Q 1. Calculate the force requirements for a vehicle considering the following values:

- Mass of Vehicle: 2000 Kg
- Weight Distribution: 60:40
- Frontal Area: 1 M²
- Road Surface: Asphalt Road
- Gradient Angle: 5 Degree, 10 Degree
- Acceleration Change: As per your considerations

Consider other requirements as per your imagination.

Ans:- To calculate the force requirements for a vehicle with the given parameters, we'll consider the following forces acting on the vehicle:

1. **Gravitational Force (Weight)**
2. **Normal Force**
3. **Frictional Force**
4. **Aerodynamic Drag Force**
5. **Force due to Road Gradient**
6. **Force for Acceleration**

Given Parameters:

- Mass of Vehicle (mmm): 2000 kg
- Weight Distribution: 60:40 (front)
- Frontal Area (A): 1 m²
- Road Surface: Asphalt Road
- Gradient Angle: 5° and 10°
- Coefficient of Rolling Resistance (Cr): 0.015 (typical for asphalt)
- Coefficient of Drag (Cd): 0.3 (assumed for a typical vehicle)
- Air Density (ρ): 1.225 kg/m³ (at sea level, standard conditions)
- Acceleration (a): 2 m/s² (considered for this scenario)

Calculations:

1. **Gravitational Force (Weight)**

   W=mg=2000kg×9.81m/s2=**19620N**

2. **Normal Force**

   N=Wcos(θ)

   For gradient angles:

   5° : N5°=19620 N×cos(5°)=19620×0.9962=**19546.84 N**

   10°: N10°= 19620N × cos(10°)= 19620×0.9848= **19309.58N**

3. **Frictional Force (Rolling Resistance)** $Fr=Cr\times N$

   For gradient angles:

   - 5°: $Fr5°=0.015\times19546.84=$**293.20 N**
   - 10°: $Fr10°=0.015\times19309.58=$**289.64 N**
4. **Aerodynamic Drag Force**

   $Fd=1/2\ \rho ACdv^2$

   Assuming a velocity (v) of 20 m/s (about 72 km/h):

   $Fd=1/2\times1.225\times1\times0.3\times(20)^2$

   $Fd=1/2\times1.225\times1\times0.3\times400$

   Fd=**73.5N**

5. **Force due to Road Gradient** $Fg=Wsin(\theta)$

   For gradient angles:

   - 5°: $Fg5°=19620\times sin(5°)=19620\times0.0872=$**1710.86N**
   - 10°: $Fg10°=19620\times sin(10°)=19620\times0.1736=$**3402.07N**
6. **Force for Acceleration**

   $Fa=ma=2000\times2=4000$

   Fa=ma=2000×2=**4000N**

Total Force Required

Summing up all the forces to get the total force required:

- **For 5° Gradient:**$Ftotal5°=Fr+Fd+Fg+Fa$
  $Ftotal5°=293.20+73.5+1710.86+4000=$**6077.56N**
- **For 10° Gradient:** $Ftotal10°=Fr+Fd+Fg+Fa$
  $Ftotal10°=289.64+73.5+3402.07+4000=$**7765.21 N**

Conclusion

- For a 5° gradient, the total force required is approximately **6077.56 N**.
- For a 10° gradient, the total force required is approximately **7765.21 N**.

These calculations ensure that the vehicle can handle the forces required to move up gradients of 5° and 10° while maintaining an acceleration of 2 m/s².