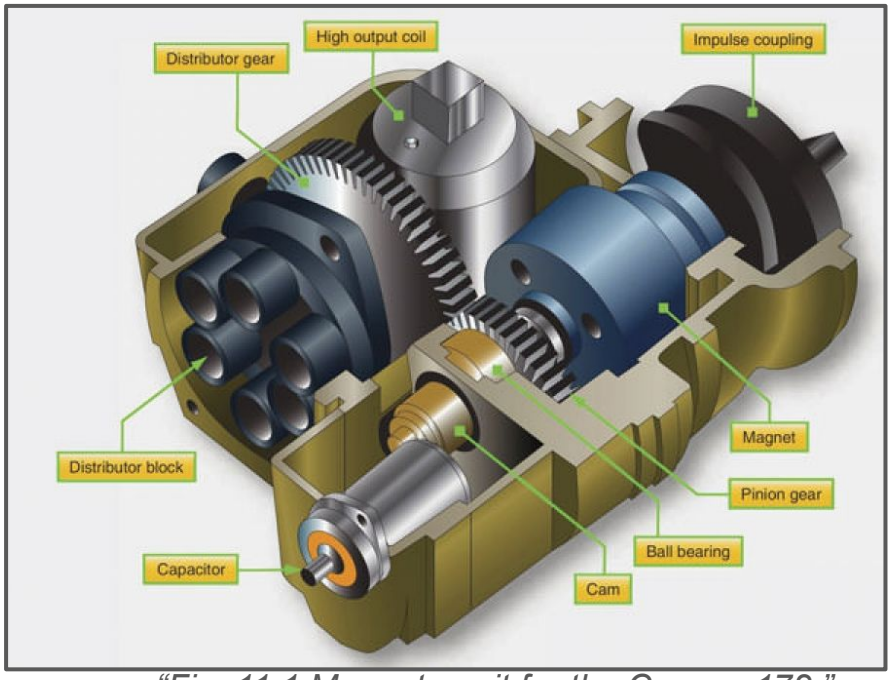






The Magneto:

The magneto used to be used in cars until they were phased out by modern computer controlled ignition systems connected to the car battery. Despite this, magnetos are still used in small engines like lawnmowers and aircraft engines due to their reliability and lack of need of a battery.



"Fig. 11.1 Magneto unit for the Cessna 172 "

Magnetos are a perfect example of reliability through simplicity.

Fuel injectors and ignition systems are modern luxuries to increase efficiency and reduce emissions but they complication adds more failure points.

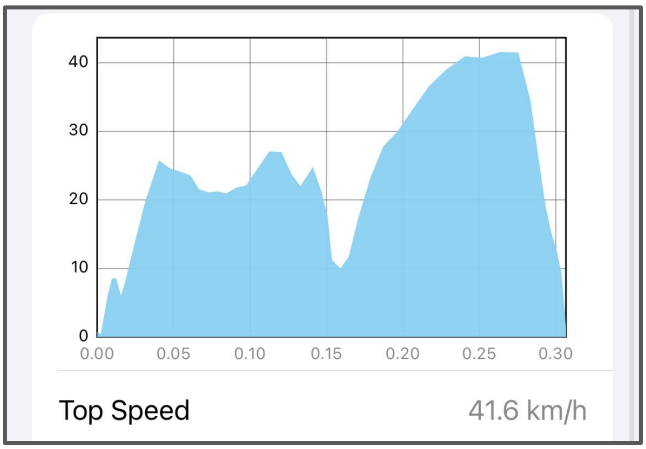
"Fig. 11.2 Cessna 172 "

This is why most piston aircraft have carburetors and magnetos.
A lawn mower has more in common with a plane engine than a car.

Lessons learnt:

We learnt organization, build quality and simplistic design. Everything in the engine was simple yet meshed with other parts to create a strong intricate machine.
It's important to work on small machines to get a greater appreciation and understanding of engineering principles. Even from this project I learnt many skills which I can apply in Over Under, and hopefully soon, in applications such as aerospace engineering which I want to pursue.

Also its just plain fun.



Citations:

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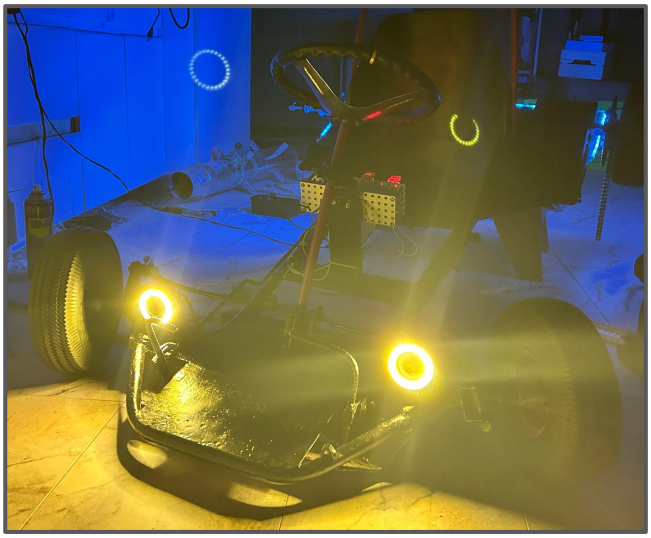
All diagrams made in Google Slides



"Go-Kart after a fresh coat of paint, and the addition of headlights, taillights and a horn"