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.

Automobile

- An automobile (or automotive) is a vehicle that is capable of propelling itself

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 Motor Vehicle**: Small motor vehicles. eg: Car, jeep, Scooter, motorcycle
- **Heavy Motor 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.
- **Electric vehicles :** Automobiles that use electricity as a power source. e.g: Electric cars, electric buses.
- **Hybrid Vehicles** – Vehicles that use two or more distinct power sources – e.g: Hybrid buses, hybrid cars like Toyota Prius, Honda Insight
- **Hydrogen vehicles** – Vehicles that have hydrogen as a power source – e.g: Honda FCX Clarity

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:

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

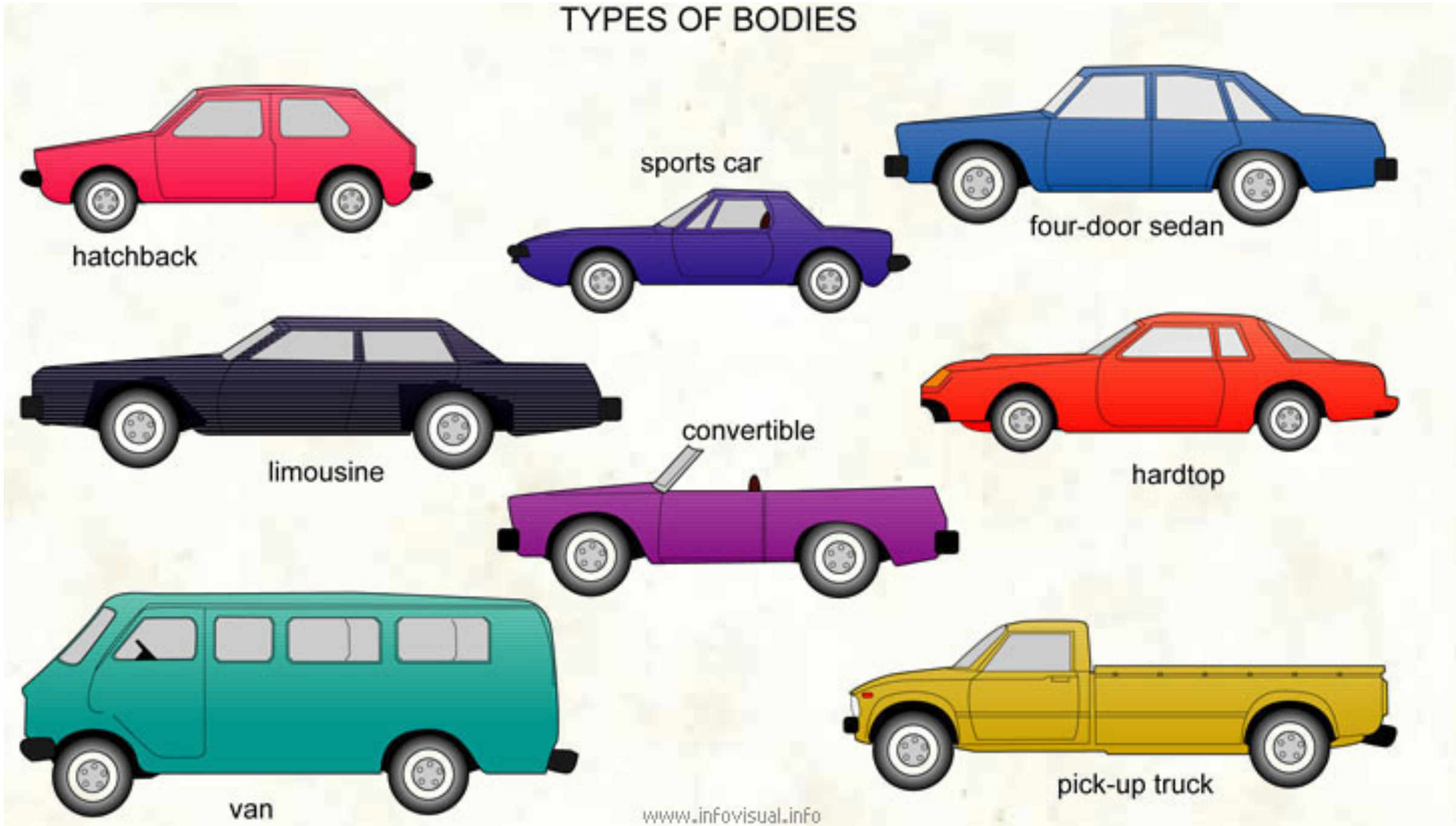
6. Based on type of transmission:

- **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.

Types of car body



Sedan

A sedan, is a passenger car with a bonnet covering the engine and a separate boot fo luggage at the rear.

Honda City

Hatchback

A hatchback is a car with a sloping back and a hinged rear door that opens upwards.

Maruti Suzuki Baleno

Estate

Estates (or station wagons) have a body style similar to a sedan, but with an extended rear luggage or cargo area.

Audi RS6

MPV

MPVs (Multi-Purpose Vehicles) feature a one- or two-box design and are taller than station wagons.

Toyota Innova Crysta

SUV

An SUV (Sports Utility Vehicle) is similar to an estate, but usually bigger and higher off the ground.

Ford Endeavour

Crossover

A crossover is a vehicle built on a car platform but often with features such as SUV-like increased ground clearance and a higher seating position

Ford Freestyle

Two-wheeler Specification Comparison

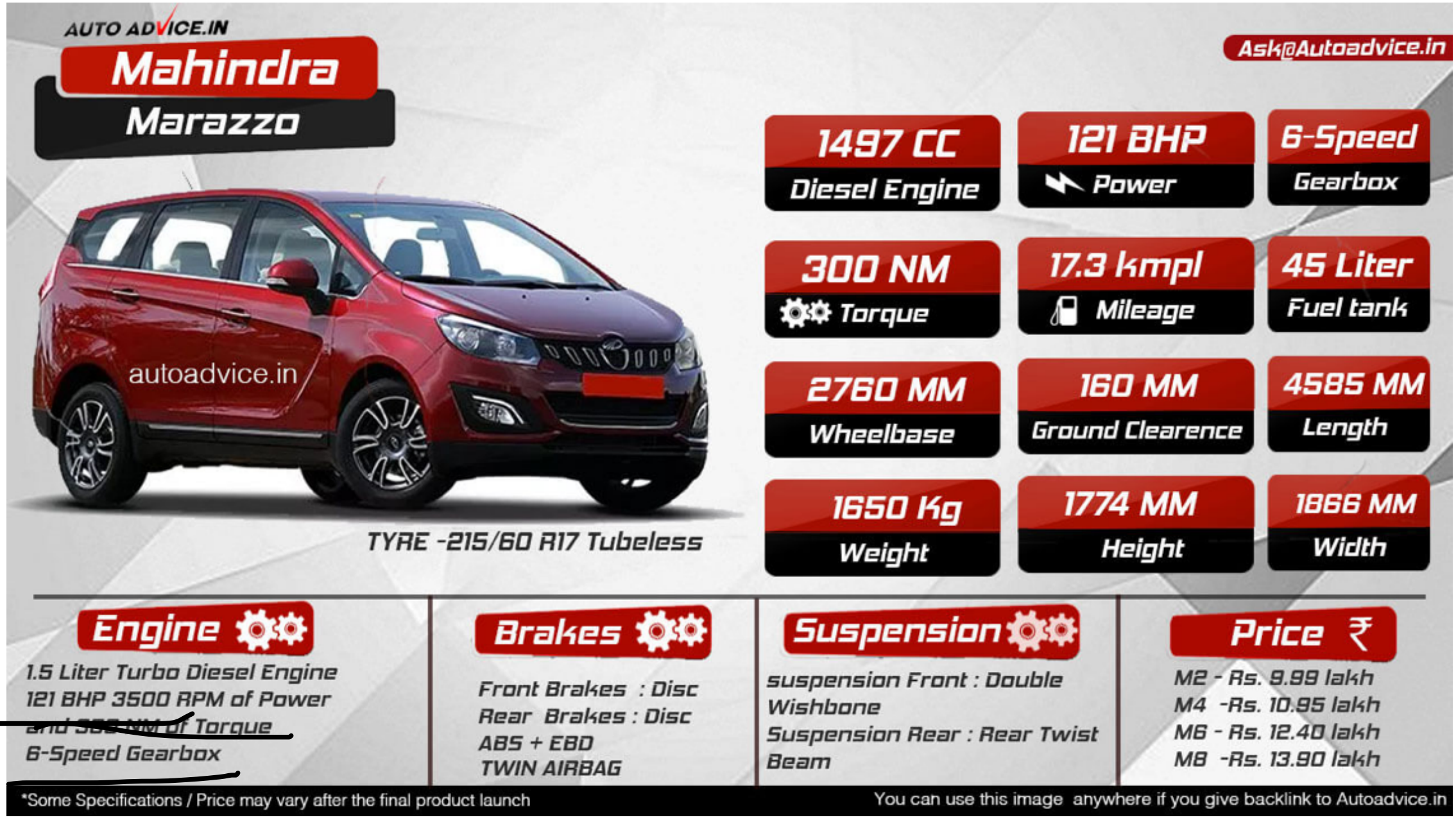
	Passion Pro 110	**Honda Unicorn 150**	**Bajaj Pulsar NS200**
Engine Type	Single Cylinder, 4-Stroke, OHC with i3S	Single Cylinder, 4-Stroke, SI Engine	Single Cylinder, 4-Stroke, 4-Valve, SOHC, Triple Spark, DTS-i Engine
Displacement	109.15 cc	149.2 cc	199.5 cc
Max Power	9.5 PS @ 7500 rpm	12.91 PS @ 8000 rpm	23.5 PS @ 9500 rpm
Max Torque	9 Nm @ 5500 rpm	12.8 Nm @ 5500 rpm	18.3 Nm @ 8000 rpm
Cooling System	Air Cooled	Air Cooled	Liquid Cooled
Fuel Supply	Carburettor	Carburettor	Fuel Injection
Gear Box	4 Speed	5 Speed	6 Speed
Compression Ratio	10:1	9:1	11:1
Mileage (Overall)	73 kmpl	60 kmpl	36 kmpl
Front/ Rear Brake	Drum/Drum	Disc/Drum	Disc/Disc

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



Heavy vehicles

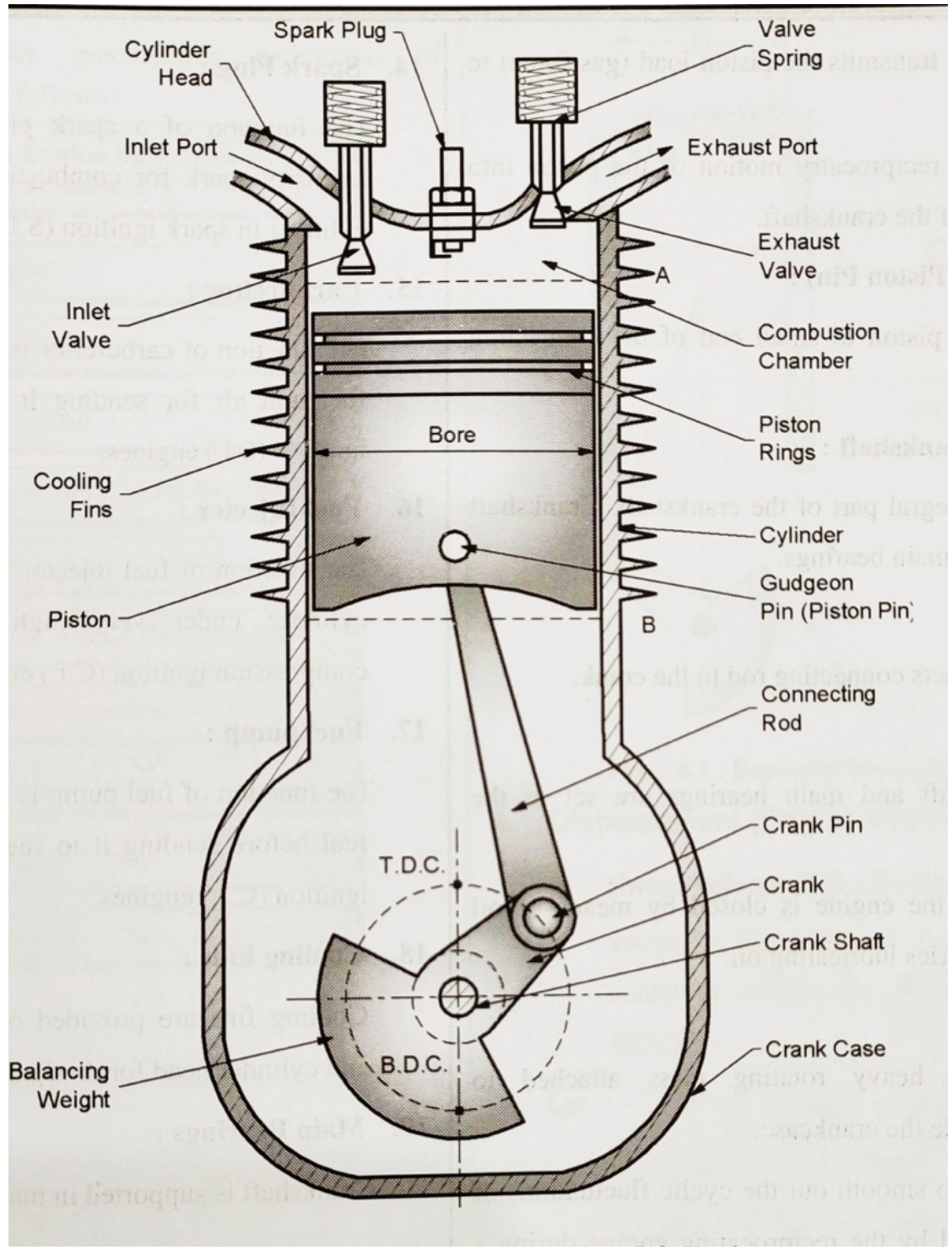
Gradeability Comparison 6x4 Tipper (230 HP) – 1st & Crawler Gear

Gradeability Comparison	BB 2523	TATA Prima Lx 2523.K	TATA LPK 2523
Paramater	**1st Gear**	**1st Gear**	**1st Gear**
Eng Torque	810	900	835
Gear Ratio	9.48	9.139	9.139
Rear axle ratio	4.78	5.58	5.58
Drive line eff	0.95	0.95	0.95
	34,869	43,601	40,452
	65,544	72,912	76,038
Legal GVW	25000	25000	25000
Grade ability	**26%**	**29%**	**30%**

Gradeability Comparison	BB 2523	TATA Prima Lx 2523.K	TATA LPK 2523
Paramater	**Crawler Gear**	**Crawler Gear**	**1st Gear**
Eng Torque	810	900	835
Gear Ratio	14.57	12.868	12.868
Rear axle ratio	4.78	5.58	5.58
Drive line eff	0.95	0.95	0.95
	53,592	61,392	56,958
	1,00,736	1,02,662	1,07,064
Legal GVW	25000	25000	25000
Grade ability	**40%**	**41%**	**43%**

- TATA Prima Lx, & TATA LPK 2523 have higher Gradeability than required to negotiate the gradient in the subject applications.

Parts of an Engine



Engines Components & Materials

1. Cylinder block & Crank case:

- To hold engine components, water jackets
- Cooling jackets, oil passages, passages for push rods,
  fitment for crank shaft, lubrication pump etc
- Grey CI, Al alloy

2. Cylinder head:

- SP, injectors, valve openings, comb chamber, mounting for valve operating mechanism
- CI , Al alloy

3. Oil pan:

- Oil sump
- Pressed steel sheet, Al alloy

Engines Components & Materials

1. Cylinder block/ Crank case:

- For holding major components like crankshaft, cylinder head, liners, gears, pumps etc.
- Cooling jackets, oil passages, passages for push rods etc
- Grey CI, Al alloy

2.Cylinder head:

- For fitment of SP/ injectors, valve openings, comb chamber, valves & valve operating mechanism
- CI , Al alloy

3. Oil pan:

- Oil sump
- Pressed steel sheet, Al alloy

Engines Components & Materials

4. Manifolds:

- Inlet & exhaust tubing for AF intake & exhaust
- CI

5. Gaskets:

- For leak proof sealing between two components
- Embossed steel, cork, special rubber

6. Cylinder liners (Replaceable):

- Pistons reciprocket in cylinders for comb space
- Steel alloyed with Si, Mn, Nickel, Chromium
- Centrifugally cast, hardened by nitriding, chromium plating
- Dry & Wet liners

Engines Components & Materials

7. Piston:

- For transmission of force, light weight, high thermal k, low thermal coeff of expansion
- Al alloy

8. Piston rings:

- For high pr leak proof sealing between piston & cylinder, 2 to 4 + 1 to 2 oil scrapper rings
- Alloy CI with Si, Mn with chromium plating

9. Connecting rod:

- For transmitting force on piston to crankshaft
- I-section, drop forged from steel
- Axial and bending stresses

Engines Components & Materials

10. Piston/Gudgeon Pin:

- For connecting piston with connecting rod
- Case hardened steel

11. Crankshaft:

- For converting reciprocketing motion of piston to rotary motion of crankshaft by connecting rod, vibration damper and fly wheel fitted
- Main journal, crank pins, crank webs, counterweights
- Forged from spheroidal graphite iron

12. Main & Big end bearings:

- For facilitating holding & friction free rotation of crankshaft
- Babbitt material- alloy steel

Engines Components & Materials

13. Engine Valves:

- Inlet –for air/AF intake; Silicon-chrome steel (C+Ni +Mn+Si)
- Exhaust- for exiting burnt gases (C+Ni+Mn+Si+Mb)

14. Camshaft:

- For operating valves (rotates at half speed of C/S)
- Forged alloy steel

15. Silencer/Mufler:

- For reducing exhaust/comb sound
- Metal sheet

Engine specifications

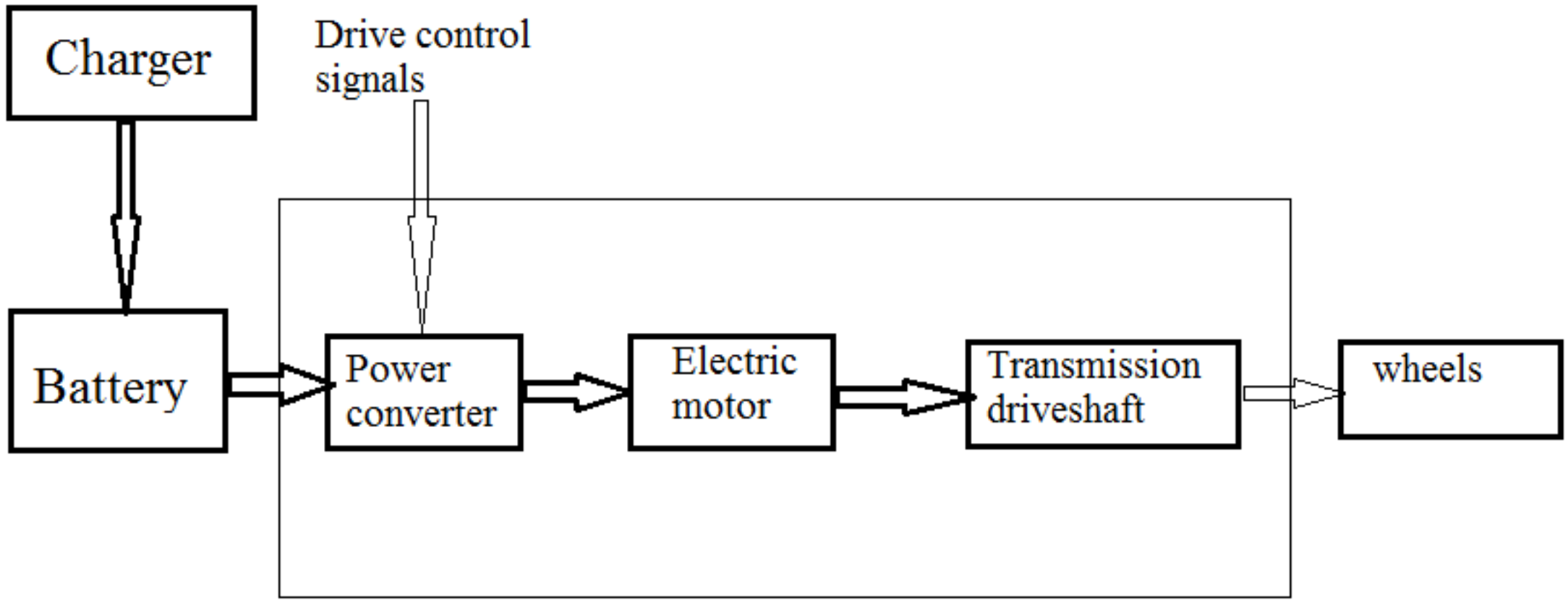
- **Engine speed:** engine speed is measured in revolutions per minute (RPM). diesel engines -1500–4000 RPM , gasoline engines (~2200–6000 RPM
- **Thrust:** Thrust is the force arising from the interaction between Piston and cylinder
- **Torque:** Torque is the force being exerted to the output shaft 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

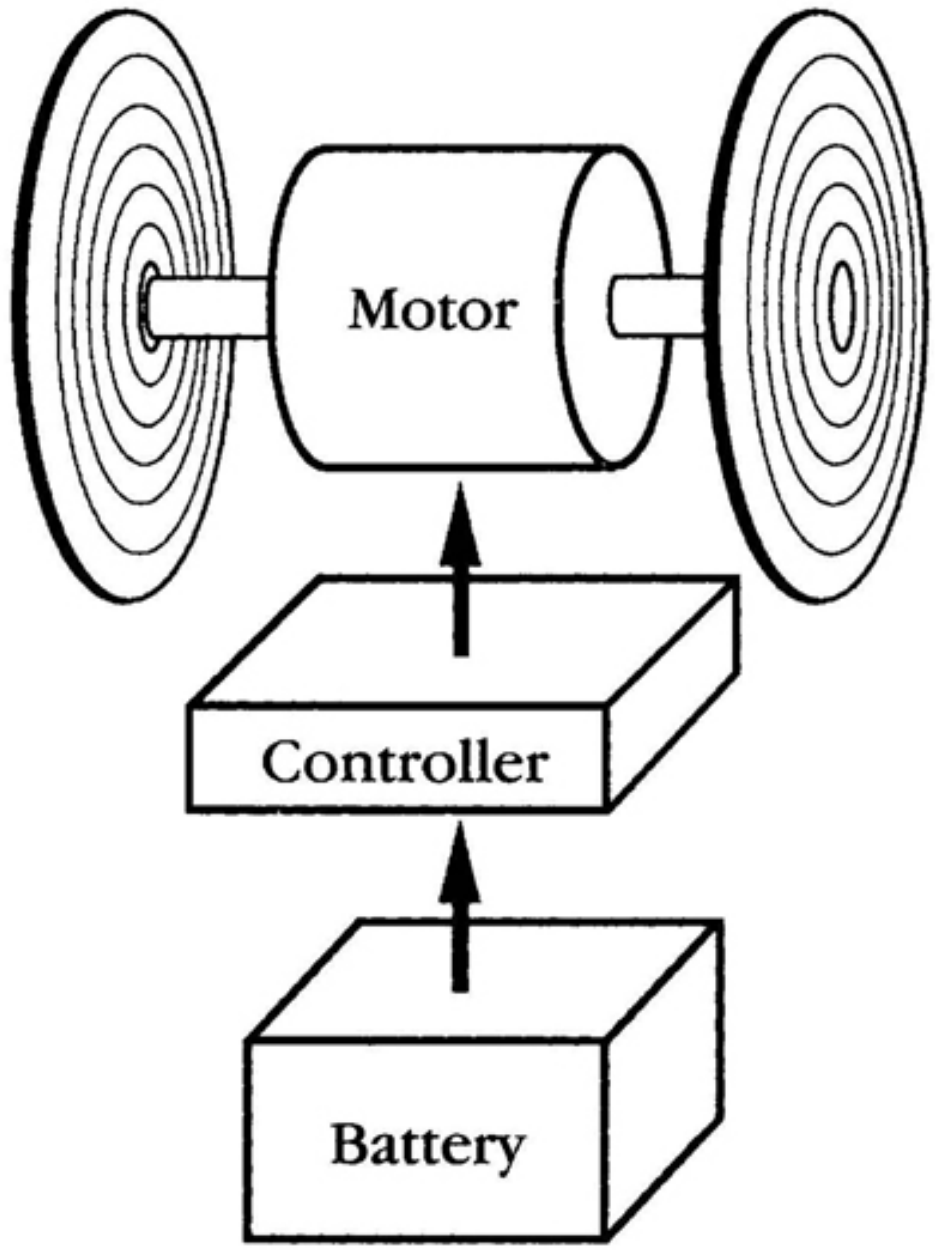
Comparison of engine specification

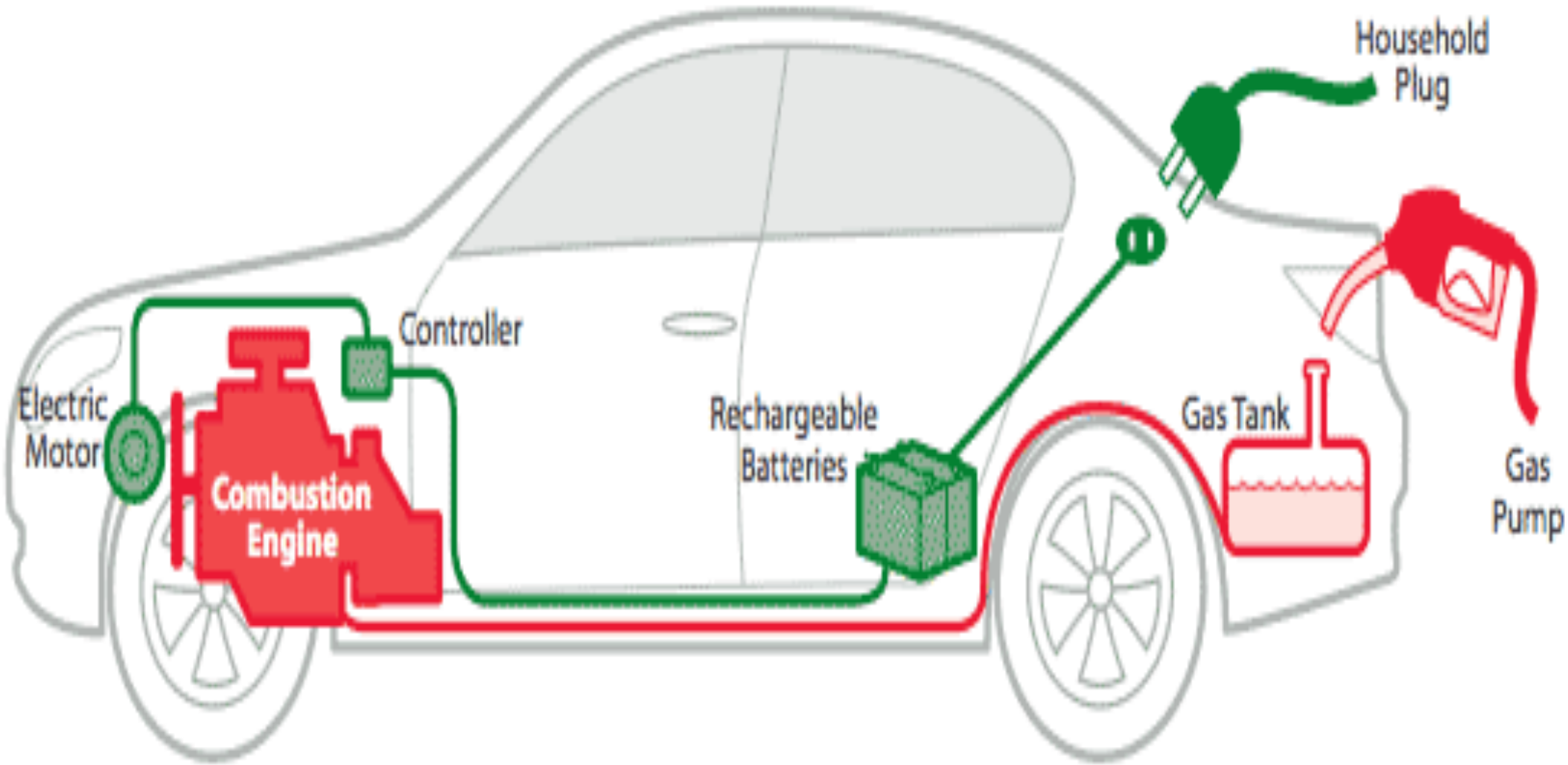
Parameter	Two wheeler Yamaha(FZ)	Three wheeler Bajaj Auto	Four wheeler Mahindra Marrazo	Heavy vehicle Bharatbenz
Type	4Stroke Air cooled	4 stroke	4 stroke liquid cooled	4 stroke diesel
Cubic capacity	149	198.88	1497	6372
Number of cyl	1	1	4	6
CR	9.5:1			
Max. HP	9.7kW	7.6kw	90.2 kW	281 kW
Max. Torque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

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.

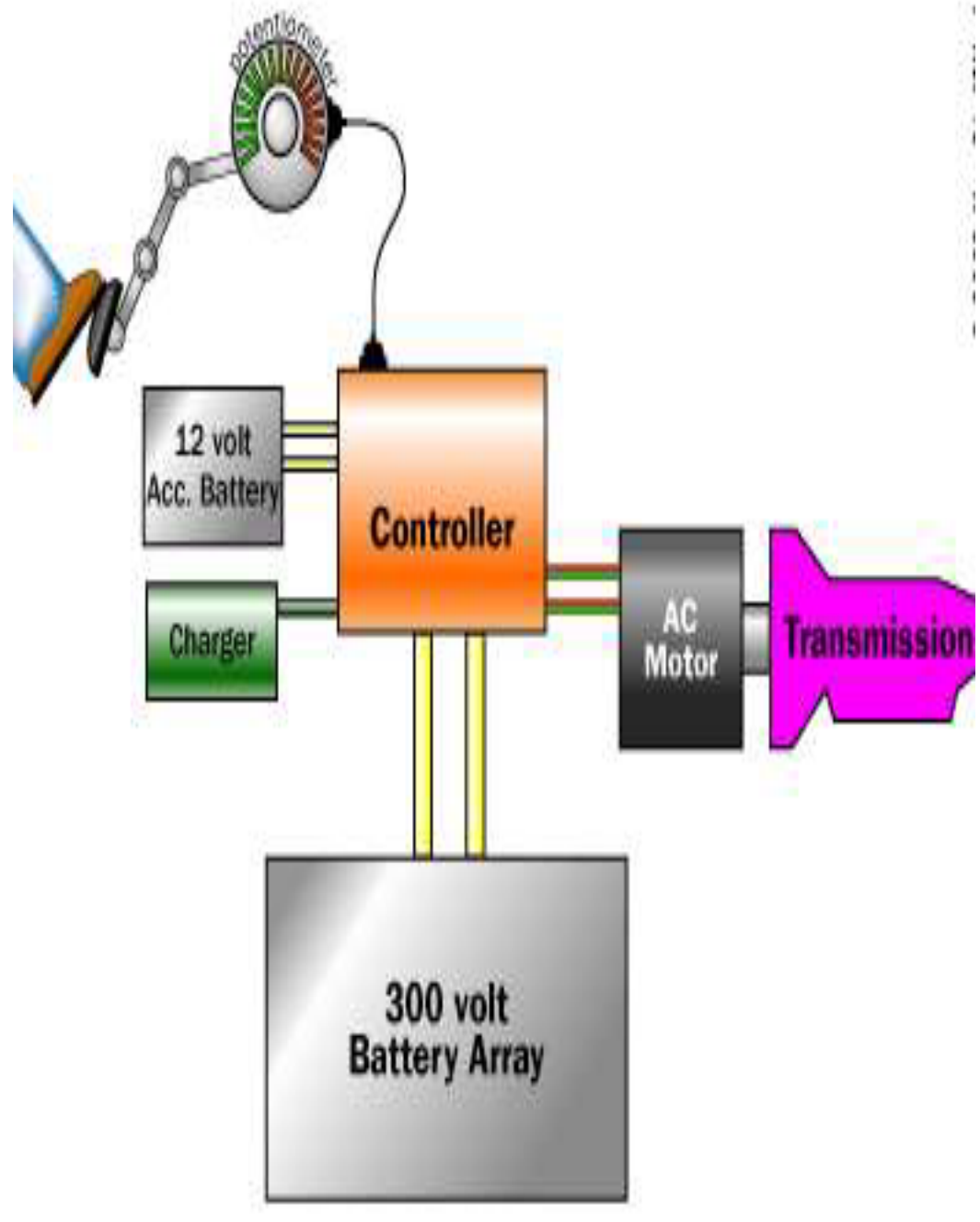

Charger
Drive control signals
Battery
Power converter
Electric motor
Transmission driveshaft
wheels


Motor
Controller
Battery


Household
Plug
Controller
Electric
Motor
Combustion
Engine
Rechargeable
Batteries
Gas Tank
Gas
Pump

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

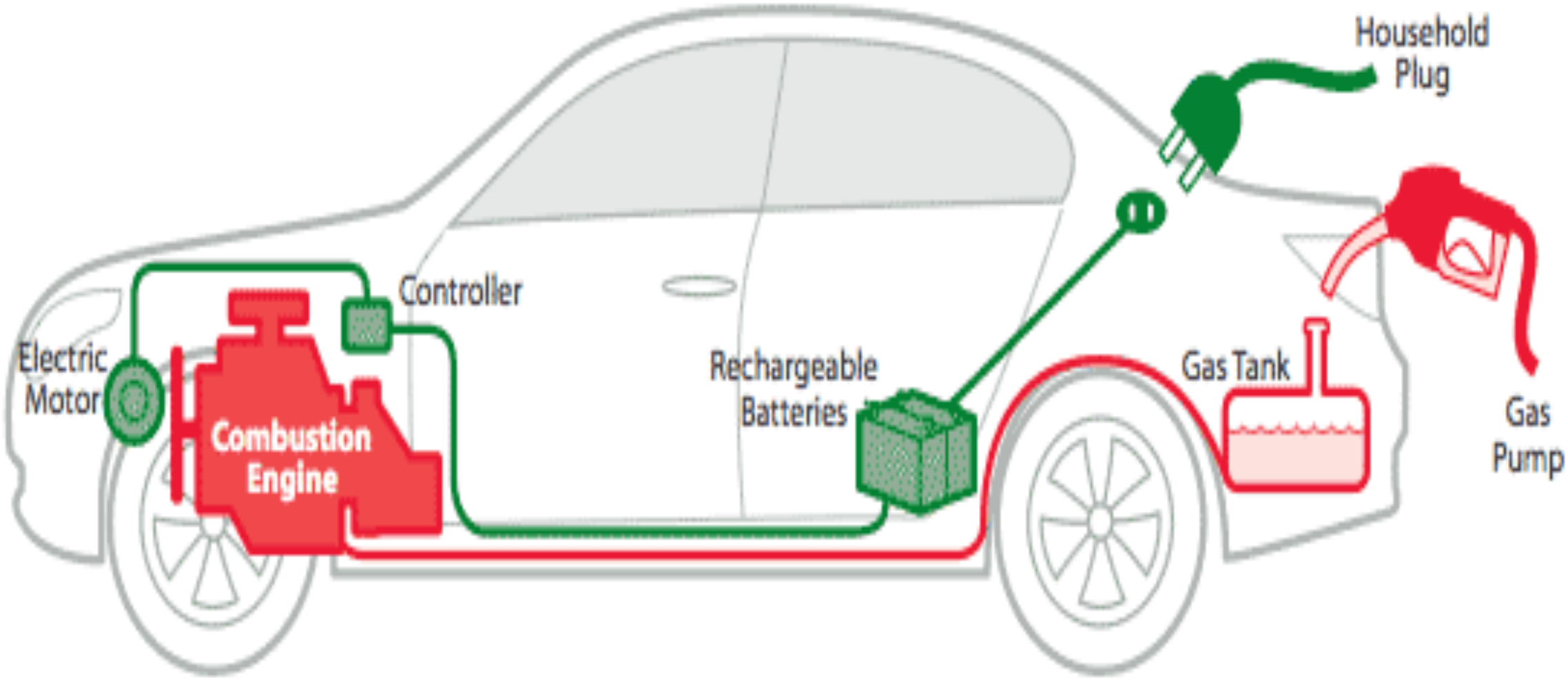
- Reduce dependence on oil and gasoline
- Pollutants and noise free.
- Recyclable batteries
- No fire hazards
- Low maintenance and operation cost

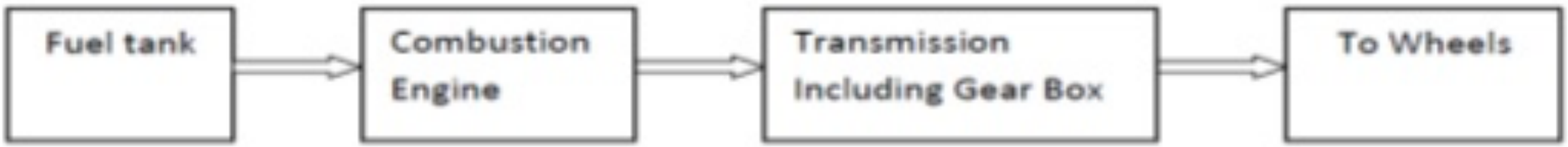
Disadvantages

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

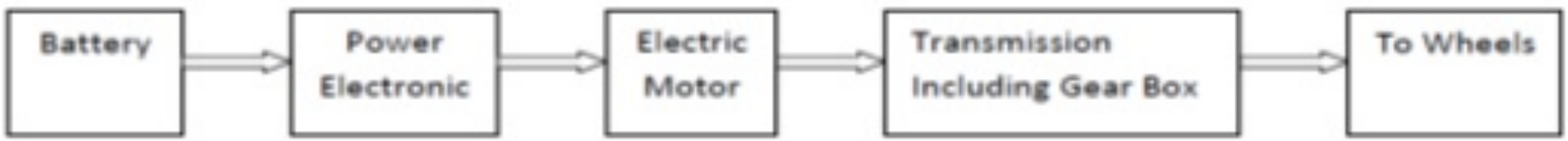
Hybrid Vehicle

- 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.


Household
Plug
Controller
Electric
Motor
Combustion
Engine
Rechargeable
Batteries
Gas Tank
Gas
Pump

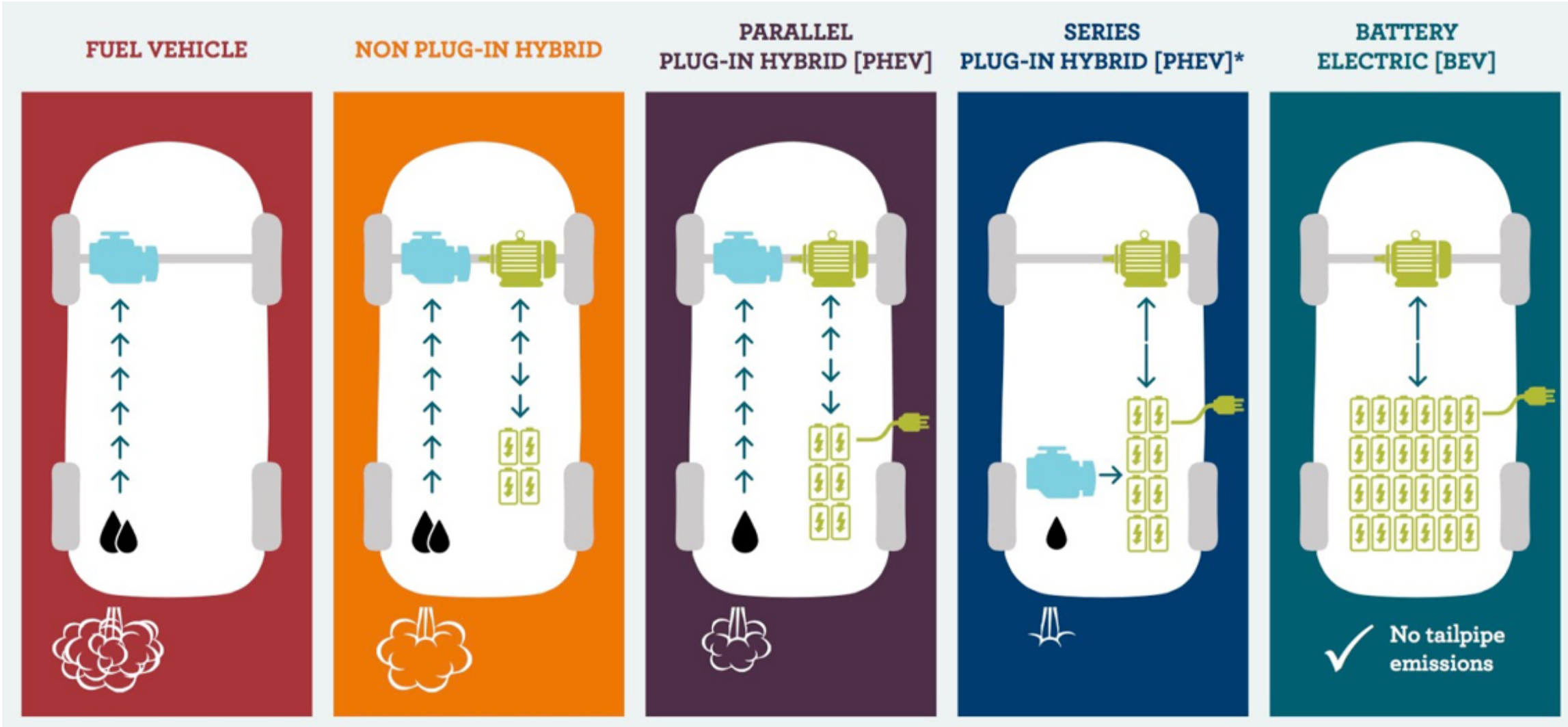


The Arrow depicts flow of Energy within a mechanical drive train



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)

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

3.20.1 Cost Comparison of Four Wheelers

	Maruti-M-800	Tata Indica Vista	Hyundai Accent
No. of cylinders	3 Cylinder In-Line Water Cooled Four Stroke Petrol Engine	4 Cylinder In-Line Water Cooled Four Stroke Petrol Engine	Four Cylinder In-Line Water Cooled Four Stroke Petrol Engine
Torque	60 Nm at 2500 rpm	200 Nm at 1750 to 3000 rpm	124 Nm at 4500 rpm
Power and Speed	Engine Power = 40 BHP @ 5500 rpm	Engine Power = 75 HP @ 4000 rpm	94 BHP @ 5500 rpm
Cooling system	Water Cooled	Water Cooled	Water Cooled
Cubic capacity	Cylinder Capacity = 800 cc (cubic centimeter)	Cylinder Capacity = 1250 cc (cubic centimeter)	1527 cc (cubic centimeter)
Types of brakes used	Ventilated Disc Type Front Brake and Drum Type Rear Brake	Ventilated Disc Type Front Brake and Drum Type Rear Brake	Disc Type Front Brake and Drum Type Rear Brake
Cost of Vehicle	2 to 2.5 lacs	4.5 to 5 lacs	6 to 7 lacs