NOTE- This answer sheet is prepared on google jamboard

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QUESTION 1

Worlds first automobile was builta by Nicolas Cugnot in 1768 (steam powered). In 1806 Isaac de Revas invented worlds first IC engine powered by Hydrogen. In 1826 Anyos Zedlik invented the electric motor to power up a toy.But form sources we also across the invention done by by Sibrandus Stratingh and Christopher Becker who invented the first working electric car in 1836.

Coming to 1865 electric tram was invented in Burmingham and the guy Thomas Parkar built his first productinable electric vehicle. and after 1884 the electric vehicle started forming a great market in Europe. In 1890 in Us william morrision build 7 seater electric vehicle excluding driver.

In early 20th centuary electric advancements were at peak they had long range, no emmision, no sound and low mainten ance cost in terms of mechanical parts.It covered around 30 to 35% of market. But after 1910 it started falling as IC engines vehicles were easy to refuel, can be taken for very high distance range. Meanwhile assembly line production was started by ford and his cost reduction scheme, he was able to make a big market of IC engine vehicles in Market and IC engine fuels are also easy to handle and less reactive. The self start motor by chevrolet had solved the probllem of cranking the engines which again made the fall in EV sales.

In world war 2 The vehicles needed to be faster and can be refueled fastly and carry a lot load. Thus invention of bikes and rise in sale of IC engine vehicles was declining the EV sales at that time.

In mid 20th century in Europe, the great Smog caused death to 12000 people and now almost after a decade in USA, around 600 people died the same manner like in europe. The California research institute started the study regarding the same they came with conclusion that around 45 - 50 % pollution is caused by vehicles. They started the organization which is non- govt. funded commitee known as California Air Resources Board. They gave many rules to all vehicle manufacturers to have atleast one electric vehicle per year. few regulations were like-

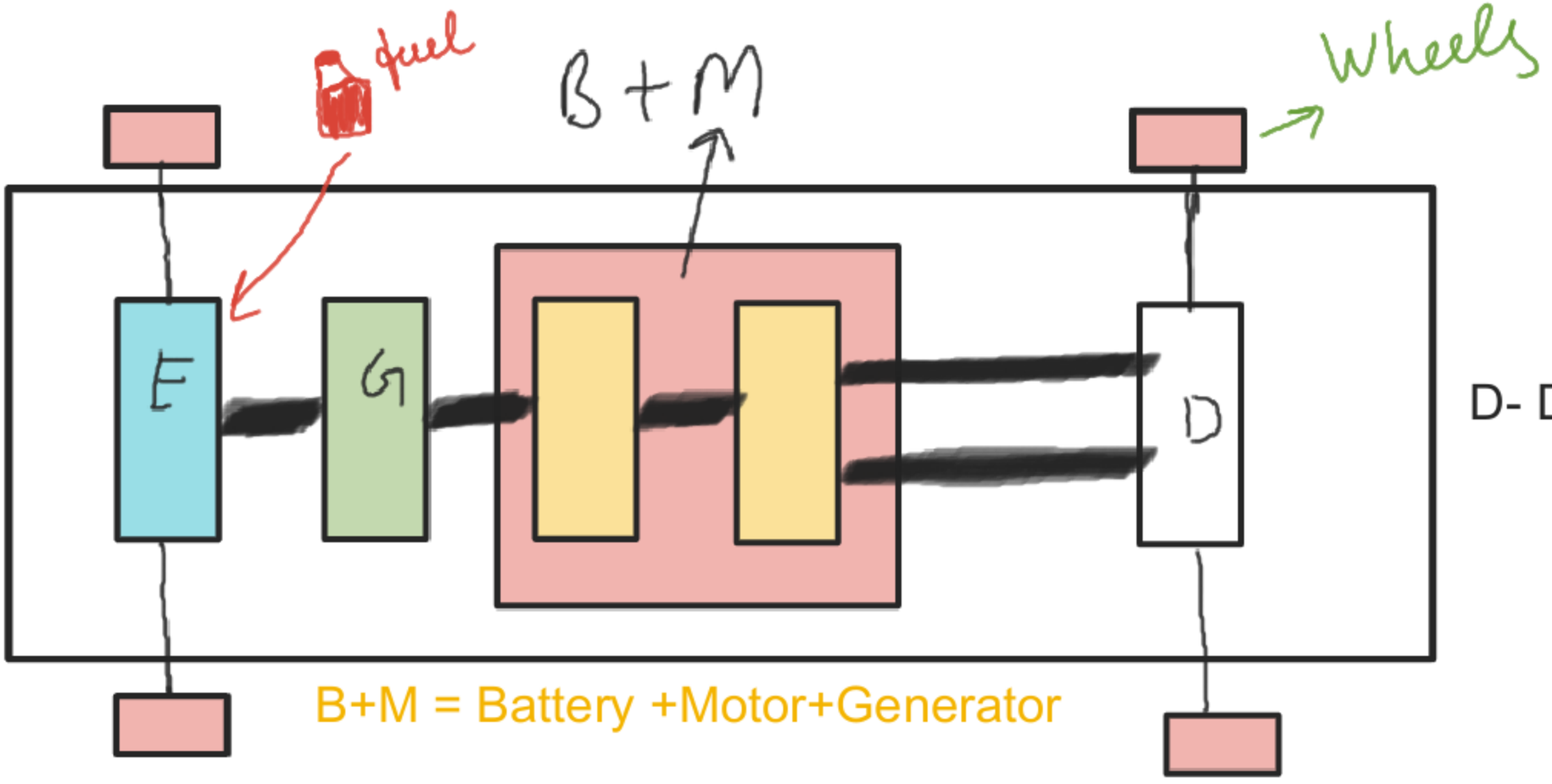
1. Low Emission Vehicle- I (1993-2003)- All manufacturrers to provide Zero Emmision Vehicle in market. These models cannot be purchased but can be rented for a couple of years and return the same to manufacturuers and people don't wanted to buy those and filled case against CARB and companies are not allowing to purchase the EV's. This pulled out LEV-1

2.LEV, ULEV (ultra low emmsion vehicle) and PZEV (Pure Zero Emission vehicle) which caused the begininng of Hybird Vehicles . Again like previous regulation and cases, the companies again fought for the Ic engines but at 2006 Tesla Roadster shocked the market as it was fully pure electric vehicle.

THis again gave a rise in electric vehicle industry.

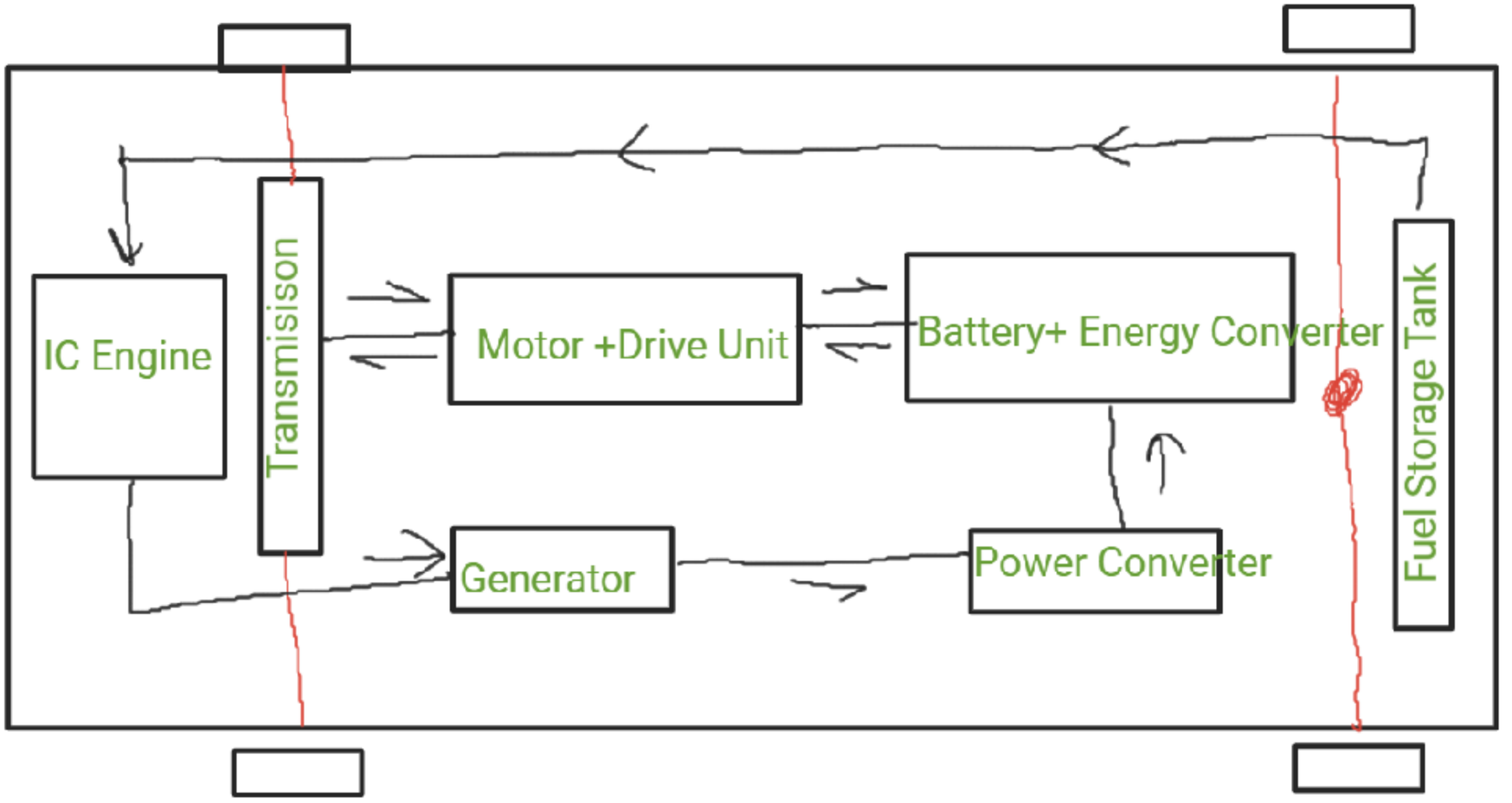
QUESTION 2

Basic Hybrid Electric vehicles



Hybird refers to a vehicle which has combination of two different types of power sources. A hybrid vehicle is commonly a combination of IC engine and an electric powered motor. As shown in last figure. Supposing that a vehicle is running and its battery is dicscharged, than it gets charged by various applications like from the diffrential, from regenrative braking system etc. This doesnot effect much on the vehicle performance. Now assuming if the battery is charged and we get stuck in slow moving traffic. than one can opt for runnning the whole vehicle just on the battery power. usuually hybrid vehicles can cover 20-40km in traffic road. Now if assuming if anyone on highway needs the boost in speed. He can opt to run vehicle on both Engine and motor.

(a) Series HEV



In this system the unlike Parralel type, the IC engine here is connected to a generator instead of transmission system . This generator charges battery and in return the Motor drives the transmission system. Here battery is the major soruce of power tranmission

Main Advantages are -

1. No clutch required for this type

2. More fuel can be saved. as Ic engine itself acts as generator hence less power loss in tranmission and light weight gearbox also can be used.

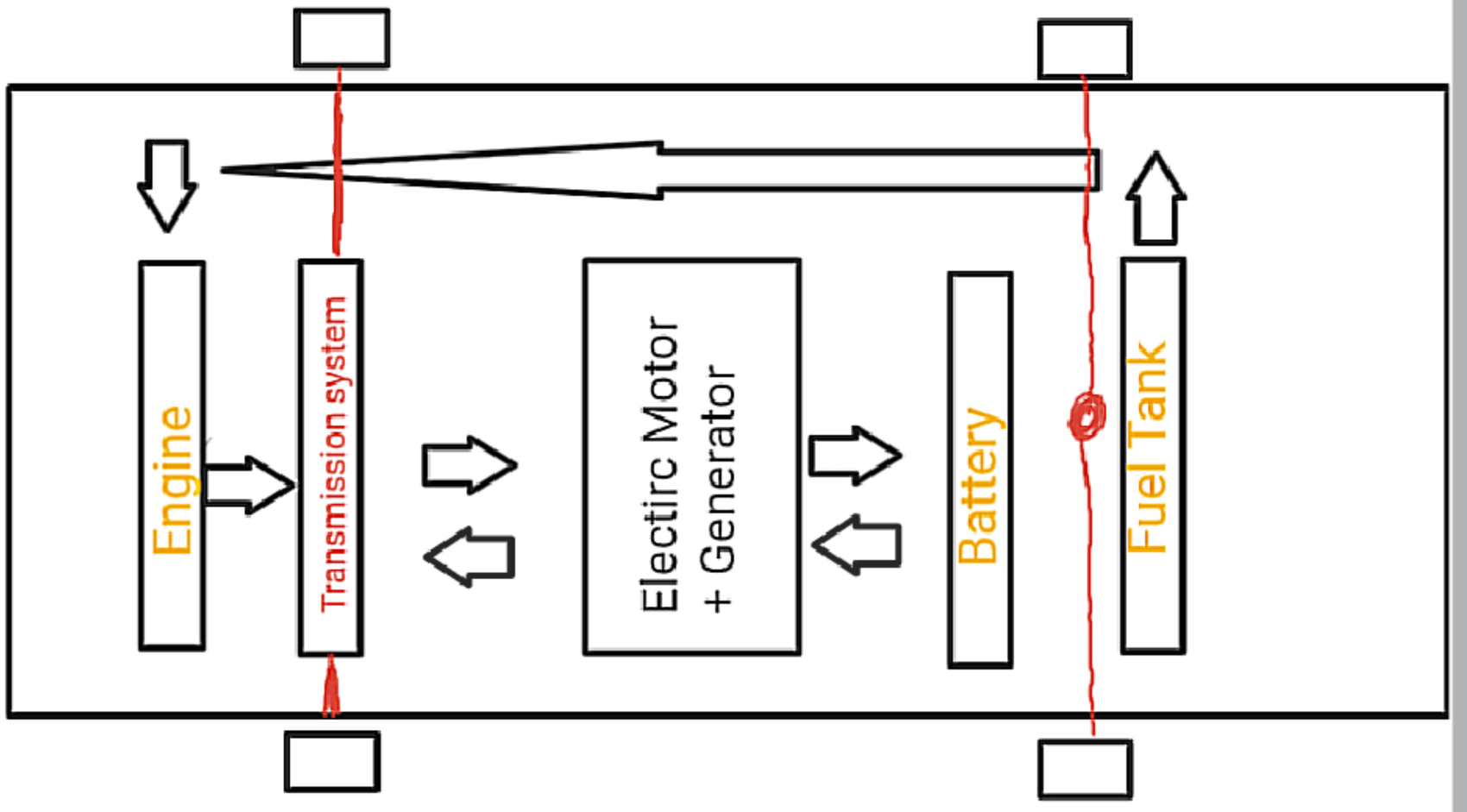
Main disadvantages are -

1. Complex design of the drive units.

2. battery is only the major energy supplier thus vehicle becomes heavy due to battery content.

3. Expensive than Parralel type HEV

(b) Parallel HEV



Most commonly used HEV type used. In this type of arrangment.Motor and engine are connected to tranmission system. Ic engine is major power supplier in this case

Main Advantages are -

1. Smaller motor as major power supplier is engine only.
2. Smaller battery and less space consumption by it.
3. Even if uou run out of fuel, battery can drive the vehicle of minimum 20 to 30 km (IN worst case).

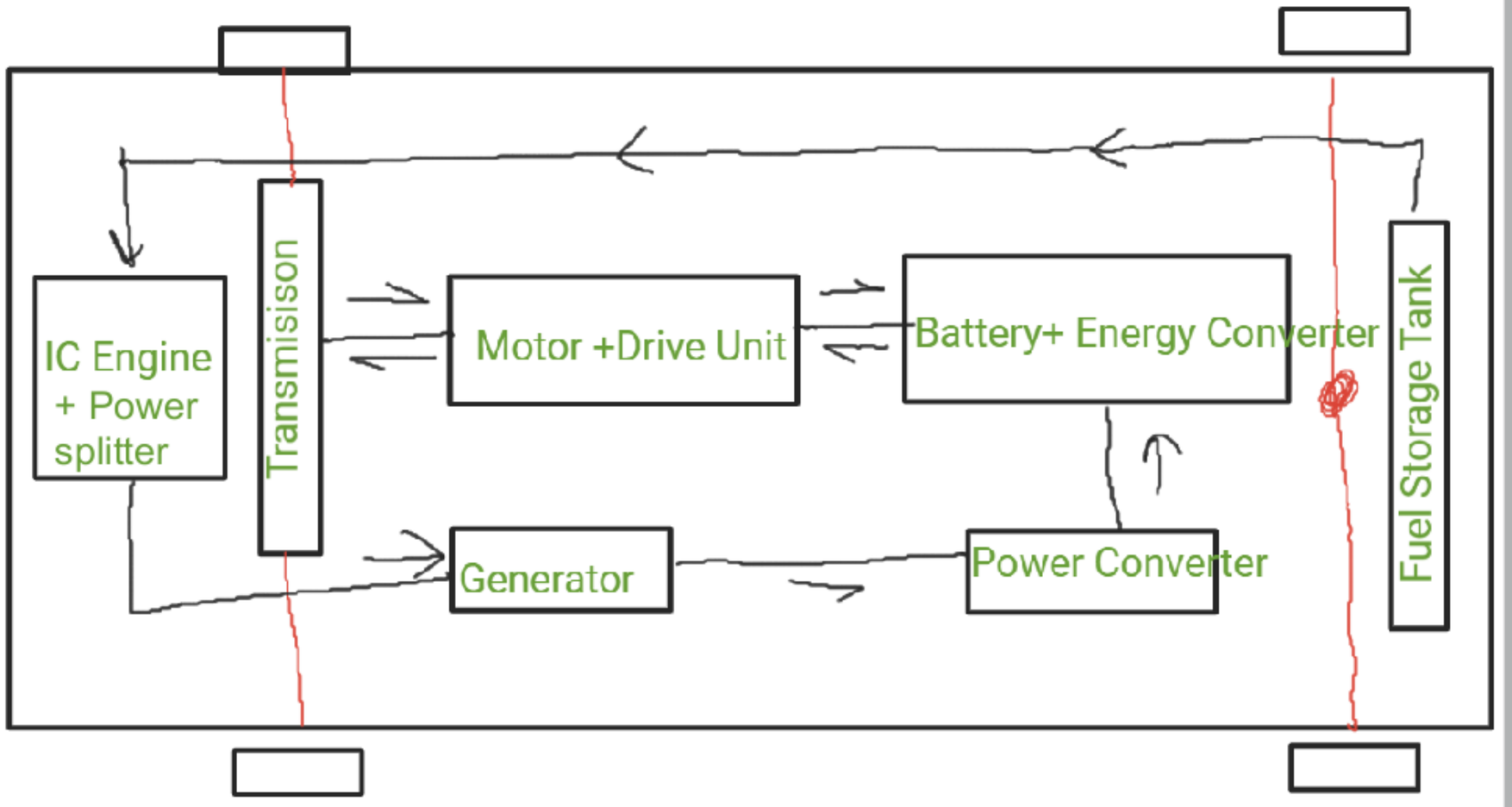
Main disadvantages are -

1. If vehicle is on battery powered mode, the max speed is reduced to a lot extent.

2. Efficiency losses are there due to common transmission system. For cases like-

(Only engine power), (engine + battery), (only battery) , Only Engine + battery charging) and (Regenrative Charging)

(c) Series - Parallel HEV



This is modification to series type,here power splitter is used to divide power between the transmission and generator. At the same time battery can be charged and also the power can be transferred via transmission system.

Main Advantages are -

1. More efficient transmission as compared to series type HEV.

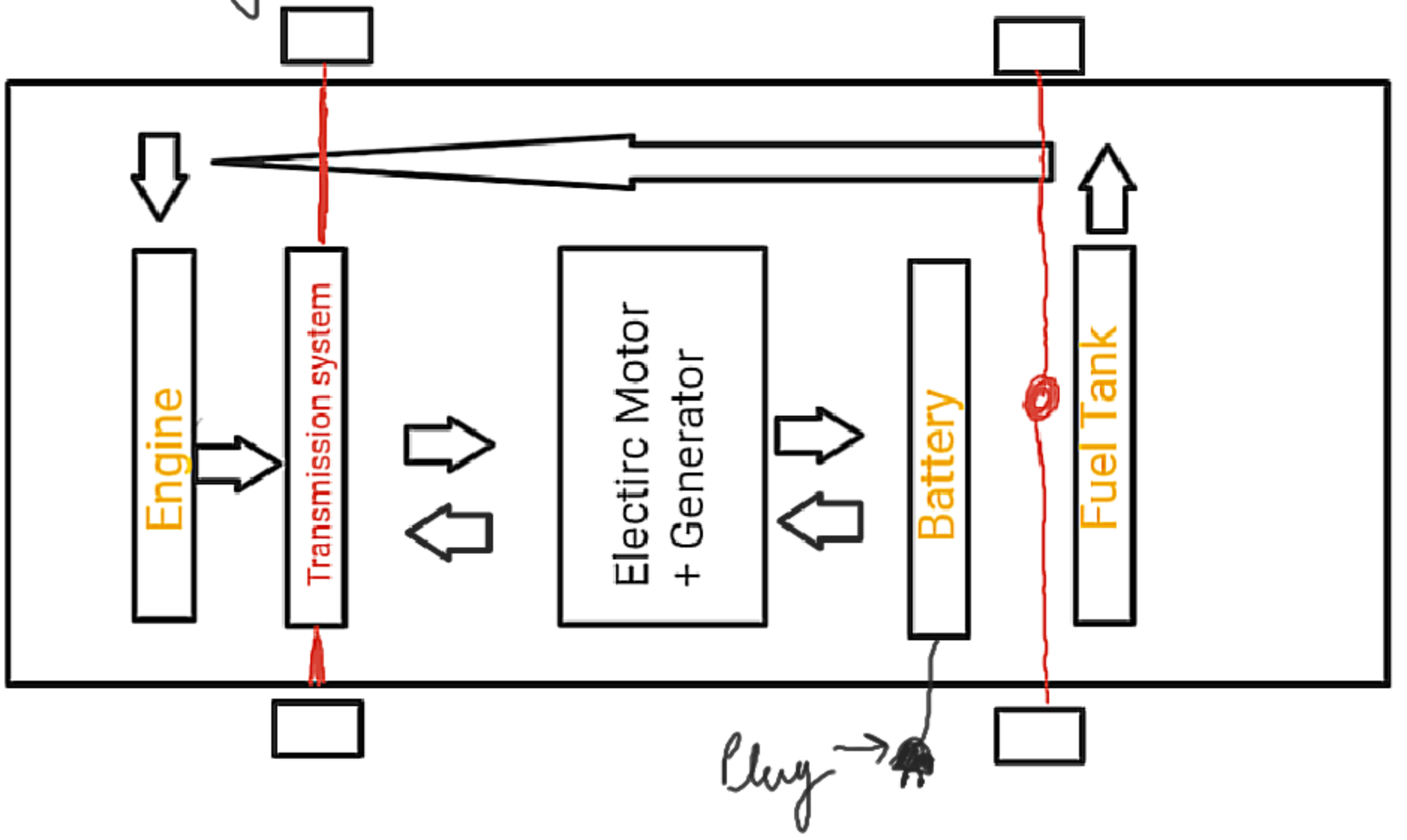
2. Smaller engine size as compaered to PArralel hence less noisy.

Main disadvantages are -

1. IT is very bulky setup and requires lot space for the engine and power splitter and battery as well.

2. Lesser tranmission effiiciency at high load

(d) Plug-in type HEV



Only battery recharging systems are added in this type. It can be used in both parralel or in series.

Main Advantages are -

1. Much leser engine size.

2. Good for short ranges

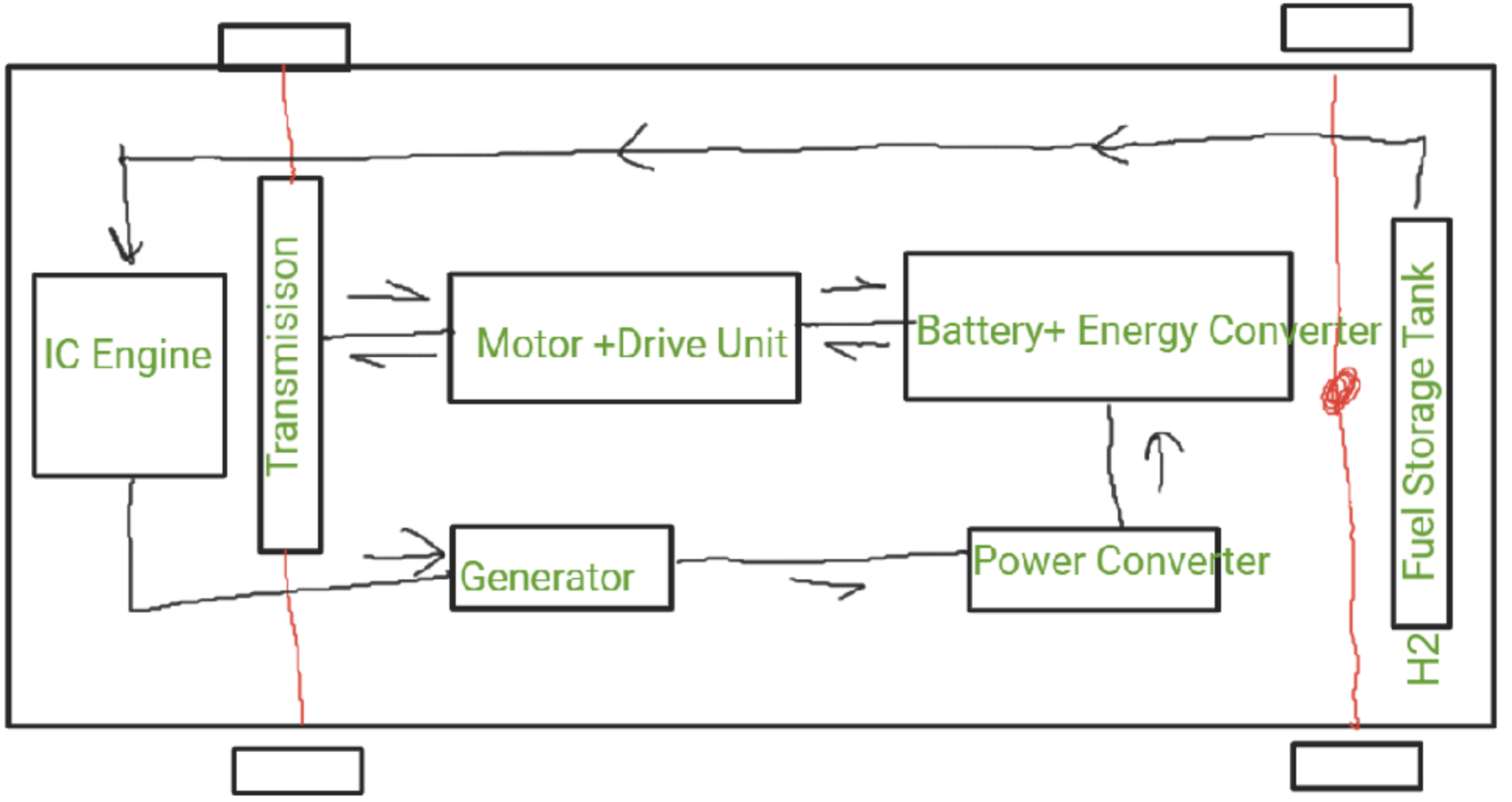
3. Smaller engine size as compaered to Parrralel hence less noisy.

Main disadvantages are -

1. Not good for very long range travell.

2. Additional Charging system to be installed in vehicle causing less space but more parts and wiring etc.

(e) Fuel-Cell vehicle.



Gasoline tank replaced with hydrigen tank, can be used in any type of HEV concepts.

Main Advantages are -

1. Fully green vehicle.

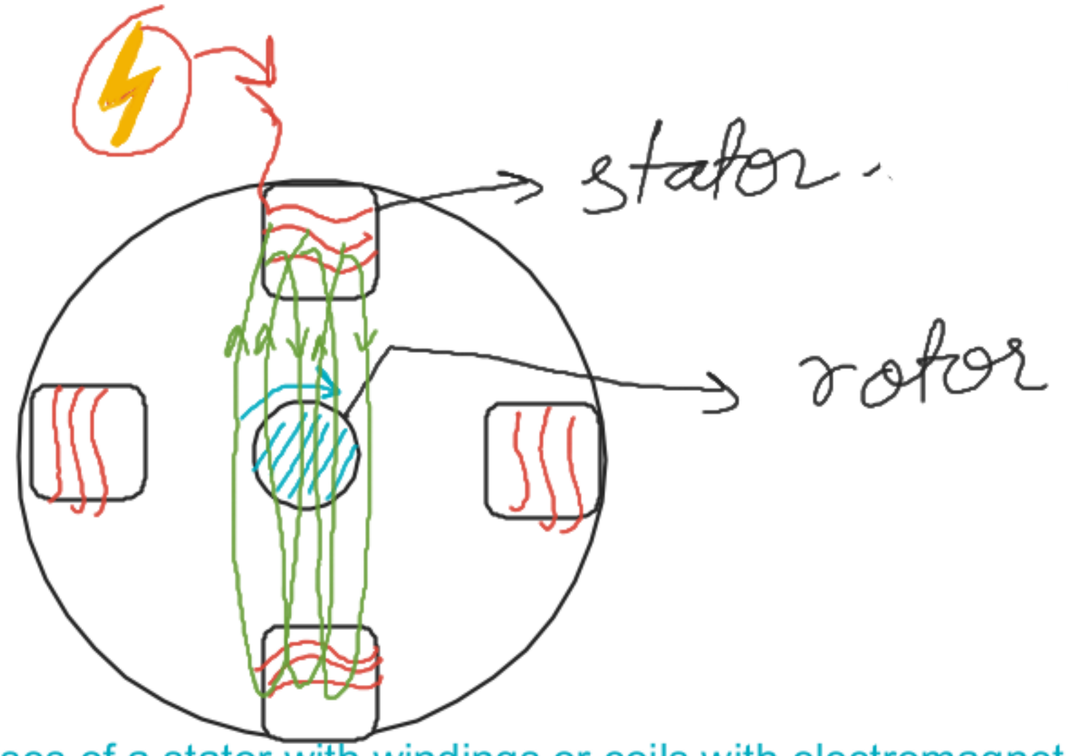
Main disadvantages are -

1. H2 handelling is very difficult as it is highly explosvie

2. As H2 is highly expandable as well, hence the engine needs be very durable to hold high pressure after the combustion.

QUESTION 3

BLDC motor → (Brushless)



green lines represents magnetic fields

BLDC motor comrpises of a stator with windings or coils with electromagnet and a rotor with permanent magnets. This motor doesnot contains brush which makes it sparkproof and noiceless. Since it has no contact parts, hence its maintenance is also easier. In this motor torque is generated by the magnetic filed imosed by electromagnets over the permanent ones which happens in angular motion.

As rotor starts rotating, if let say the COIL 1 is close to PERMANENT MAGNET NUMBER 1, the electricity starts flowing through the COIL 2 , which makes the PERMANENT MAGNET number 1 to get attracted towards the COIL2 .

In this motor the permanent magnets are arranged such that they are having opposite polarities facing each other. This implies the magnet just opposite to PERMANENT MAGNET 1 will cause the polarity in the coil to be just opposite as of COIL 1

In this figure if we consider the magent 1, the nearest coil to it will have opposite polarity that is SOUTH, hence it will pull the permanent magnet towards it and due to magnetic field, the coil 2 will experience the electric currnet which will induce the magnetic effect it coil 2 of same polarity as of COIL1

Coils are energized as per the sensor that detacts the presence of permanent magnet and the electromagnetic field