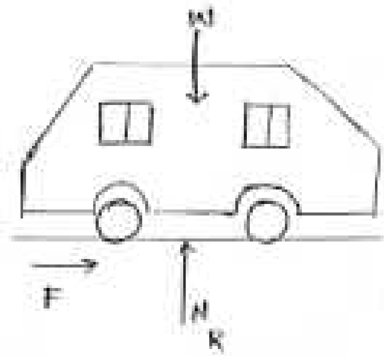
A car of mass 150 kg is travelling on a horizontal track of mass at 36 km/hour. Determine the time needed to stop the car. The coefficient of friction between the tyres and the road is 0.45



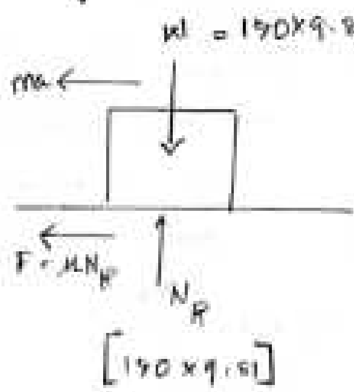
Apply the following method

i) Impulse - momentum equation $[mu - Ft = mv]$

ii) D' Alembert's principle $[F = ma]$

iii) Work - Energy method $\left[F_S = \frac{W}{2g}(v^2 - u^2)\right]$

Free body diagram



Given mass

$m = 150\ kg$

Weight $W = 150 \times 9.81 = 1471.5\ N$

$u = 36\ km/hr = 36 \times \frac{1000}{60 \times 60}$

$= 10\ m/s$

$F = \mu \times N_R \quad [N_R = W]$

$= 0.45 \times 150 \times 9.81$

$= 662.17\ N$

$mu - Ft = mv$

$150 \times 10 - 662.17 \times t = 150 \times v$

[$v = 0$ ⇒ The car is brought to rest]

$150 \times 10 - 662.17 \times t = 0$

$1500 = 662.17t$

$\frac{1500}{662.17} = t$

$t = 2.265\ sec$

D' Alembert's principle [Impulse force act on the opposite direction to stop the car → hence indicating the force is -ve]

$-F - ma = 0$

$-(\mu \times N_R) - ma = 0$

$-(0.45 \times 150 \times 9.81) - 150 \times a = 0$

$-662.17 - 150a = 0$

$$-662.17 = 150a$$

$$-\frac{662.17}{150} = a$$

$$a = -4.41 \ m/s^2$$

find 't'

$$V = u + at$$

$$0 = 10 + (-4.41)t$$

$$-10 = -4.41t$$

$$\frac{10}{4.41} = t$$

$$t = 2.26 \ sec$$

iii) Work Energy method:-

$$Fs = \frac{W}{2g}(v^2 - u^2)$$

$$F = \mu \times N_R = (0.45 \times 150 \times 9.81)$$

$$0.45 \times 150 \times 9.81 \times s = \frac{150 \times 9.81}{2 \times 9.81}(0 - 10^2)$$

$$662.17 \times s = \frac{150 \times 9.81}{2 \times 9.81} \times 100$$

$$s = \frac{150 \times 9.81 \times 100}{2 \times 9.81 \times 662.17}$$

$$s = 11.32 \ m$$

$$v^2 = u^2 + 2as$$

$$0 = 10^2 + 2 \times a \times 11.32$$

$$a = 4.41 \, m/s^2$$

To find 't'

$$v = u + at$$

$$0 = 10 + (4.41) t$$

$$t = 2.26 \text{ sec}$$