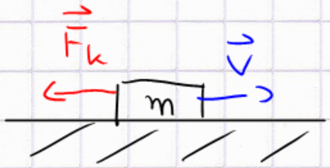
Friction

→ opposes motion

(i) Kinetic friction ($\vec{F}_k$)



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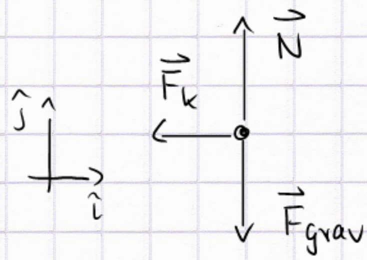


$$N = mg$$

$$|\vec{F}_k| \equiv F_k = \mu_k N \qquad \text{(empirical law)}$$

μ_k: coefficient of kinetic friction

analyze motion of sliding mass:

$$m a_x = -F_k = -\mu_k N = -\mu_k mg$$

$$\Leftrightarrow \quad a_x = -\mu_k g \qquad \text{(constant and independent of m)}$$

$$\Rightarrow v_x = v_0 + a_x t = v_0 - \mu_k g t$$

coming to a stop: $\quad v_x \overset{!}{=} 0 = v_0 - \mu_k g t_{stop}$

$$\Leftrightarrow \quad t_{stop} = \frac{v_0}{\mu_k g}$$

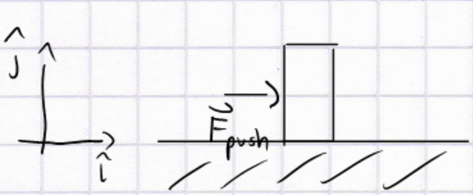
travelled distance: $\quad x(t) = x_0 + v_0 t - \frac{\mu_k g}{2} t^2$

$$\Delta x = x(t_{stop}) - x_0 = v_0 t_{stop} - \frac{\mu_k g}{2} t_{stop}^2$$

$$= \frac{v_0^2}{2\mu_k g}$$

(ii) Static friction ($\vec{F}_s$)

example: pushing a fridge



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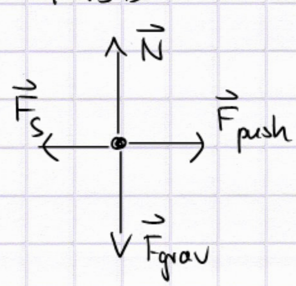

$$\left.\begin{array}{ll} \hat{\imath}: & -F_s + F_{push} = 0 \\ \hat{\jmath}: & -mg + N = 0 \end{array}\right\} \text{static equilibrium}$$

If one increases F_{push}, F_s increases accordingly – as long as:

$$F_s \leqslant \mu_s N \qquad \text{(empirical law)}$$

μ_s: coefficient of static friction

empirically one finds $\mu_k \leqslant \mu_s < 1$