Madhura Kulkarni.

Q.1st A two wheeler with drag coefficient of 0.51 and frontal projection area of 0.72 m^2 has a max velocity of 130 kmph. Calculate the air resistance of the vehicle for the speed from 0-130 kmph (Take max speed increment of 5 kmph)
Also, plot the graph of aerodynamic force vs the speed.

Given,

Air density $= \rho = 1.225\ kg/m^3$

drag coefficient $= C_d = 0.51$

F.P Area $= A = 0.72\ m^2$

Max velocity $= V_{max} = 130$ kmph

$V_2 = 130$ kmph

$V_1 = 0$

Vehicle Resistance $F_D = ?$

$$F_d = \frac{1}{2} \rho V^2 C_D A = \frac{1}{2} \times 1.225 \times \frac{130000}{60 \times 60} \times 0.51 \times 0.72$$

$$\boxed{F_d = 8.12175}$$

Vehicle	Initial Accel^{n} Speed (kmph)	Time	Frontal Area	Cd	mass m (kg)	Radius of Tire
Nissan Leaf	0 - 100	7.9s	2.14 m^2	0.28	1640kg	16 Inch = 0.4064 m
Tesla Model S Plaid	0 - 100	1.99	2.4 m^2	0.24	2069kg	14.05 in = 0.357
Tata Nexon EV	0 - 100	9.3			1400kg	
MG ZS EV	0 - 100	8.2			1539kg	
Hydai Kona	0 - 100	6.6		0.29	1743kg	
Ather 450X	0 - 40	3.9	0.79 m^2	0.2	108kg	12" = 0.305 m
Royal Enfield	0 - 60	4.2		0.66	195kg	
Bajaj Dominar	0 - 100	8.4			187kg	
Hero Splendor	0 - 60	8			110 kg	
Toyota Prius			2.22 m^2	0.26		

14/05/2022 23:04

MAHATMA GANDHI MISSION

Q.2nd For the following vehicles determine the drag resistance at the speed of 40 kmph

1) Nissan Leaf:

Drag Resistance force

Formulae → $F_d = \frac{1}{2} \rho C_d \times A \times V^2$

- $\rho_{Air} = 1.225 \text{ kg/m}^3$

  $C_d(\text{Nissan}) = 0.28$

  Frontal Area of Nissan = $A = 2.14 \text{ m}^2$

- ~~600~~ $V = 40 \text{ kmph} = \frac{40000}{60 \times 60} = \frac{400}{36} = \frac{100}{9} \text{ m/s}$

$F_d(\text{Nissan}) = \frac{1}{2} \times 1.225 \times 2.14 \times \left(\frac{100}{9}\right)^2 \times 0.28$

$F_d(\text{Nissan}) = ~~161.821~~ \; 45.3099$

2) Tesla Model S Plaid

$C_d(\text{Tesla Model S Plaid}) = 0.24$

$A_{(TMSP)} = 2.4 \text{ m}^2$

$V = \frac{100}{9} \text{ m/s}$

$F_{d(TMSP)} = \frac{1}{2} \times 1.225 \times 0.24 \times 2.4 \times (123.45679)$

$F_{d(TMSP)} = 43.556$

14/05/2022 23:05

3) Toyota Prius

$A_{(Tp)} = 2.22 m^2$

$Cd = 0.26$

$Fd = \frac{1}{2} \rho \times Cd \times A \times V^2$

$= 1.225 \times 0.26 \times 2.22 \times 123.45679 / 2$

$Fd_{(Tp)} = \cancel{87.2926}$ 43.646

4) Aether 450X

$A_{(A)} = 0.79 m^2$

$Cd = 0.2$

$Fd = \frac{1}{2} \cancel{\rho \times 0.} \times 1.225 \times 0.2 \times 0.79 \times 123.45679$

$Fd = 11.948$

Q. 3rd For the ~~rest~~ vehicles calculate the peak power and torque of the motor required.

★ $F_{Total} = ma + \left(\frac{1}{2} \rho C_d \times A \times V^2\right) + \left(Mg \sin\theta\right) + \left(\mu mg \cos\theta\right)$

Normal Road gradient = 1 in 30 or 3.3%

→ Let us take ~~to~~ road gradient = $\theta = 0°$.

$mg = 9.81$

$\rho = 1.225$

ma = Mass of the vehicle in kg.

★ peak Power = $F_{total} \times V$

★ Peak Torque = $F_{total} \times$ Radius of the tire

→ Generally rolling resistance is between 0.01 - 0.02

Let us take $\mu = 0.02$

→

1) Nissan Leaf

$$F_{Total} = 1640 + \left(\frac{1.225 \times 0.28 \times 2.14 \times 100^2}{2}\right) + \left(9.81 \sin 0\right) + \left(0.02 \times 9.81 \times \cos 0\right)$$

$F_{Total} = 5310.296$

Peak Power = $F_{total} \times V$

$= 5310.296 \times 100$

Peak Power = 531.0296×10^3 W

Peak Torque = $F_T \times$ Radius of tyre

$= 5310.296 \times 0.4064$

Peak Torque = 2158.104 N.m

14/05/2022 23:05

2) Tesla Model S Plaid :-

$$F_{Total} = 2069 + \left(\frac{1.225 \times 0.24 \times 2.4 \times 100^2}{2}\right) + (9.81 \sin\theta) + (0.02 \times 1)$$

$$\boxed{F_T = 5597.02}$$

Peak Power $= F_T \times V$

$= 5597.02 \times 100$

$$\boxed{P_p = 559.702 \text{ KW}}$$

Peak Torque $= F_T \times$ Radius of Tyre

$= 5597.02 \times 0.357$

$$\boxed{T_p = 1.998 \times 10^3 \text{ Nm}}$$

3) Ather 450 X

$$F_T = 108 + \left(\frac{1.225 \times 0.2 \times 0.79 \times 40^2}{2}\right) + 0 + 0.02$$

$$\boxed{F_T = 1075.77}$$

peak Power $= 1075.77 \times 40$

$$\boxed{P_p = 43.0308 \text{ KW}}$$

Peak Torque $= 1075.77 \times 0.305$

$$\boxed{T_p = 328.1099 \text{ N.m}}$$

14/05/2022 23:05