

Systems In Mechanical Engineering

UNIT-III

Vehicles and their Specifications 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

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.
- **Electric vehicles :** Automobiles that use electricity as a power source. e.g: Electric cars, electric buses.
- **Hybrid vehicles :** Vehicles that use two or more power sources. e.g: Hybrid cars.

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.

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

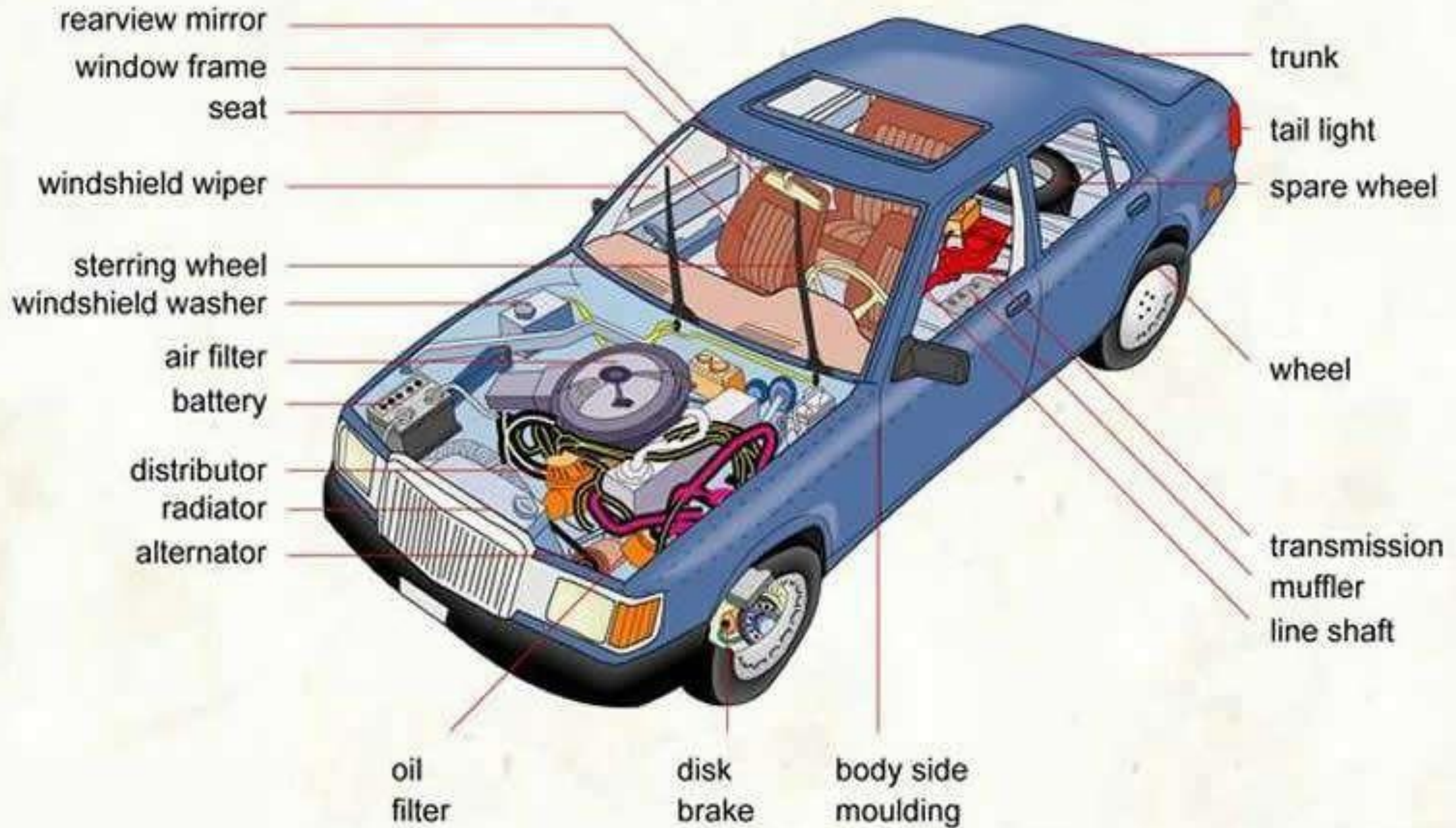
6. Based on type of transmission:

- **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 storing 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



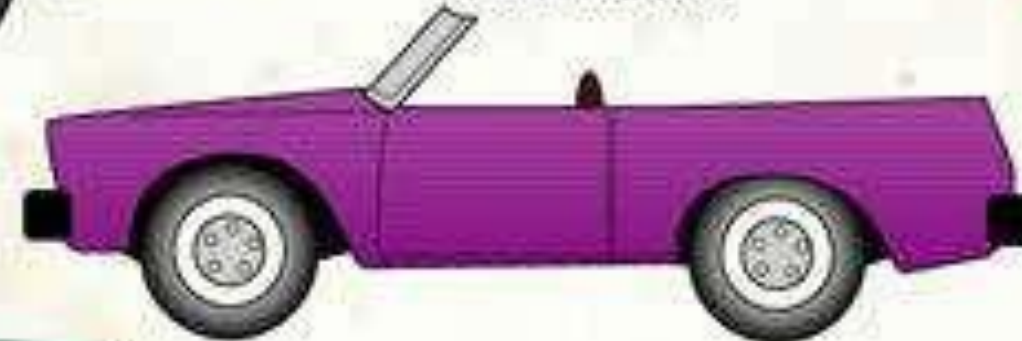
sports car



four-door sedan



limousine



convertible



hardtop



van



pick-up truck

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, wiper, stereo, etc

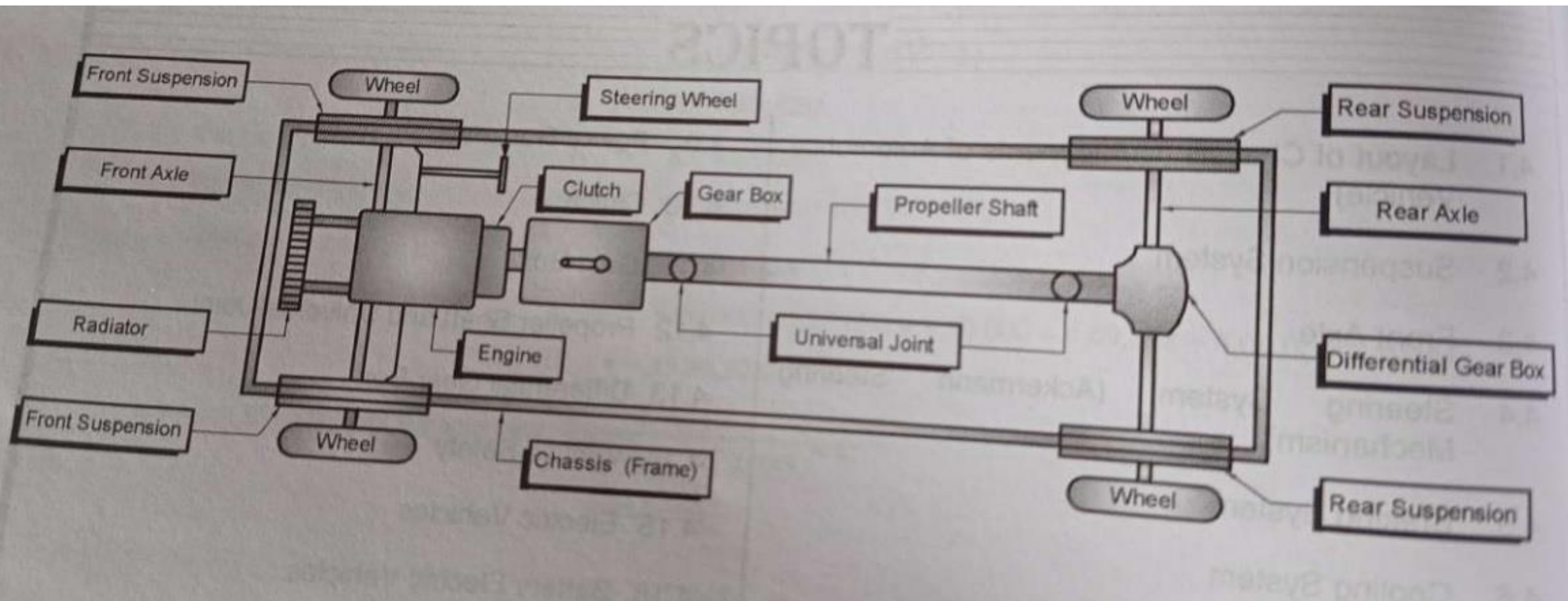
1. Engine or Power Plant

- 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.

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
Dimensions	
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
Engine/Transmission	
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
Breaks & Tyres	
Front & Rear Brake	Hydraulic Single Disc/Drum
Front & Rear Tyres	100/80-17 / 140/60-R17
Electricals	
Battery	12 V, 5.0 Ah
Head Light	12V – 35W / 35W – Halogen bulb
HOSTED ON : TEAM-BHP.COM copyrights respective owners	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%

Four wheeler specification

AUTO ADVICE.IN

Mahindra

Marazzo

Ask@Autoadvice.in



TYRE -215/60 R17 Tubeless

Other

Engine	Brakes	Suspension	Price ₹
1.5 Liter Turbo Diesel Engine 121 BHP 3500 RPM of Power and 300 NM of Torque 6-Speed Gearbox	Front Brakes : Disc Rear Brakes : Disc ABS + EBD TWIN AIRBAG	suspension Front : Double Wishbone Suspension Rear : Rear Twist Beam	M2 - Rs. 9.99 lakh M4 -Rs. 10.95 lakh M6 - Rs. 12.40 lakh M8 -Rs. 13.90 lakh

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

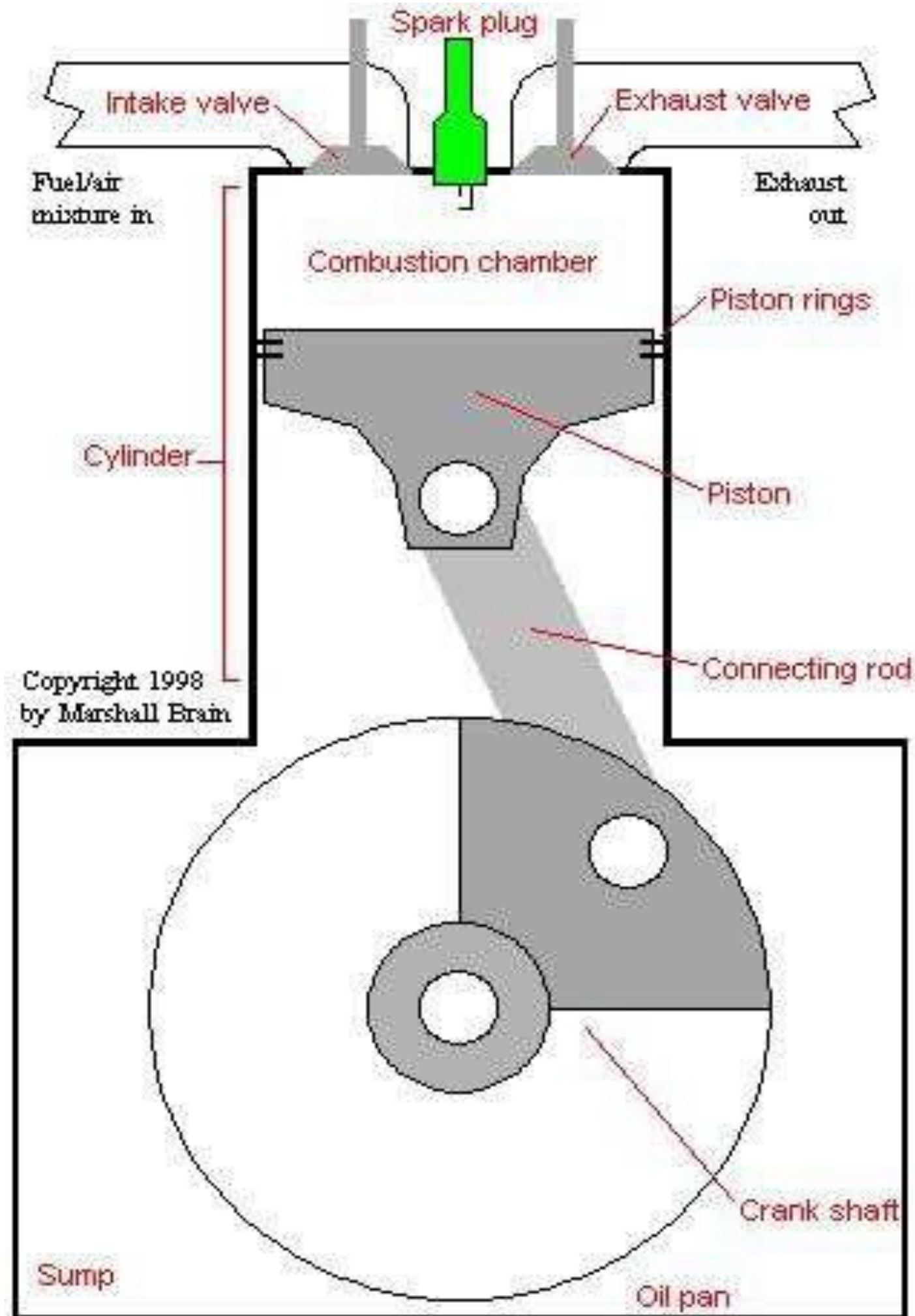
1774 MM
Height

1866 MM
Width

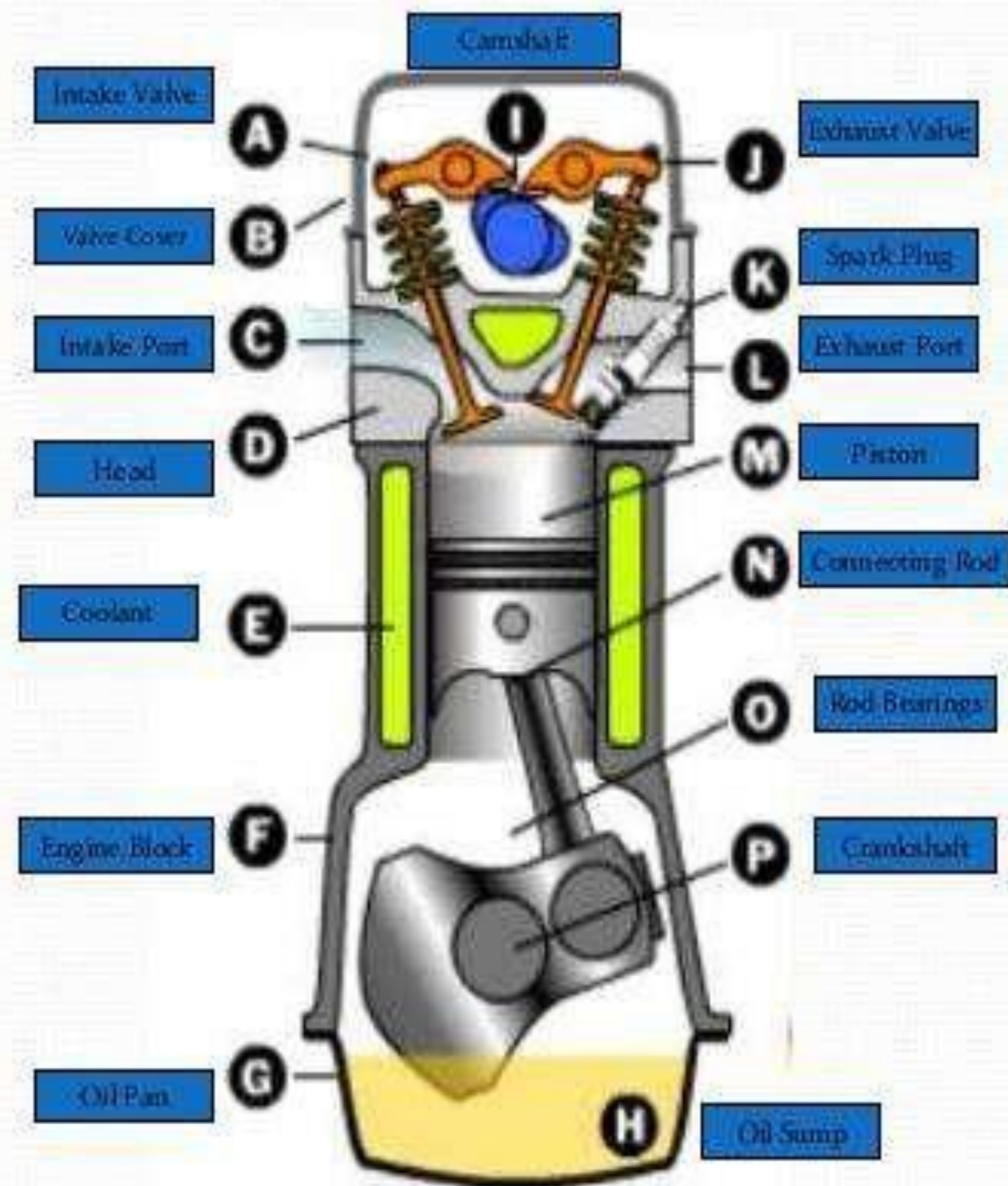
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Parts of an Engine



BASIC COMPONENTS



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

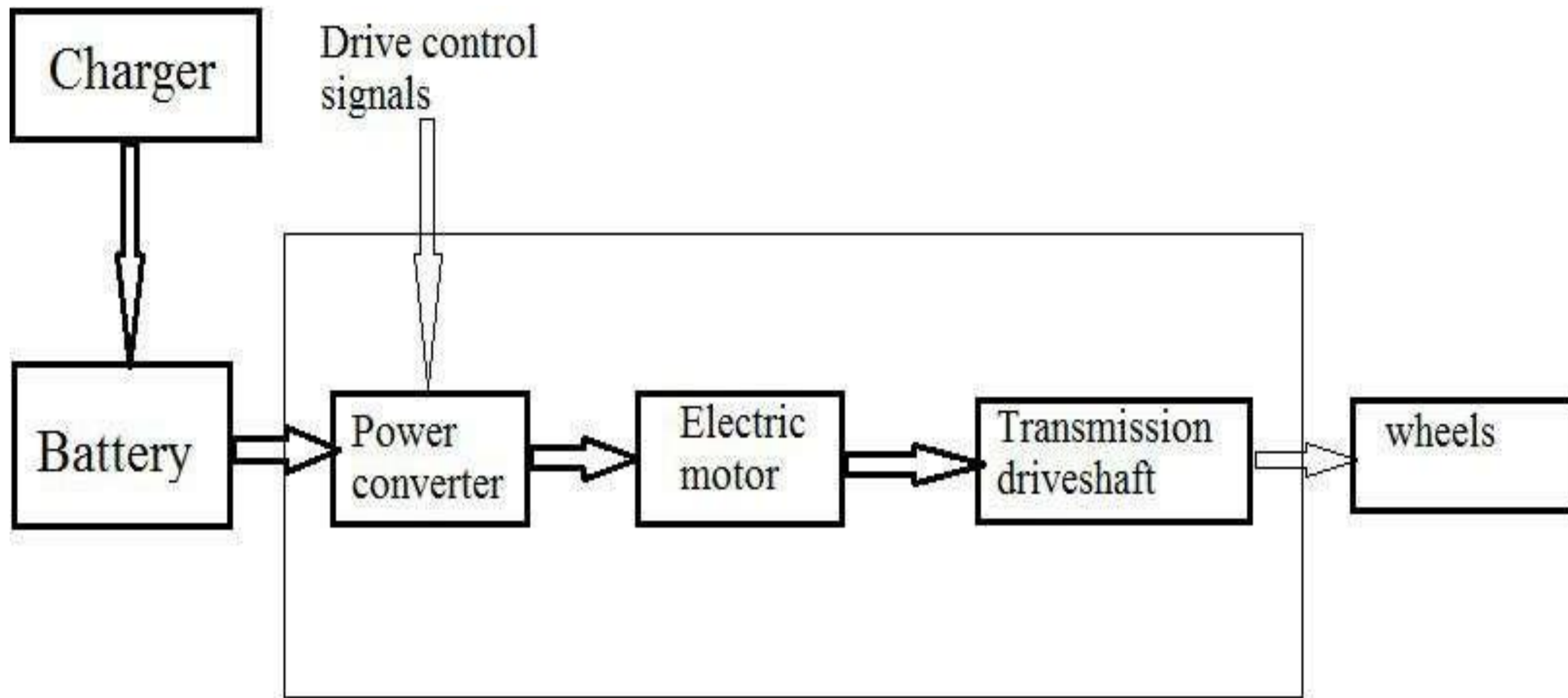
- **Engine speed:** engine speed is measured in revolutions per minute (RPM). diesel engines -1500–4000 RPM , gasoline engines (~2200–6000 RPM)
- **Thrust:** Thrust is the force arising from the interaction between Piston and cylinder
- **Torque:** Torque is the force being exerted to the output shaft of an engine.
- **Power:** Power is the amount of work being done
- **Efficiency:** Ratio of output to input
- **Ground Clearance:** Distance between the flat level ground surface and lowest part of the vehicle.
- **Kerb weight:** The weight of the vehicle with all standard equipment and all necessary operating consumables (engine oil, full tank of fuel) without passengers and cargo.
- **Gross weight:** The weight of the vehicle including all standard equipment, all necessary operating consumables (engine oil, gear oil, full tank of fuel), driver, passengers and cargo.
- **Boot Space:** It is the volume space in car to keep the luggage. It is specified in liters.

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			

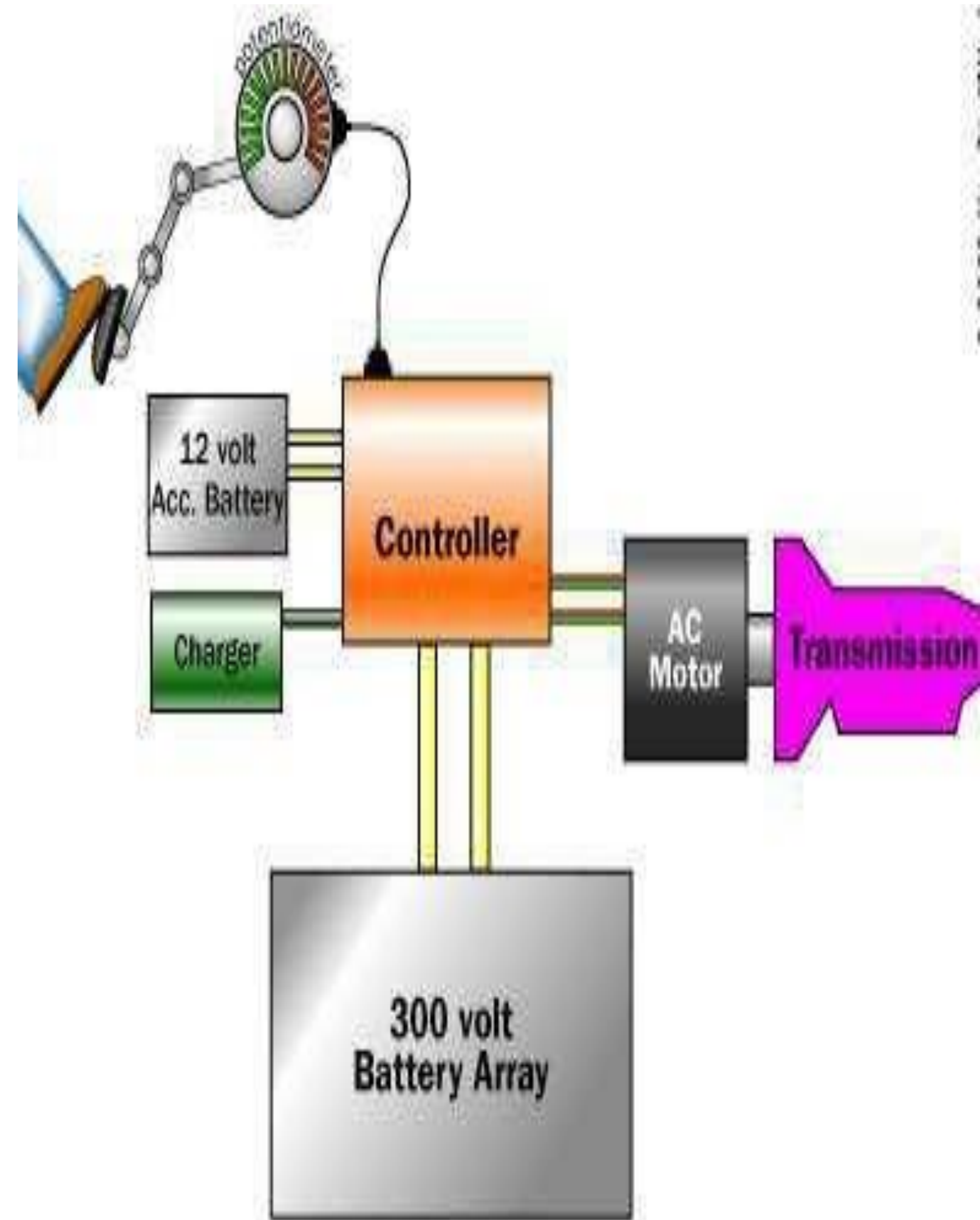
ELECTRIC VEHICLE

- 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

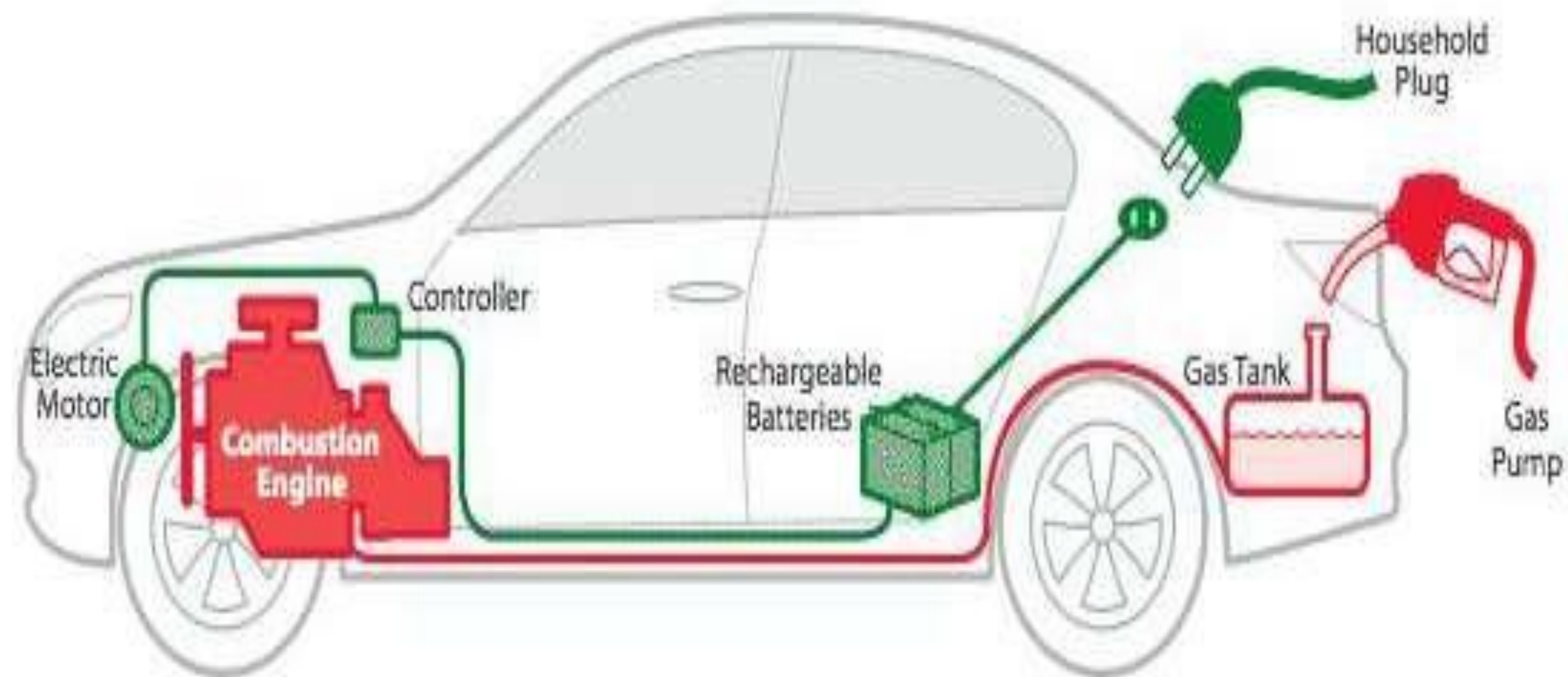
- High initial cost
- High recharge time
- Silence may be fatal
- Low speed

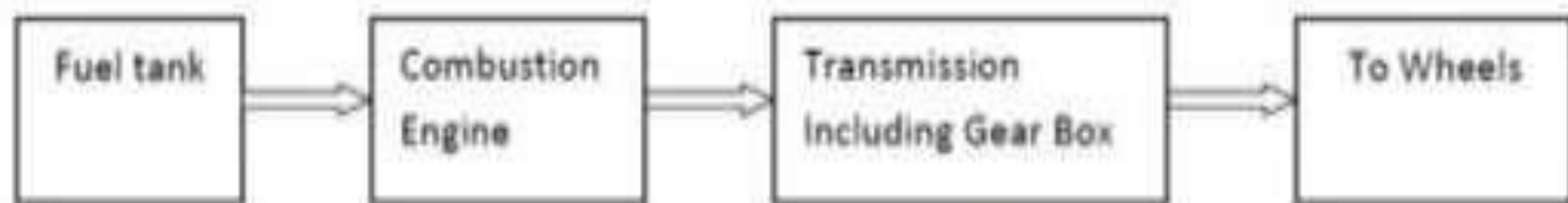
Use of battery & its capacity

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	75kwh	496 (310)

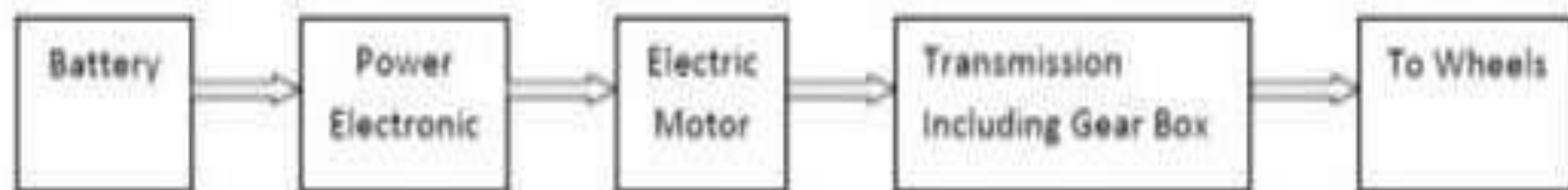
Hybrid Vehicle

- 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.



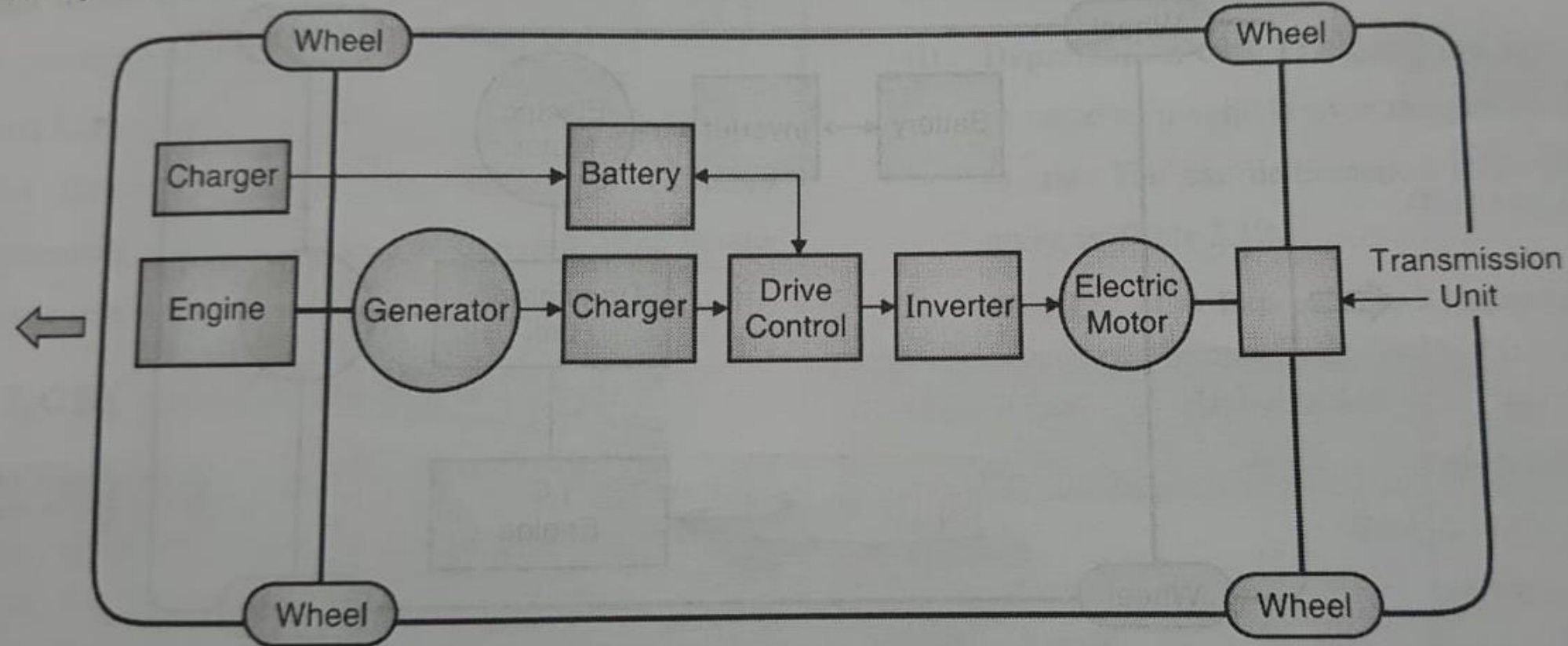


The Arrow depicts flow of Energy within a mechanical drive train



The Arrow depicts flow of Energy within an electric drive train

Series Hybrid Vehicles :



Element of Series Hybrid Vehicle

1. Battery with Charger
2. Drive Control Unit
3. Inverter
4. Electric Motor
5. I. C. Engine
6. Generator
7. Transmissions Unit (Gear Box)

Advantages of Hybrid Electric Vehicles :

Advantages of Hybrid Electric Vehicles

- (i) Combined advantages of conventional vehicles and electric vehicles
- (ii) Large travelling range
- (iii) Regenerative braking

Limitations of Hybrid Electric Vehicles :

Limitations of Hybrid Electric Vehicles

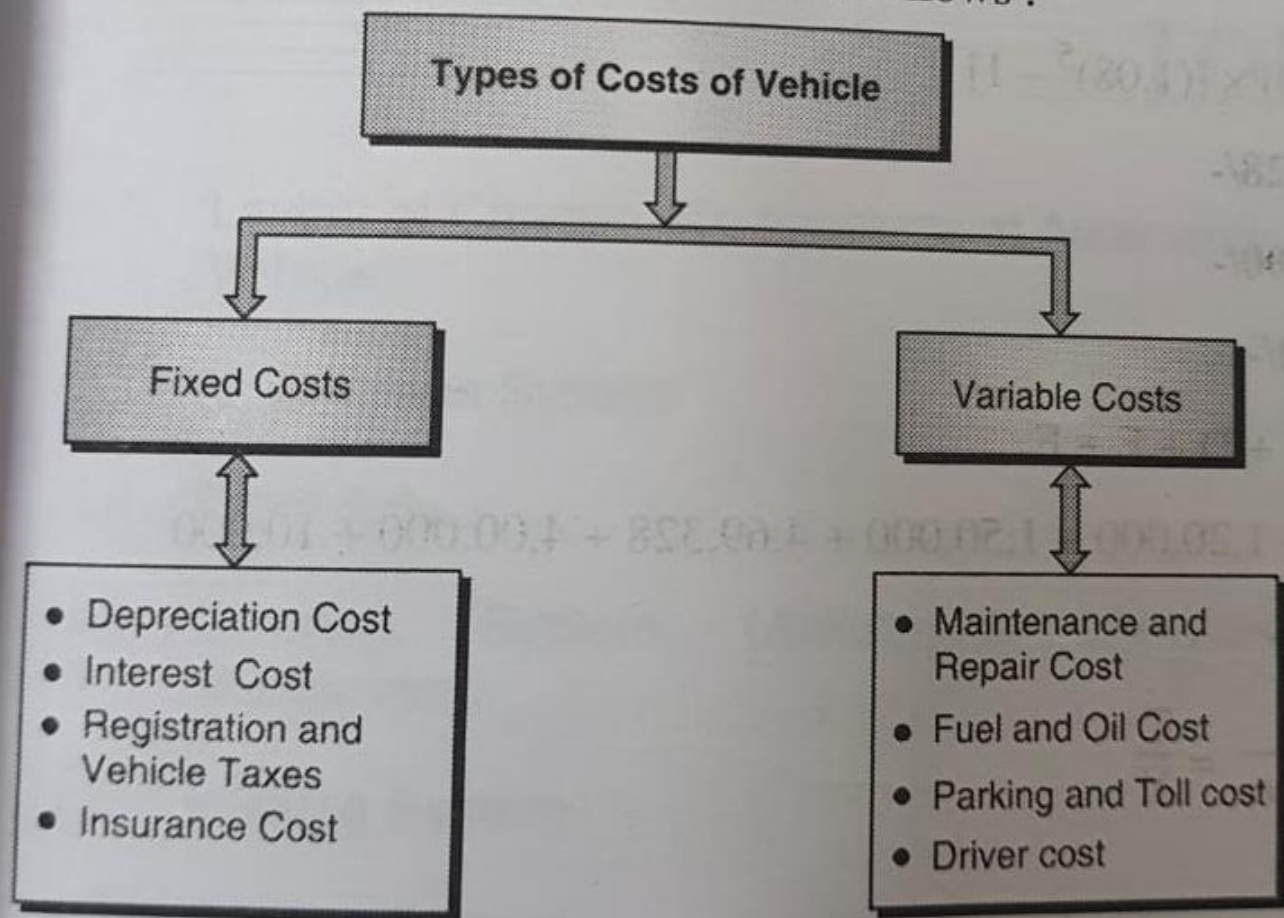
- (i) High initial cost
- (ii) Short battery life

• Cost Analysis of Vehicle

Cost analysis of a vehicle deals with calculating the average cost of using the vehicle per year or per kilometer of use.

3.12.1 Types of Costs of Vehicle :

In order to calculate the average cost of using the vehicle per year or per kilometer of use, it is necessary to consider the various types of costs of the vehicle. The various types of costs of vehicle are as follows :



1. Fixed Costs :

- **Fixed costs** : Fixed costs are those costs which will continue irrespective of whether the vehicle is in use or not.

• Various fixed costs :

- (i) **Depreciation cost** : Depreciation is the decrease in value of a vehicle over the period of time due to use. The car depreciation rates in India are given in Table 3.12.1.

Table 3.12.1 : Car Depreciation Rates in India

Age of car	Depreciation Rate	Depreciated Value of Car %
0 - 6 month	5 %	95 %
6 month - 1 year	15 %	85 %
1 year - 2 year	20 %	80 %
2 year - 3 year	30 %	70 %
3 year - 4 year	40 %	60 %
4 year - 5 year	50 %	50 %
9 year - 10 year	100 %	00 %

In India, the depreciation is 100 % in 10 years for cars and in 20 years for buses.

- (ii) **Interest cost** : Interest cost is the interest on the loan for purchasing the vehicle or the interest that could be earned on the money spent in purchasing the vehicle.

- (iii) **Registration and vehicle taxes** : It is the amount spent on registration and paying vehicle taxes.

- (iv) **Insurance cost** : It is the premium paid for vehicle and third party insurance.

2. Variable Costs :

- **Variable costs** : Variable costs are those costs which vary with the use of vehicle. If the vehicle is not used, variable costs are eliminated.

• Various variable costs :

- (i) Maintenance and repair cost
- (ii) Fuel and oil cost
- (iii) Parking and toll cost
- (iv) Driver cost