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Q1) $m = 1500 \text{ kg}$
 $A = 3 \text{ m}^2$
 $C_D = 0.5$
 $\rho = 1.2 \text{ kg/m}^3$
 $\rho_{\text{petrol}} = 0.755 \text{ kg/litre}$
 $R_r = 0.013 \text{ N} \times 9.81 = 0.13 \text{ N}$
efficiency = $80\% = 0.80$
 $V = 70 \text{ kph} = 19.4 \text{ m/s}$

Engine $P = 55 \text{ kW} = 55000 \text{ W}$

Total Rolling Resistance? $= m \times R_r \times g = 1500 \times (0.013 \times 9.81)$
 $= 1500 \times 0.13 = 195 \text{ N}$

(a)

Aero Resistance $= 0.5 C_D \times \rho \times V^2 \times A$

$= 0.5 \times 1.2 \times 19.4^2 \times 3 \times 0.5$
 $= 338.7 \text{ N}$

Total $= 338.7 + 195$
 $= 533.724 \text{ N}$

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c) power used.

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$$1.2 \text{ MJ} = 1,200,000 \text{ J} = P \times t$$

rearrange to find P

$$P = \frac{1,200,000}{0.9} = 1,333,333 \text{ W} \\ = 1333 \text{ kW or } 1.3 \text{ MW}$$

d) how many seconds

~~watts~~ = Joules / second.

$$55000 \text{ W} = 55000 \text{ J/s}$$

$$\text{Seconds} = \frac{P}{55000} = \frac{1,333,333}{55000} = 24.24 \text{ seconds.}$$

e) how many seconds on flywheel power?

$$1.2 \text{ MJ} = 1,200,000 \text{ J}$$

$$\text{to wheels} = 1,200,000 \times 0.9 \times 0.8$$

to find losses.

$$\text{power to wheels} = 864,000 \text{ J} = 864 \text{ kJ or } 0.86 \text{ MJ}$$

$$\text{Seconds} = \frac{864,000}{5000} = 172.8 \text{ seconds}$$

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how many whole cycles?

$$P_1 + P_2 = 24.24 + 172.8$$

$$\text{Total} = 197.04$$

$$\text{Total per hour} = 3600 \text{ seconds}$$

$$\text{So } \frac{3600}{197.04} = 18.27 \text{ cycles.}$$

So it can complete
18 cycles.

what volume of fuel?

$$55 \text{ kW at } 255 \text{ g/kWh}$$

$$= 18.27 \times 24.24$$

$$= 442.86 \text{ seconds for Phase 1.}$$

$$\text{fuel used} = \frac{442.86}{3600} = 0.123018$$

$$255 \text{ g} \times 0.123018 \times 55$$

$$= 1725.3 \text{ g} + 18.27 \text{ g}$$

$$= 1743.27 \text{ g.}$$

(h) driver experience.

using this method the driver may experience a lower total fuel consumption with the engine turning off for a period of time and using the stored power in the flywheel.

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Q3) $k_{\text{weight}} = 1600 \text{ kW}$
 $G.V \text{ weight} = 2600 \text{ kg}$
 $\text{tow limit} = 900 \text{ kg}$

Battery vehicles don't consume fuel, it consumes power stored in the batteries. depending on the battery capacity, the distance per charge can vary. this also depends on the vehicle speed and auxiliary systems draining this power. The batteries will take a while to charge compared to refuelling the car with fuel.

Hybrid vehicles can use both an engine and batteries to power the vehicle. this lowers the total emissions and can increase the range before refuelling.

at low speed the electric motor will power the car, using no fuel. then at higher speed the engine will take over and also charge the battery.

Hydrogen fuel cell cars can produce their own energy, increasing the miles covered it has a hydrogen tank feeding to a battery which then powers an electric motor.

These can also be refilled much faster than an electric car.