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%Forces Acting on a Vehicle
% Rolling Resistance
% Aerodynamic Drag Resistance
% Grading Resistance

% We will be comparing 6 Cars to know the amount of Resistive forces
acting on them when  parameters same

%Tata Nano, Alto 800, Renault Duster, Mahindra SUV,
Ferrari, Bugati  %mass of vehicle in kgs
L = [755 850 1235 1825 1475 1990];
%weight of vehicle in N
T = L*9.81;
%Weight acting on each tire N
W = T/4;
%angle of inclination of road (can range between 0 to 18)
%velocity of vehicle (unit) = mps
V = 0:5:30;
%Aerodynamic drag coefficient
Cd = 0.25;
%Air density unit = kg/m^3
P = 1.225;
%Frontal area of the vehicle unit = m^2
A = [2.4 2.19 3.08 3.37 2.366 2.405];
%Constant reflecting loss and elastic characteristic of the tire material
C = 0.02;
%Outside Diameter
D = [0.49276 0.58928 0.69088 0.6731 0.68072 0.7204];
%Tire section Height
ht = [0.09398 0.12954 0.12954 0.1335 0.08636 0.0935];
%Tire Section Width
w = [0.135 0.185 0.215 0.205 0.245 1.265];
%Aerodynamic drag force acting on all cars
%V is velocity of vehicle (unit) = mps
Fa= Cd*0.5*P.*(V.^2).*A';
%%
% Rolling Resistance Force acting on all cars
% rolling resistance coefficient
%U=1/w;
%I=1/D
```

```
U= [1/0.135 1/0.185 1/0.215 1/0.205 1/0.245 1/1.265];
I= [1/0.49276 1/0.58928 1/0.69088 1/0.6731 1/0.68072 1/0.7204];
fr= C*(w.*I).*sqrt(ht.*U);
Fr= fr.*W;
%%
% Grading Resistance acting on all vehicles
at various angles E= 0:1:18;
Fg=zeros(length(E),length(T));
for n=1:length(E)
 i=0;
 j=j+1;
 Fg(n,:)= T.*sind(n);
end
Fg;
%%
 figure;
 plot(V,Fa)
 grid on;
 title('AeroDynamic Drag Force');
 legend('Tata Nano','Alto 800','Renault Duster','Mahindra
 SUV','Ferrari','Bugati'); xlabel('Velocity');
 ylabel('Aerodynamic Drag Force [N]');
%%
 figure;
 yline(Fr(1),'m')
 yline(Fr(2),'r')
 yline(Fr(3),'g')
 yline(Fr(4),'b')
 yline(Fr(5),'k')
 yline(Fr(6),'Color','#A2142F')
 grid on;
 title('Rolling Resistance Force vs Velocity');
 legend('Tata Nano','Alto 800','Renault Duster','Mahindra
 SUV','Ferrari','Bugati'); xlabel('Velocity ');
 ylabel('Rolling Resistance Force [N]');
%%
figure;
 plot(E,Fg)
 grid on;
 title('Gradient Force');
 legend('Tata Nano','Alto 800','Renault Duster','Mahindra
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 SUV','Ferrari','Bugati'); xlabel('Angle of Inclination');
 ylabel('Gradient Force [N]');
%%
% At constant Inclination
figure;
F=zeros(size(Fa));
for n=1:length(Fr)
 F(n,:)=Fa(n,:)+Fr(1,n);
end
F;
 plot(V,F)
 grid on;
 title('Total Force');
 legend('Tata Nano','Alto 800','Renault Duster','Mahindra
 SUV','Ferrari','Bugati'); xlabel('Velocity');
 ylabel('Total Force [N]');
%%
% Aerodynamic Drag Force, Rolling Resistance and Total Force Vs
Velocity per car % Tata Nano
figure;
plot(V,Fa(1,:))
grid on;
hold on
yline(Fr(1),'m')
hold on
plot(V,F(1,:))
hold off
title('Aerodynamic Drag Force, Rolling Resistance and Total Force Vs
Velocity on Tata  Nano car');
legend('Aerodynamic Drag Force','Rolling Resistance
Force','Total Force'); xlabel('Velocity');
ylabel('Total Force [N]');
```