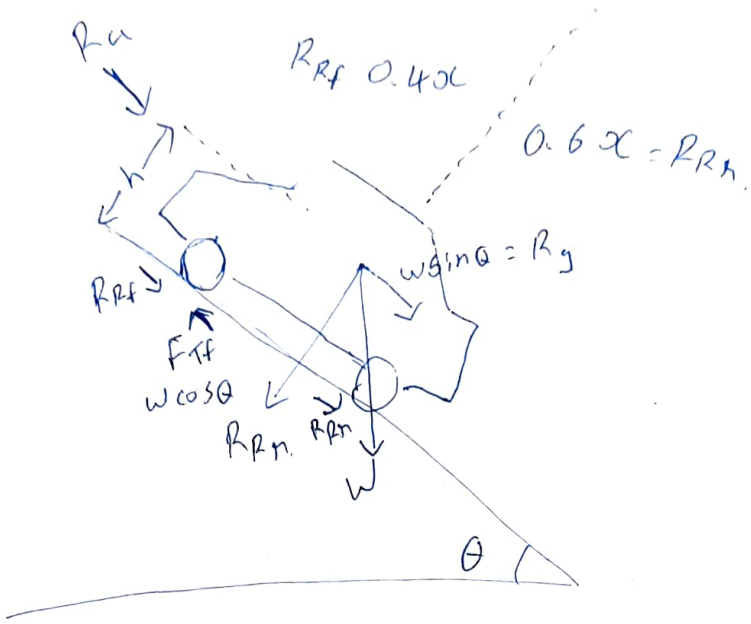
Q: 1



1) Aerodynamic Resistance (R_a)

$R_a = \frac{1}{2} \times \rho \times C_d \times A \times V^2$ here ρ = Air density $\Rightarrow 1.225\ kg/m^3$ @ 25°C

V = Velocity of vehicle

A = Projected Area

ρ =

C_d = coefficient of drag

2) Gravitational Resistance / Gradient Resistance (R_g)

here, $R_g = W \sin\theta$ (θ = gradient angle)

for $\theta = 0° \Rightarrow R_g = 0$ (min)

$\theta = 90° \Rightarrow R_g = W$ (max)

3) Roling Resistance (R_R) :- It acting at contant Patch.

$R_R = R_{Rf} + R_{Rn}$

here $R_{Rn} = 0.6 R_R$ (Because vehicle stand on inclined. so in Real wheel more resistance faced)

& $R_{fn} = 0.4 R_f$

4) Traction force (F_T) :->

$F_T = F_{TF} + F_{TR}$

for 4-wheel drive if $F_{TR} = 0.6 F_T$ & $F_{TF} = 0.4 F_T$

for front wheel drive -> $F_T = F_{TF}$ &

for rear wheel drive -> $F_T = F_{TR}$.

Now. Aerodynamic, gravitational & Roling Resistance is acting to opposite on ~~the~~ Vehicle & Traction force is acting to helping the vehicle.

so we can write -

$$F_T - (R_a + R_R + R_g) = m \times a$$

Here F_T = Traction force } Addition forces

R_a = Aerodynamic Resistance

R_g = gravitation Resistance } Resistance forces

R_R = Roling Resistance

m = mass & a = acclaration

so, $\boxed{F_T = m \times a + (R_a + R_R + R_g)}$

Here we take $R_a = \frac{1}{2} \times \rho \times C_d \times A \times V^2$

$R_R = W \cos\theta$. but vehicle is static so we need to add static friction μ_R

$= \mu_R \cdot W \cos\theta$. OR $\mu_R \cdot mg \cos\theta$ ($\because W = mg$)

$R_g = W \cdot \sin\theta$. OR $mg \sin\theta$ ($\because W = mg$)

so, $F_T = m \times a + \left[\frac{1}{2} \times \rho \times C_d \times A \times V^2\right] + \left[\mu_R \cdot W \cos\theta\right] + \left[W \sin\theta\right]$

$\therefore \boxed{F_T = m \times a + \left[\frac{1}{2} \times \rho \times C_d \times A \times V^2\right] + \left[\mu_R \cdot mg \cos\theta\right] + \left[mg \sin\theta\right]}$

Q: 2 $m = 1765\ kg$; $L = 2.84\ m$; $a_1 = 1.22\ m$; $a_2 = 1.62\ m$

Front Axle load :-

$$W_{fs} = m \cdot g \times \frac{a_1}{L} = 1765 \times 9.81 \times \frac{1.22}{2.84}$$

$W_f = 7437.9$ ~~kg~~ N OR 7.43 kN

Real Axle load :-

$$W_{Rs} = m \cdot g \times \frac{a_2}{L} = 1765 \times 9.81 \times \frac{1.62}{2.84}$$

$W_R = 9876.6$ N OR 9.87 kN

Q: 3 Completed in Word file (Find the attachment)