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# ***Systems In Mechanical Engineering***

## **UNIT-III**

### **Vehicles and their Specifications**

***Mr. Girish G Khope***



# Syllabus

- Classification of automobile.
- Vehicle specifications of two/three wheeler, light motor vehicles, trucks, buses and multi-axle vehicles.
- Engine components (Introduction).
- Study of engine specifications, comparison of specifications of vehicles.
- Introduction of Electric and Hybrid Vehicles.  
Cost analysis of the Vehicle.

# Classification of Automobile

## 1. Based on Purpose :

- **Passenger vehicles:** These vehicles carry passengers. e.g: Buses, Cars, passenger trains.
- **Goods vehicles:** These vehicles carry goods from one place to another place. e.g: Goods lorry, Goods carrier.
- **Special Purpose:** These vehicles include Ambulance, Fire engines, Army Vehicles.

## 2. Based on Load Capacity:

- **Light duty vehicle:** Small motor vehicles. eg: Car, jeep, Scooter, motorcycle
- **Heavy duty vehicle:** large and bulky motor vehicles. e.g: Bus, Truck, Tractor

# Classification of Automobile

## 3. Based on fuel used:

- **Petrol engine vehicles** : Automobiles powered by a petrol engine. e.g: scooters, cars, motorcycles.
- **Diesel engine vehicles** : Automobiles powered by diesel engine. e.g: Trucks, Buses, Tractors.
- **Gas vehicles** : Vehicles that use gas turbine as a power source. e.g: Turbine powered cars.
- **Electric vehicles** : Automobiles that use electricity as a power source. e.g: Electric cars, electric buses.
- **Steam Engine vehicles** : Automobiles powered by steam engine. e.g: Steamboat, steam locomotive, steam wagon.

## 4. Based on Drive of the vehicles:

- **Left-Hand drive** : Steering wheel fitted on the left-hand side.
- **Right-Hand drive** : Steering wheel fitted on the right-hand side.
- **Fluid drive** : Vehicles employing torque converter, fluid flywheel or hydramatic transmission.

# Classification of Automobile

## 5. Based on number of wheels and axles:

- **Two wheeler** : motorcycles, scooters
- **Three-wheelers** : Tempo, auto-rickshaws
- **Four wheeler** : car, Jeep, Bus, truck
- **Six-wheelers** : Buses and trucks have six tires out of which four are carried on the rear wheels for additional reaction.
- **Six axle wheeler** : Dodge(10 tire) vehicle

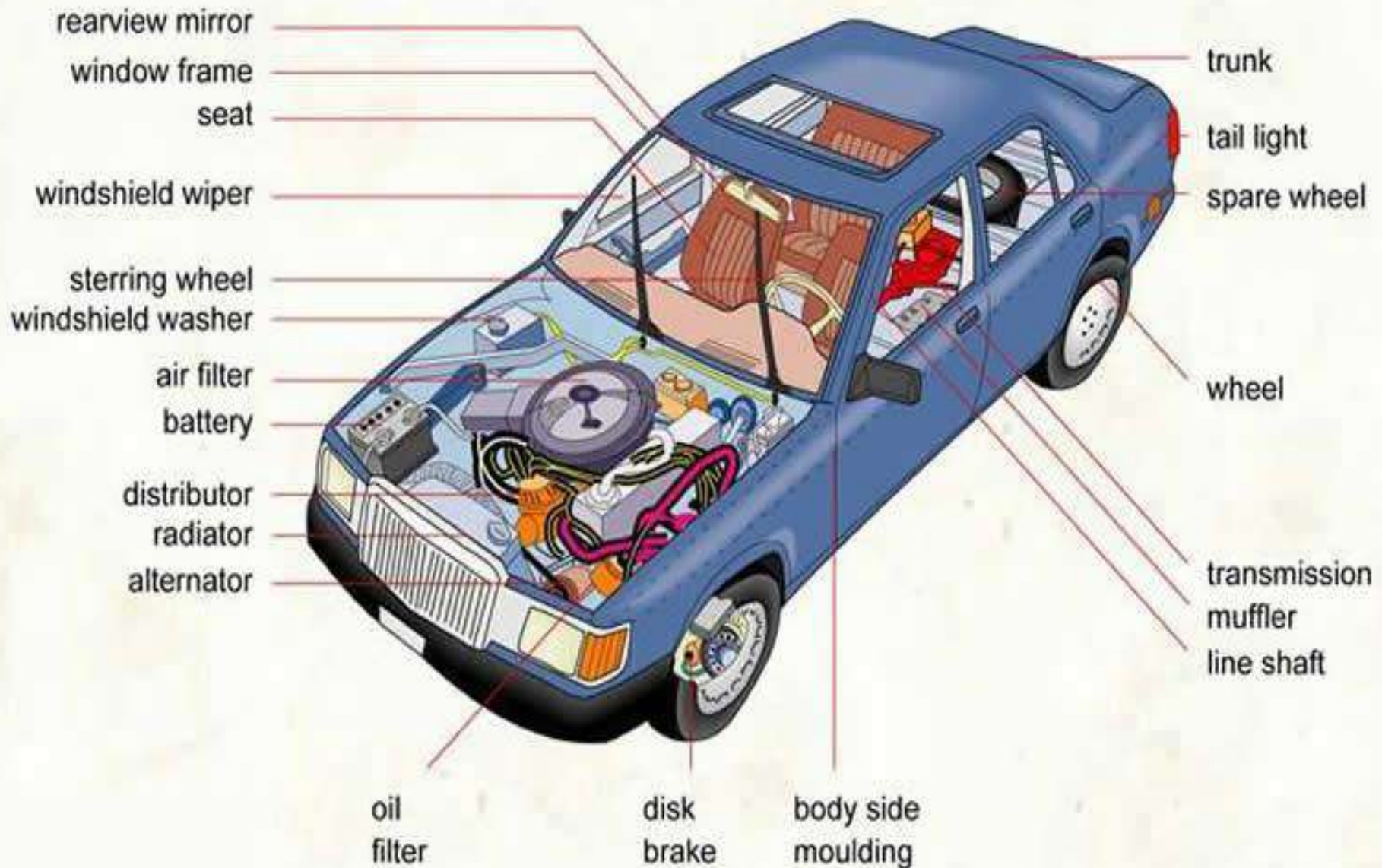
## 6. Based on type of transmission:

- **Automatic transmission vehicles**: Automobiles that are capable of changing gear ratios automatically as they move. e.g: Automatic Transmission Cars.
- **Manual transmission vehicles**: Automobiles whose gear ratios have to be changed manually.
- **Semi-automatic transmission vehicles**: Vehicles that facilitate manual gear changing with a clutch pedal.

## 7. Based on Suspension system used:

- **Convectional** – Leaf Spring
- **Independent** – Coil spring, Torsion bar, Pneumatic.

# ANATOMY OF AN AUTOMOBILE



- **Trunk:** place for stowing baggage
- **Tail light:** rear light.
- **Spare wheel:** wheel of a car used to replace a damaged wheel.
- **Wheel:** round object that turns around a central axel and allows the car to advance
- **Transmission:** automobile apparatus that transmits mechanical power to the wheels
- **Muffler:** device used to reduce engine noise.
- **Line shaft:** axle on which mechanical power is transmitted to the wheels.
- **Body side moulding:** decorative moulding on the side of a car.



- **Disk brake:** mechanism that slows and stops a car by friction, by pressing a disk against the axle of a wheel.
- **Oil filter:** device that removes impurities from oil passing through it.
- **Alternator:** generator that produces an alternating current.
- **Radiator:** apparatus that cools the motor.
- **Distributor:** case that is used to fire the cylinders.
- **Battery:** device that generates electric current
- **Air filter:** device that remove impurities from air passing trough it.

- **Windshield washer:** liquid used to clean the windows.
- **Steering wheel:** device used to handle a car in conjunction with steering and gear systems.
- **Windshield wiper:** movable device, made partly of rubber, that wipes the windshield and rear window of a car.
- **Seat:** type of armchair in the passenger compartment of a car.
- **Window frame:** border around a window.
- **Rearview mirror:** inside mirror used for looking backward.

# *Types of car body*

## TYPES OF BODIES



hatchback



sports car



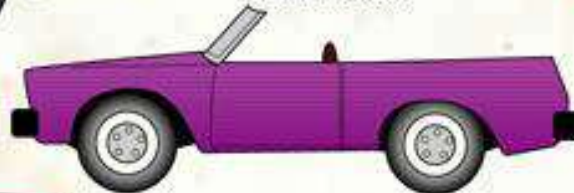
four-door sedan



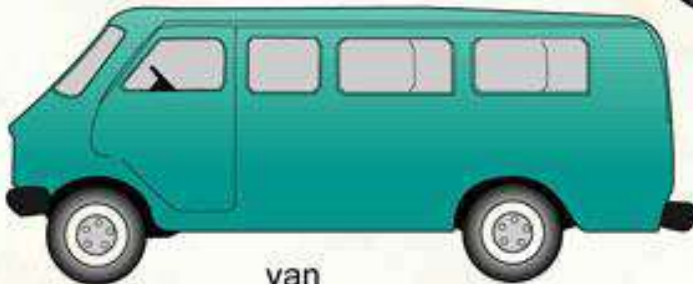
limousine



hardtop



convertible



van



pick-up truck

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# ***COMPONENTS OF AUTOMOBILE***

The automobile can be considered to consist of five basic components :

- 1. The Engine or Power Plant** : It is source of power.
- 2. The Frame and Chassis** : It supports the engine, wheels, body, braking system, steering, etc.
- 3. The transmission** which transmits power from the engine to the car wheels. It consists of clutch, transmission, shaft, axles and differential.
- 4. The body** fitted on chassis.
- 5. Accessories** including light, air conditioner, stereo, wiper, etc

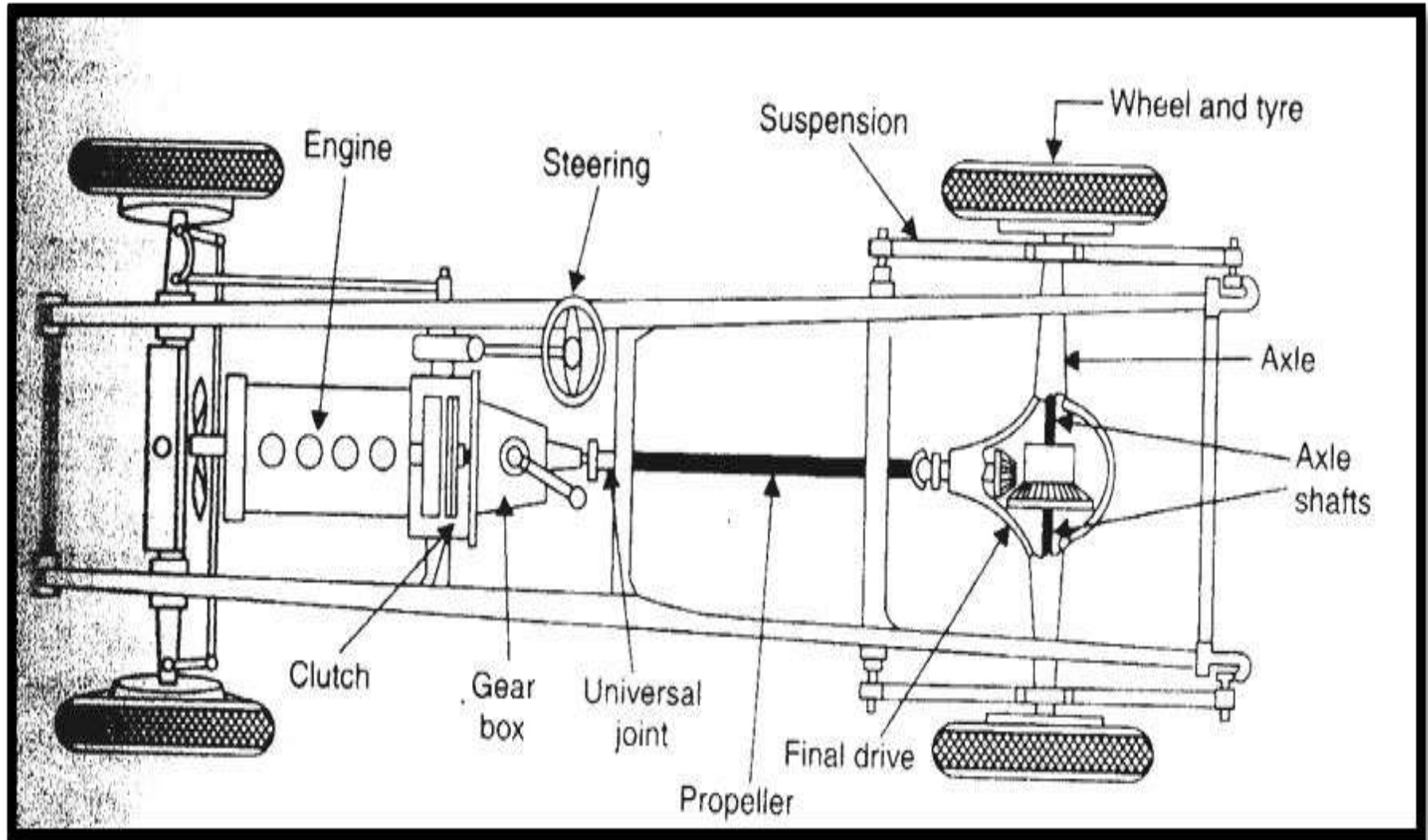
# ***1. Engine or Power Plant***

- The engine is the power plant of the vehicle.
- In general, internal combustion engine with petrol or diesel fuel is used to run a vehicle.
- An engine may be either a two-stroke engine or a four-stroke engine.
- An engine consists of a cylinder, piston, valves, valve operating mechanism, carburetor, fan, fuel feed pump and oil pump, etc.
- Besides this, an engine requires ignition system for burning fuel in the engine cylinder.

## 2.CHASIS & FRAMES

- The chassis is formed by the frame with the frame side members and cross members.
- The frame is usually made of box, tubular and channel members that are welded or riveted together.
- In addition to this, it comprises of the springs with the axles and wheels, the steering system and the brakes, the fuel tank, the exhaust system, the radiator, the battery and other accessories.
- Along with this the frame supports the body.

# ***LAYOUT OF AUTOMOBILE CHASIS***



### ***3. TRANSMISSION SYSTEM***

- The power developed by the engine is transferred to the wheels by transmission system.
- Transmission system must do three jobs :
  - a. It must provide varying gear ratios. Number of gear ratio are equal to number of gears in a vehicle.
  - b. It must provide a reverse gear for moving vehicle in reverse direction.
  - c. It must provide a neutral or disconnecting arrangement so that the engine can be uncoupled from the wheels of the vehicle



## ***4. CLUTCH***

- The purpose of the clutch is to allow the driver to couple or decouple the engine and transmission.
- When clutch is in engaged position, the engine power flows to the transmission through it (clutch).
- When gears are to be changed while vehicle is running, the clutch permits temporary decoupling of engine and wheels so that gears can be shifted.
- In a scooter, the clutch is operated by hand where as in a car the clutch is operated by foot.

## ***5. BRAKING SYSTEM***

- Brakes are used to slow down or stop the vehicle.
- Hydraulic brakes are generally used in automobiles, where brakes are applied by pressure on a fluid.
- Mechanical brakes are also used in some vehicles. These brakes are operated by means of levers, linkages, pedals, cams, etc.
- Hand brake or parking brake is known usually mechanical brake. These are used for parking the vehicles on sloppy surfaces and also in case of emergency.

## ***6. GEAR BOX***

- Gear box contain gearing arrangement to get different speeds.
- Gears are used to get more than one speed ratios.
- When both mating gears have same number of teeth, both will rotate at same number speed. But when one gear has less teeth than other, the gear with less number of teeth will rotate faster than larger gear.
- In a typical car, there may be six gears including one reverse gear.
- First gear gives low speed but high torque. Higher gears give progressively increasing speeds.

# ***7. STEERING SYSTEM***

- Front wheels can be turned to left and right by steering system so that the vehicle can be steered.
- The steering wheel is placed in front of driver.
- The primary function of the steering system is to provide angular motion to front wheels so that vehicle can negotiate a turn. It also provides directional stability to vehicle when the vehicle moves ahead in straight line.
- Now-a-days, many vehicles are equipped with power steering which uses pressure of a fluid to reduce steering effort.
- When driver turns the steering wheel, a hydraulic mechanism comes into play to provide most of the effort needed to turn the wheel.

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## ***8. FRONT AXLE***

- It carries the weight of the front of the vehicle and also takes horizontal and vertical loads when vehicle moves on bumpy roads.
- When brakes are provided on front wheels, it endures bending stresses and torsional stresses.
- It is generally made from steel drop forging. It is robust in construction.

## ***9. SUSPENSION SYSTEM***

- Main function of the suspension system is to isolate the body of the vehicle from shocks and vibrations generated due to irregularities on the surface of roads.
- It is in the form of spring and damper. The suspension system is provided both on front end and rear end of the vehicle.
- A suspension system also maintains the stability of the vehicle in pitching or rolling when vehicle is in motion.

# Two wheeler specification

Yamaha	FZ/FZ-S/Fazer
<b>Dimensions</b>	
Length* Width *Height	1,973 mm × 770 mm × 1,090 mm/1973mm x 770mm x 1045mm/1,973mm × 761mm × 1,119mm
Wheelbase	1,334mm
Ground Clearance	160 mm
Fuel Tank Capacity	12 liters
Kerb Weight	135 Kgs/141 Kgs
<b>Engine/Transmission</b>	
Type	Air cooled, 4 - stroke single cylinder
Displacement	153 cc
Max. Power	14PS / 7500 rpm
Max. Torque	13.6 Nm @ 6000 rpm
Bore x Stroke	58.0 × 57.9 mm
Clutch & Gear box	Multi-plate wet Clutch & 5 Speed constant mesh gear box
Fuel Supply System	Carburetor
<b>Breaks &amp; Tyres</b>	
Front & Rear Brake	Hydraulic Single Disc/Drum
Front & Rear Tyres	100/80-17 / 140/60-R17
<b>Electricals</b>	
Battery	12 V, 5.0 Ah
Head Light	12V – 35W / 35W – Halogen bulb
HOSTED ON : 	Self-start & Kick start

# Three wheeler specification

## TECHNICAL SPECIFICATIONS



### COMPACT

### PETROL · LPG · CNG · DIESEL

Power

7.6 KW at 5000 rpm

Torque

17Nm at 3500 rpm

Cubic Capacity

198.88 cc

Transmission

4 forward + 1 reverse gear

Clutch

Wet multidisc type

Engine Type

4 Stroke

Kerb weight

348 Kg

Wheel Base

2000 mm

Overall width

1300 mm

Overall length

2635 mm

Overall Height

1700 mm

Gradeability

19%

Other Subjects: <https://www.studymedia.in/fe/notes>



# Four wheeler specification

AUTO ADVICE.IN

**Mahindra**  
**Marazzo**

Ask@Autoadvice.in



TYRE -215/60 R17 Tubeless

**1497 CC**  
Diesel Engine

**121 BHP**  
Power

**6-Speed**  
Gearbox

**300 NM**  
Torque

**17.3 kmpl**  
Mileage

**45 Liter**  
Fuel tank

**2760 MM**  
Wheelbase

**160 MM**  
Ground Clearance

**4585 MM**  
Length

**1650 Kg**  
Weight

**1774 MM**  
Height

**1866 MM**  
Width

## Engine

1.5 Liter Turbo Diesel Engine  
121 BHP 3500 RPM of Power  
and 300 NM of Torque  
6-Speed Gearbox

## Brakes

Front Brakes : Disc  
Rear Brakes : Disc  
ABS + EBD  
TWIN AIRBAG

## Suspension

suspension Front : Double  
Wishbone  
Suspension Rear : Rear Twist  
Beam

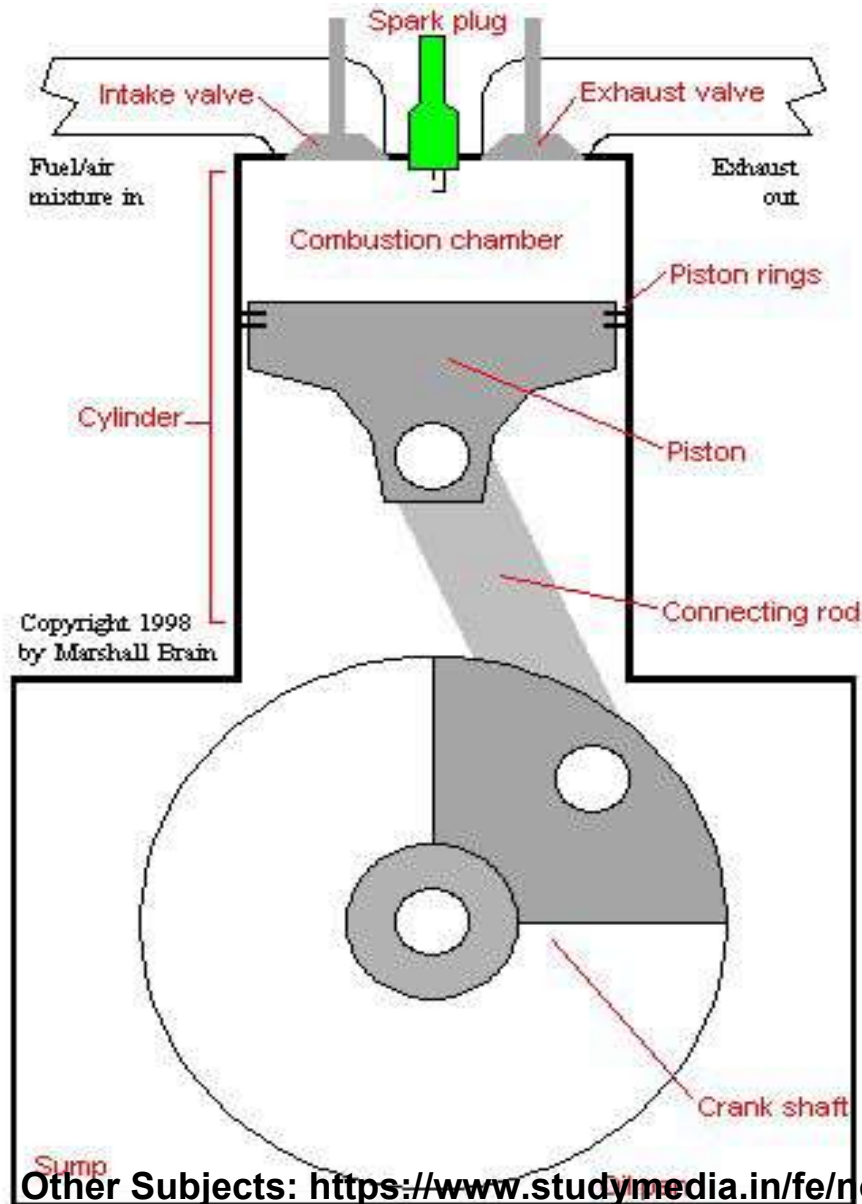
## Price ₹

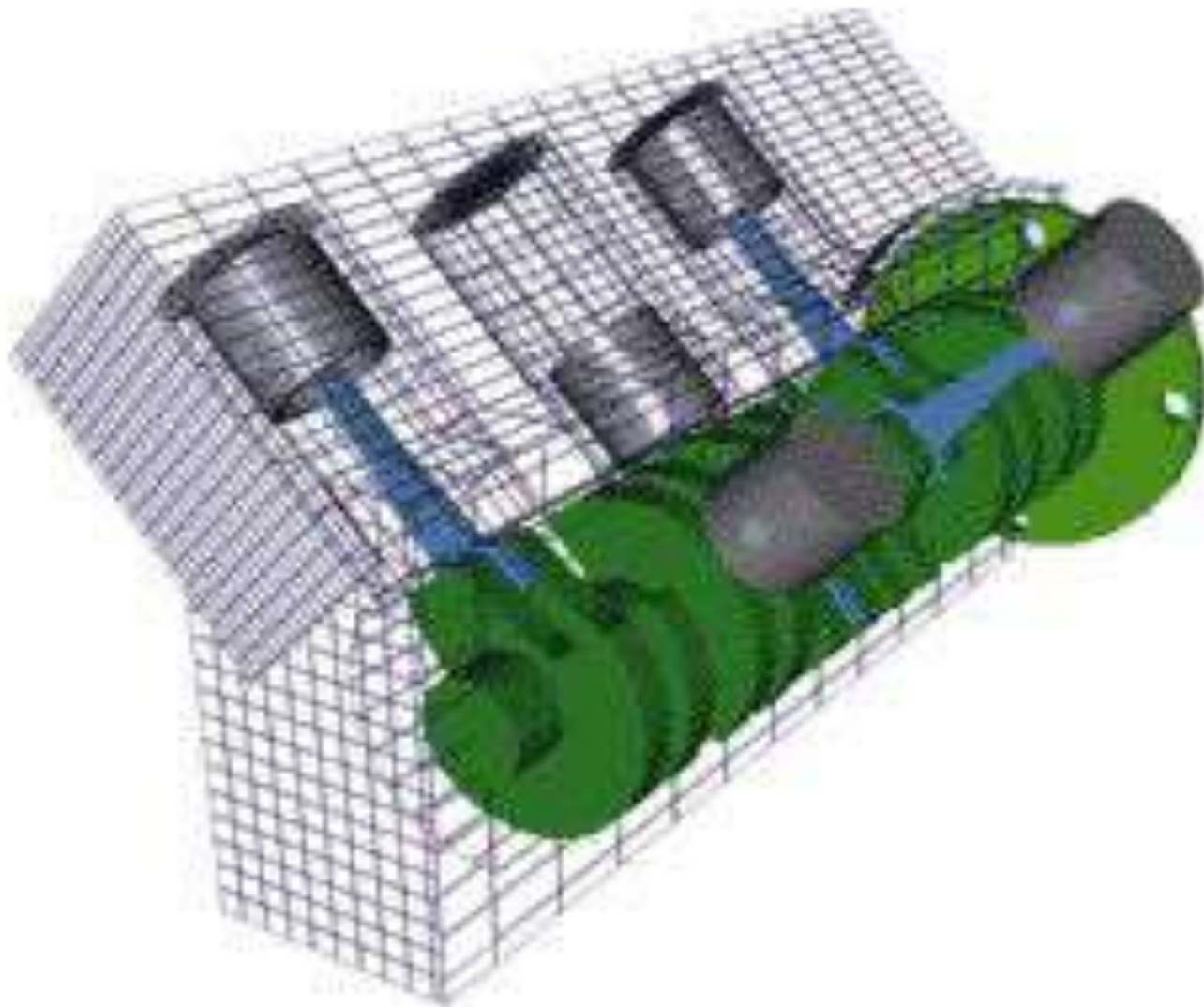
M2 - Rs. 9.99 lakh  
M4 -Rs. 10.95 lakh  
M6 - Rs. 12.40 lakh  
M8 -Rs. 13.90 lakh

\*Some Specifications / Price may vary after the final product launch

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# Parts of an Engine

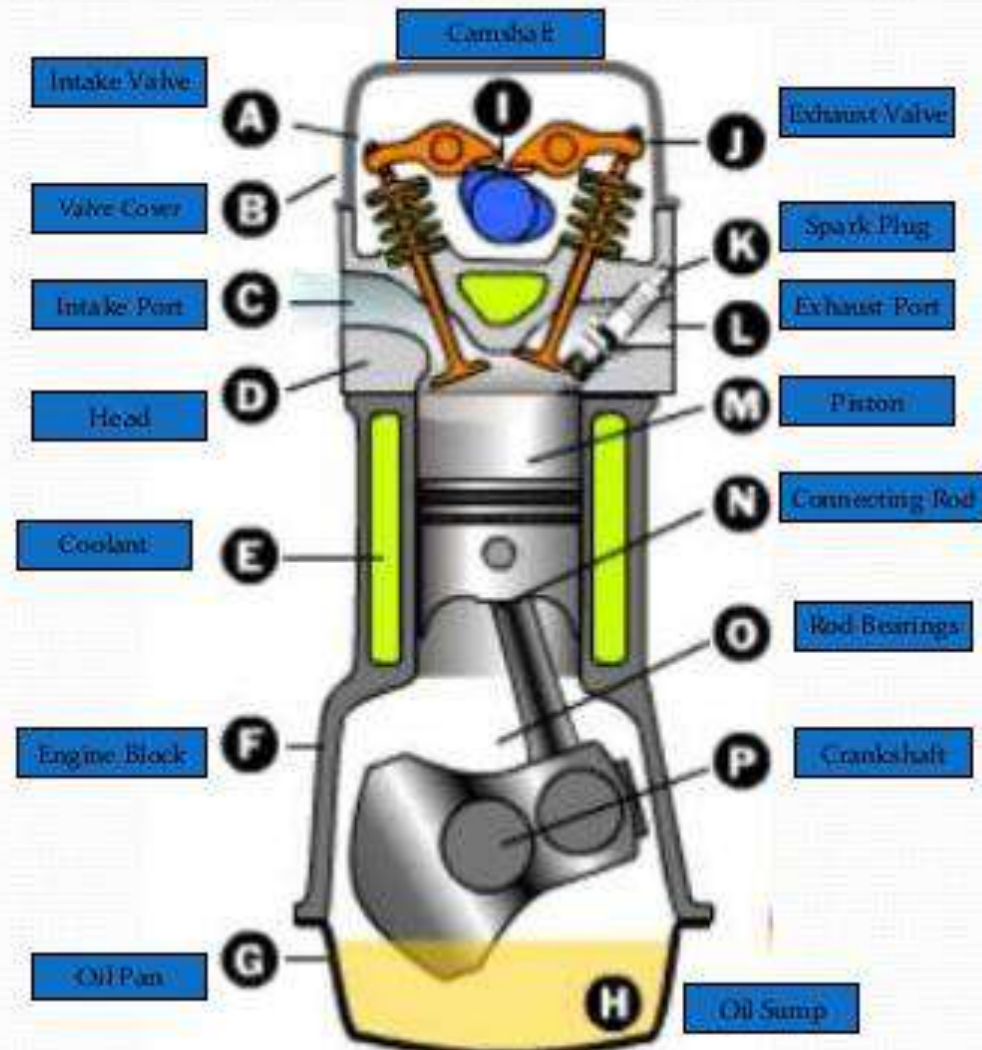




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# BASIC COMPONENTS



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# Cylinder block

Cylinder is a part in which the intake of fuel, compression of fuel and burning of fuel take place.

The main function of cylinder is to guide the piston. At the upper end of cylinder, cylinder head and at the bottom end crank case is bolted. The upper side of cylinder consists a combustion chamber where fuel burns.



# Cylinder head

The top end of the engine cylinder is closed by means of removable cylinder head. There are two holes or ports at the cylinder head, one for intake of fuel and other for exhaust. Both the intake and exhaust ports are closed by the two valves known as inlet and exhaust valve. The inlet valve, exhaust valve, spark plug, injector etc. are bolted on the cylinder head.



# Piston

A piston is fitted to each cylinder as a face to receive gas pressure and transmit the thrust to the connecting rod. It is a prime mover in the engine. The main function of piston is to give tight seal to the cylinder through bore and slide freely inside the cylinder.



# Piston rings

A piston must be a fairly loose fit in the cylinder so it can move freely inside the cylinder. If the piston is too tight fit, it would expand as it got hot and might stick tight in the cylinder and if it is too loose it would leak the vapor pressure. To provide a good sealing fit and less friction resistance between the piston and cylinder, pistons are equipped with piston rings





## Connecting rod

Connecting rod connects the piston to crankshaft and transmits the motion and thrust of piston to crankshaft. It converts the reciprocating motion of the piston into rotary motion of crankshaft. There are two end of connecting rod; one is known as big end and other as small end. Big end is connected to the crankshaft and the small end is connected to the piston by use of piston pin.



# Crankshaft

The crankshaft of an internal combustion engine receives the efforts or thrust supplied by piston to the connecting rod and converts the reciprocating motion of piston into rotary motion of crankshaft. The crankshaft mounts in bearing so it can rotate freely. The shape and size of crankshaft depends on the number and arrangement of cylinders.



# Spark plug

It is used in spark ignition engine. The main function of a spark plug is to conduct a high potential from the ignition system into the combustion chamber to ignite the compressed air fuel mixture. It is fitted on cylinder head.



# Injector

Injector is usually used in compression ignition engine. It sprays the fuel into combustion chamber at the end of compression stroke. It is fitted on cylinder head.



# Engine specifications

- **Engine speed:** engine speed is measured in revolutions per minute (RPM). diesel engines -1500–4000 RPM , gasoline engines (~2200–6000 RPM)
- **Thrust:** Thrust is the force arising from the interaction between Piston and cylinder
- **Torque:** Torque is the force being exerted to the output shaft of an engine.
- **Power:** Power is the amount of work being done
- **Efficiency:** Ratio of output to input
- **Sound levels:** In the case of sound levels, engine operation is of greatest impact with respect to mobile sources such as automobiles and trucks

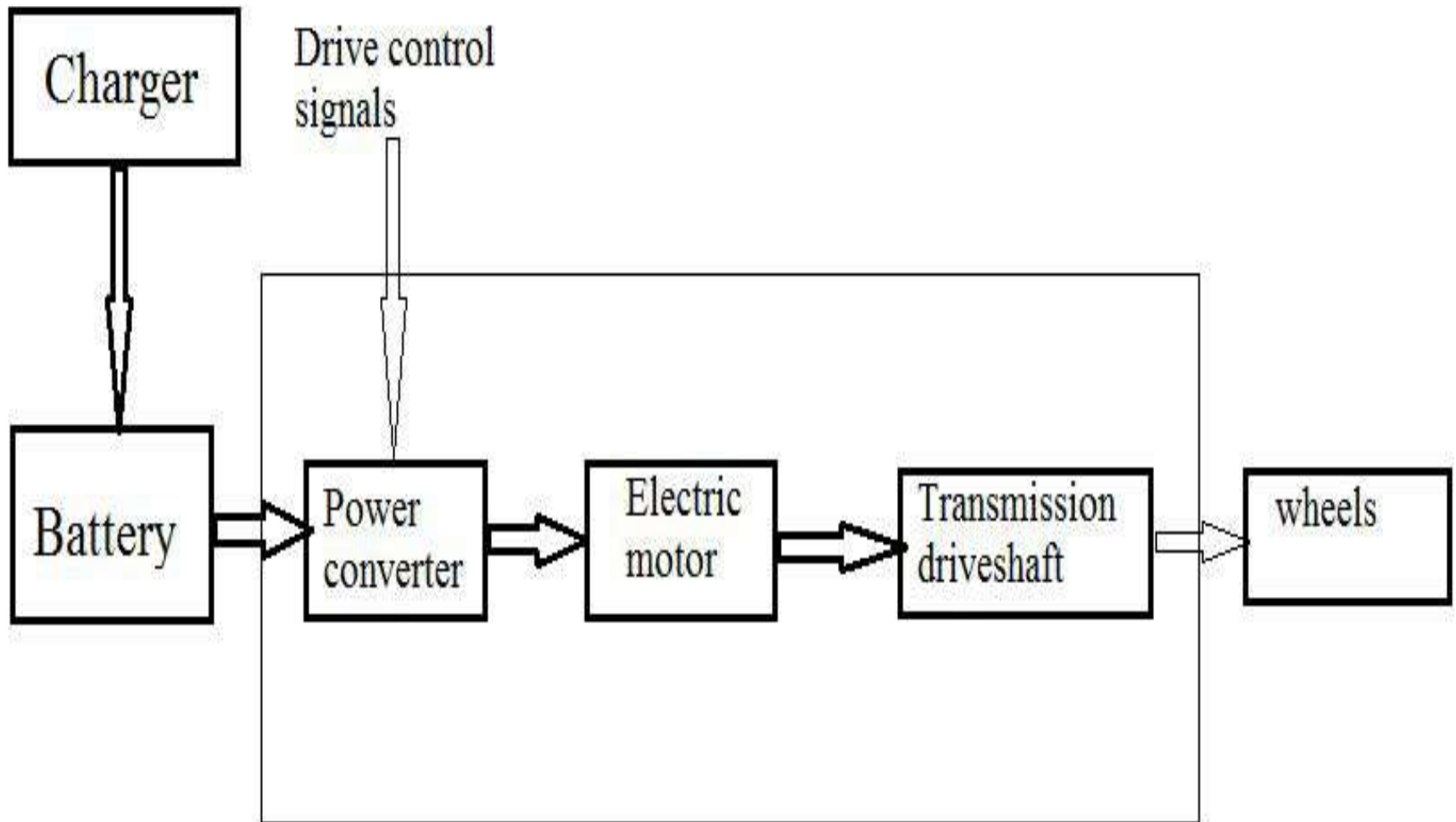
# Comparison of engine specification

Parameter	Two wheeler Yamaha(FZ)	Three wheeler Bajaj Auto	Four wheeler Mahindra Marrazo	Heavy vehicle Bharatbenz
Type	4Stroke Air cooled	4 stroke	4 stroke liquid cooled	4 stroke diesel
Cubic capacity	149	198.88	1497	6372
Number of cyl	1	1	4	6
CR	9.5:1			
Max. HP	9.7kW	7.6kw	90.2 kW	281 kW
Max. Torque	12.8NM	17 NM	300NM	1120 NM
Bore, stroke	57.3*57.9			

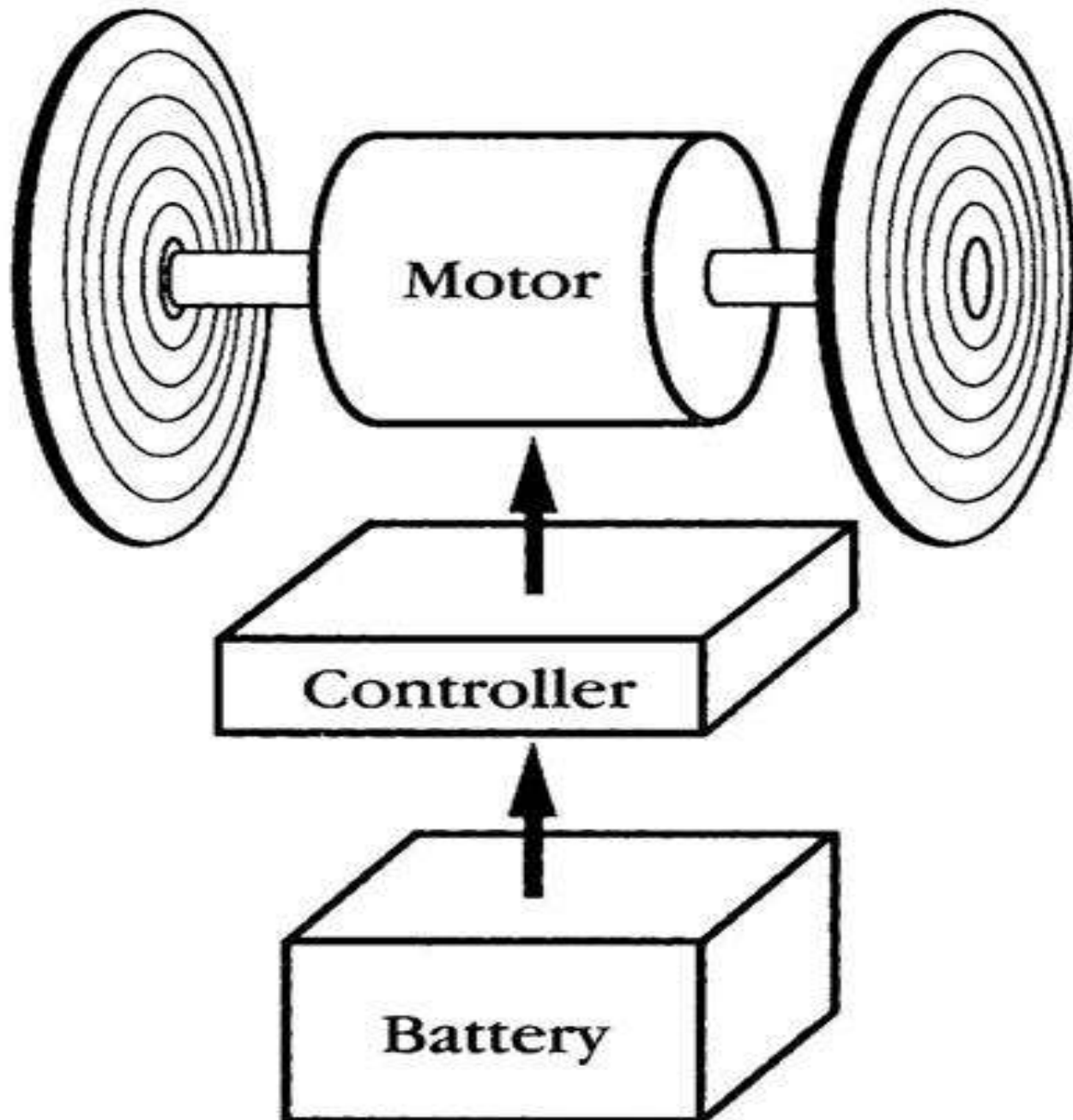
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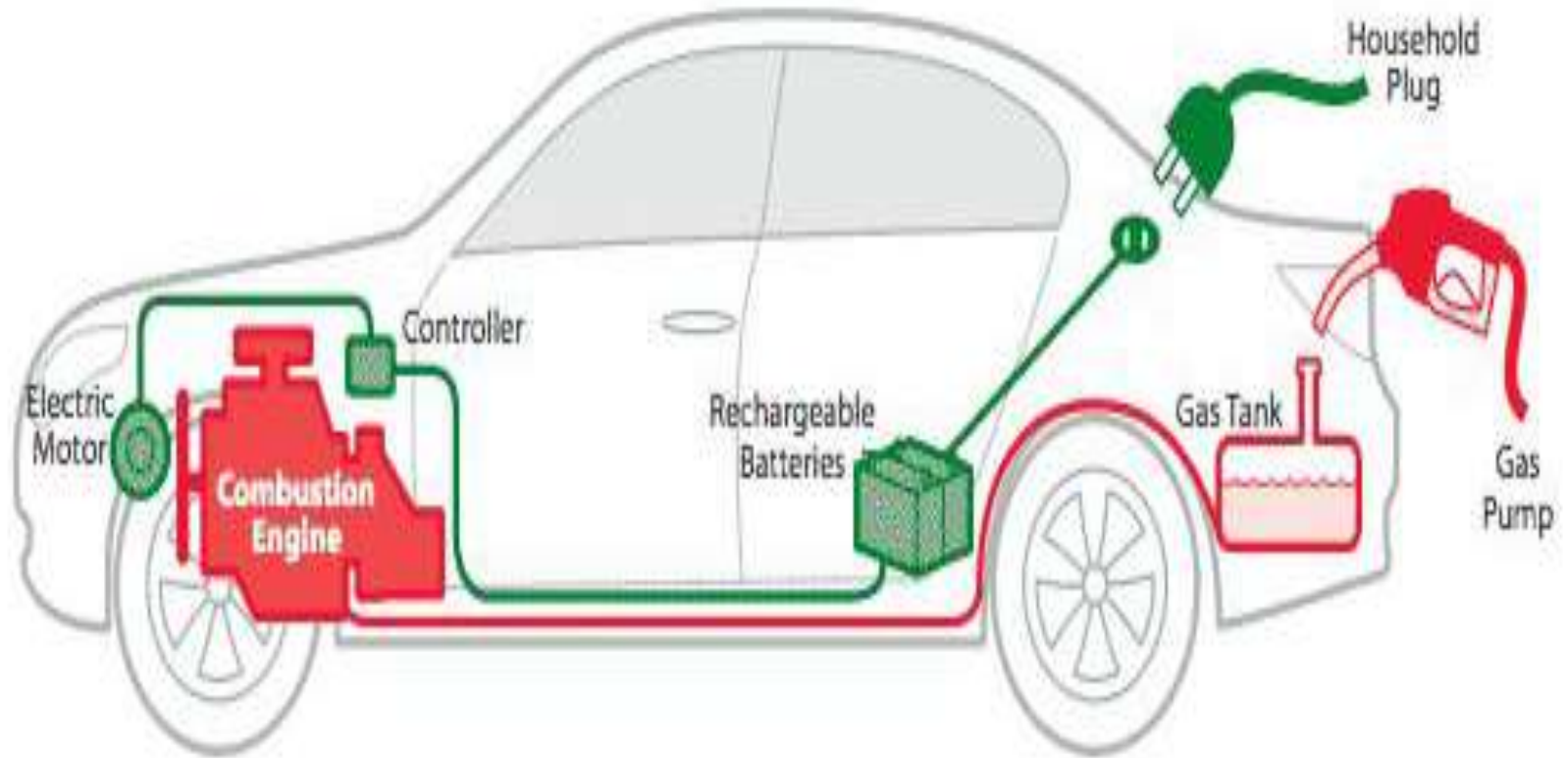
# ***ELECTRIC VEHICLE***

- An Electric vehicle is an automobile that is propelled by one or more electric motors, using electrical energy stored in energy storage device.
- The primary components are motor, controller, power source, and transmission.



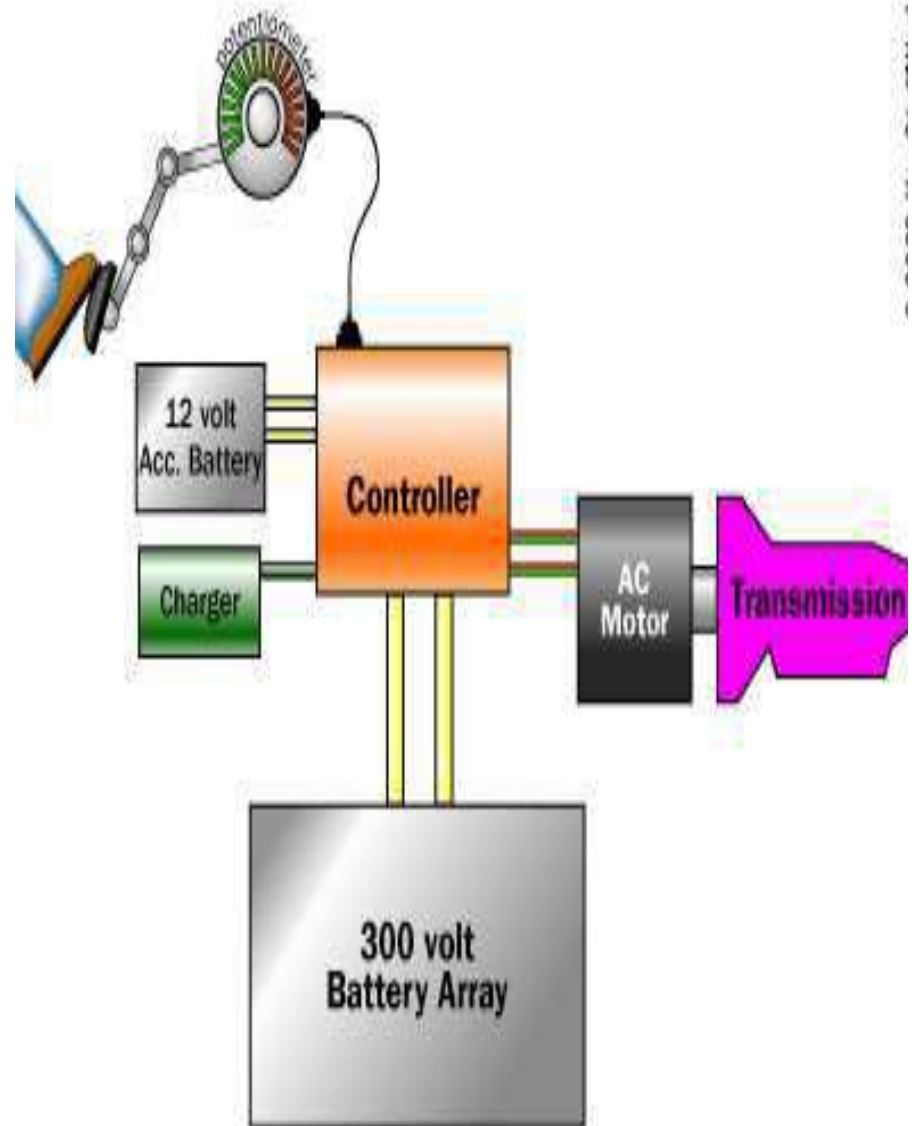






# WORKING

- The driver presses the accelerator which in turn sends the signals to the controller.
- Depending on the signals received, controller allows voltage supply to the motor.
- Motor is connected to the gear box.
- From gear box mechanical energy is transferred to the wheels through differential gear box.



# Advantages

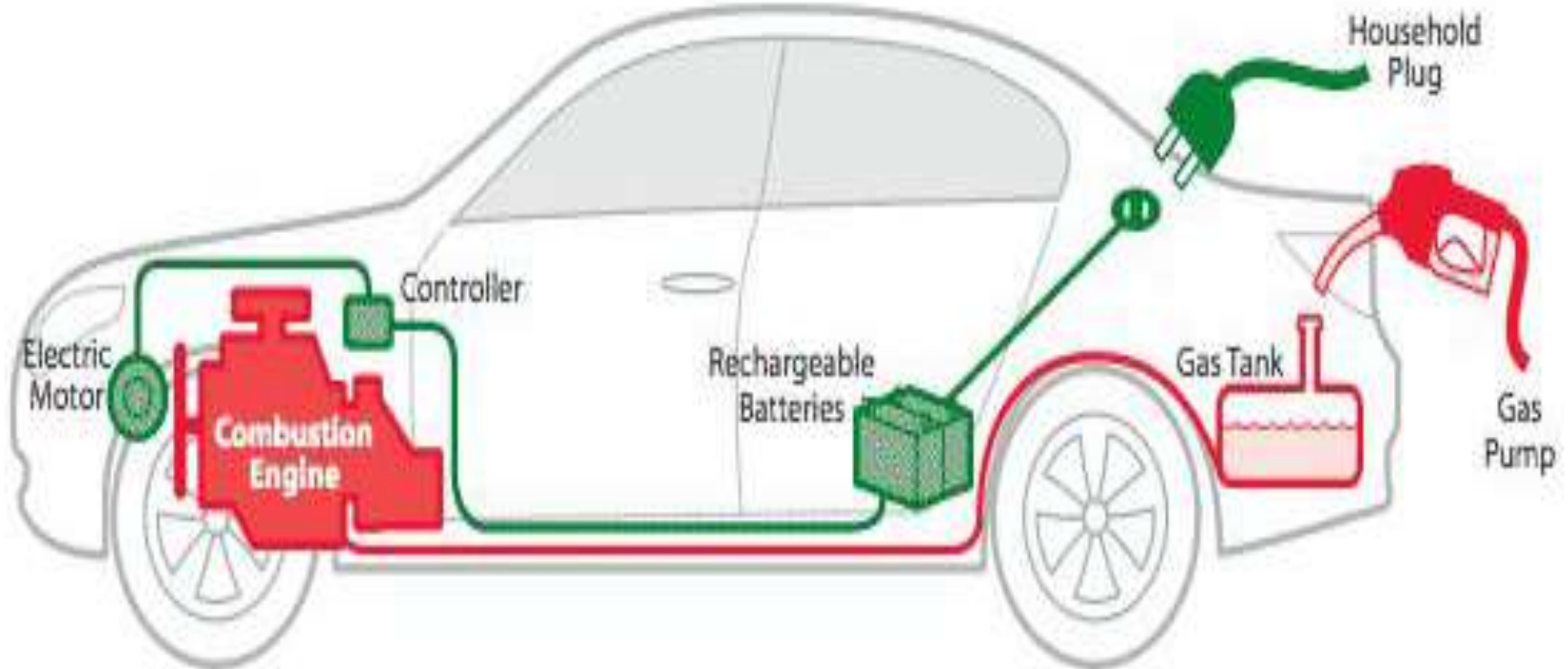
- Reduce dependence on oil and gasoline
- Pollutants and noise free.
- Recyclable batteries
- No fire hazards
- Low maintenance and operation cost

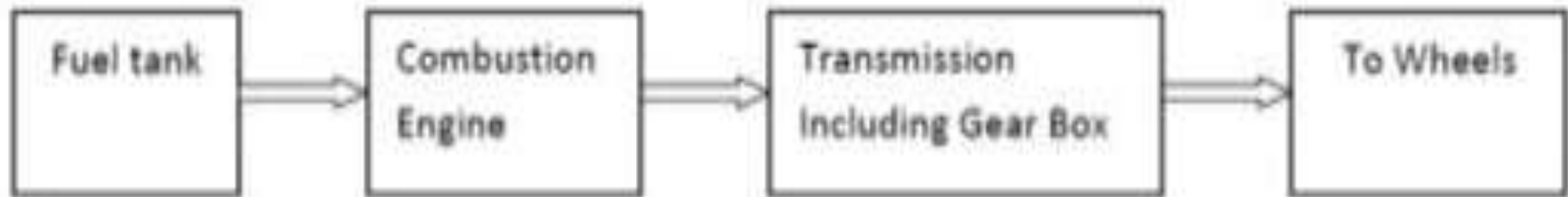
# Disadvantages

- High initial cost
- High recharge time
- Silence may be fatal
- Low speed

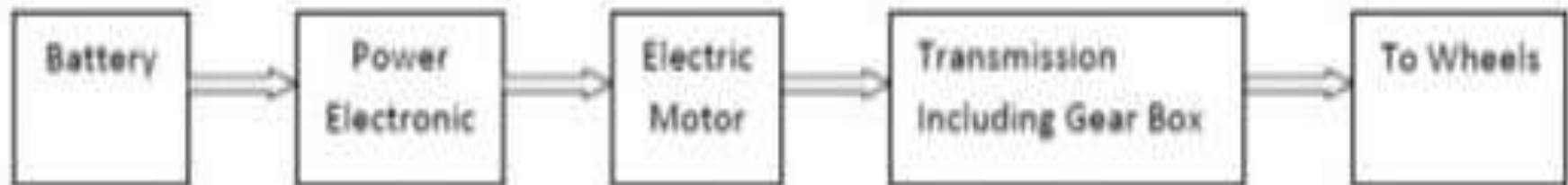
# ***Hybrid Vehicle***

- The term hybrid vehicles in general usage refer to vehicles with two or three different type of sources delivering power to the wheels for propulsion.
- The most common hybrid vehicles have an IC engine and one or more electric machines for vehicle propulsion.
- The IC engine can be used to generate electric energy 'on board' to power the machines.





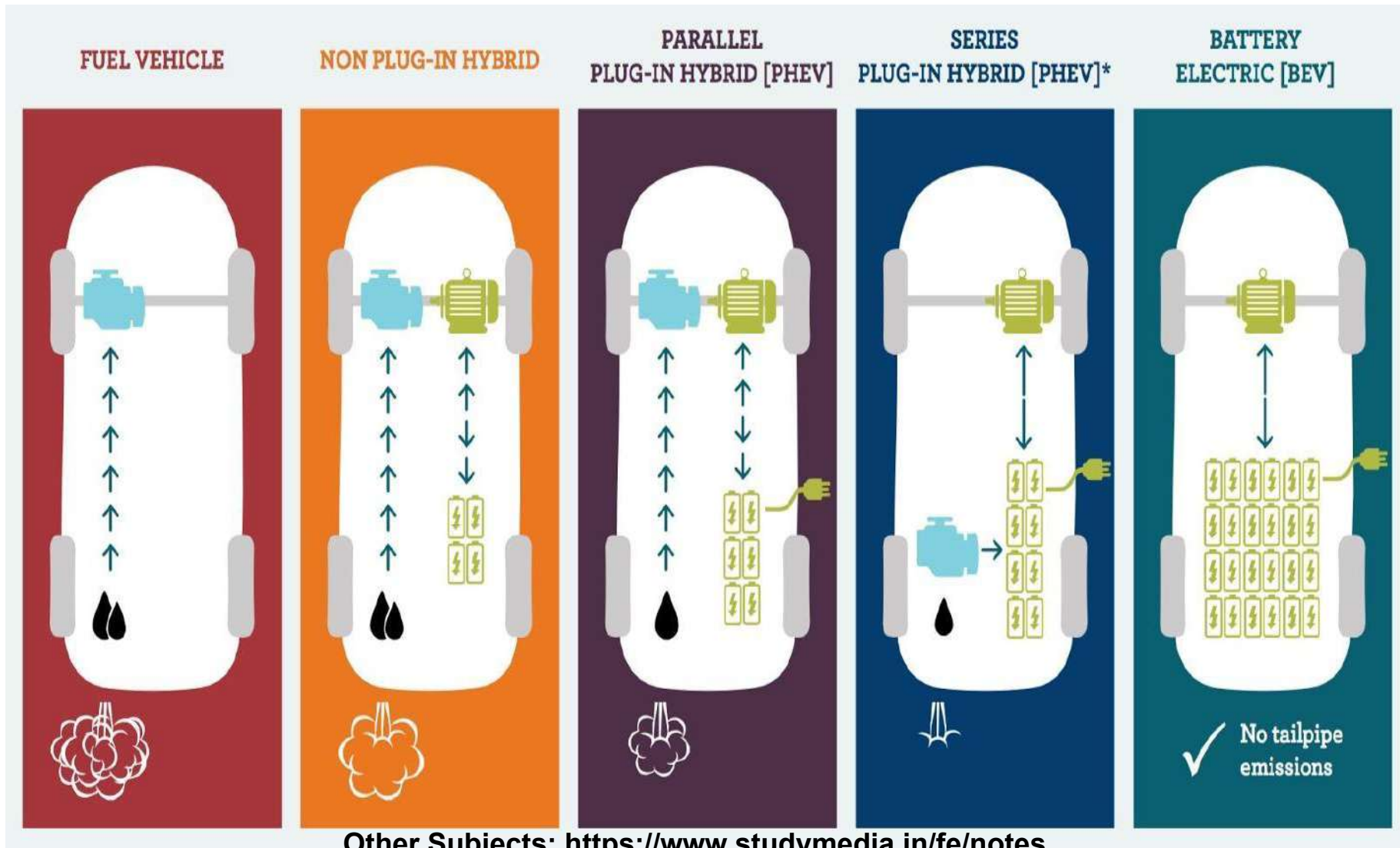
**The Arrow depicts flow of Energy within a mechanical drive train**



**The Arrow depicts flow of Energy within an electric drive train**



# Types of Hybrid Vehicles



# *Use of battery & its capacity*

EV make	Battery	Range km (mi)
BMW i3 (2019)	42kWh	345km (115)
GM Spark	21kWh	120km (75)
Fiat 500e	24kWh	135km (85)
Honda Fit	20kWh	112km (70)
Nissan Leaf	30kWh	160km (100)
Mitsubishi MiEV	16kWh	85km (55)
Ford Focus	23kWh	110km (75)
Smart ED	16.5kWh	90km (55)
Mercedes B	28kWh (31.5)*	136km (85)
Tesla S 60	60kWh	275km (170)
Tesla S 85	90kWh	360km (225)
Tesla 3	75kw	496 (310)

Other Subjects: <https://www.studymedia.in/fe/notes>

# ***Cost Analysis***

Parameters	Vehicle Cost High	Vehicle cost Low
Torque	Increase in Torque	Decrease in torque
Speed	Increase in speed	Decrease in speed
No. of cylinders	Increase in no. of cylinders	Decrease in no. of cylinders
Type of brakes	Disk brake Hydraulic brakes Pneumatic brakes	Drum shoe brakes