PHYS2350: Forces

Dr. Wolf

Fall 2024

Quick Review:

What is a force?

- A push or a pull (it is a *vector*)
- An *interaction* between *two things*

Force notation:

$$\vec{F}^{(\text{type})}_{A,B}$$

Only these forces make up the *net force* used in Newton's 2nd Law

Common "forces" that will never appear on a free-body diagram

- Centripetal Force: $ma_\perp$
- Tangential Force: $ma_{||}$
- Centrifugal Force
- Tidal Force
- Coriolis Force

All of these are either ways of characterizing the net force or forces that are a result of being in a non-inertial/accelerating reference frame.

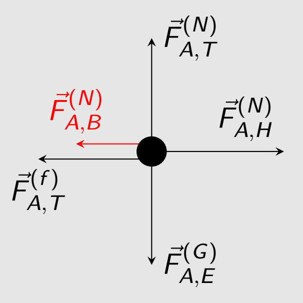
Part I. Constant speed

Newton's 2nd law

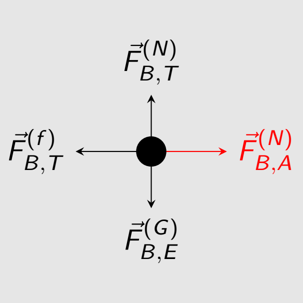
$$\vec{F}_{\text{net,system}} = m_{\text{system}}\vec{a}_{\text{system}}$$

If we have constant speed, and 1D motion, what is the acceleration?

System A

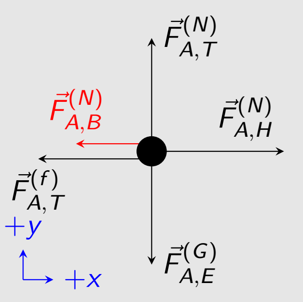


System B

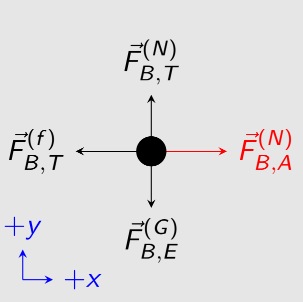


Part I. Constant speed

System A



System B



Break into components . . . . Considering magnitudes only

$$F^{(N)}_{A,H} - F^{(N)}_{A,B} - F^{(f)}_{A,T} = 0$$
$$F^{(N)}_{A,T} - F^{(G)}_{A,E} = 0$$

$$F^{(N)}_{B,A} - F^{(f)}_{B,T} = 0$$
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Part I. Vertical forces, calculating weight

For the vertical forces, we have:

$$F_{A,T}^{(N)} = F_{A,E}^{(G)} \qquad F_{B,T}^{(N)} = F_{B,E}^{(G)}$$

Calculating weight on Earth

Suppose you have an object with a mass $m = 7.0\,\mathrm{kg}$. We can calculate the weight (on Earth) by multiplying the mass of the object by the acceleration due to gravity $g = 9.81\,\mathrm{m/s^2} \approx 10\,\mathrm{m/s^2}$. So the weight is:

$$F_{m,E}^{(G)} = mg = 7.0\,\mathrm{kg} \times 10\,\mathrm{m/s^2} = 70\,\mathrm{N}$$

You should be able to numerically determine all of the vertical force magnitudes given the information in part I.F.

Part I. Horizontal forces, calculating friction

For the vertical forces, we have:

$$F^{(N)}_{A,H} = F^{(N)}_{A,B} + F^{(f)}_{A,T} \qquad F^{(N)}_{B,A} = F^{(f)}_{B,T}$$

Calculating kinetic friction

Remember, that friction is a contact force, and (when we deem it important) it will always correspond to a normal force between the same two interacting objects. It will depend on the coefficient of kinetic friction μ_k (just a number, no units) and that normal force. So if a box is sliding along a table that has a normal force $F^{(N)}_{B,T} = 20\,\mathrm{N}$ and the coefficient of static friction between the box and table is $\mu_k = 0.2$, the frictional force has a magnitude:

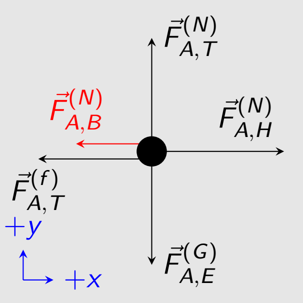
$$F^{(f)}_{B,T} = \mu_k F^{(N)}_{B,T} = 0.2 \times 20\,\mathrm{N} = 4\,\mathrm{N}$$

You should be able to numerically determine all of the horizontal force magnitudes given the information in part I.F.

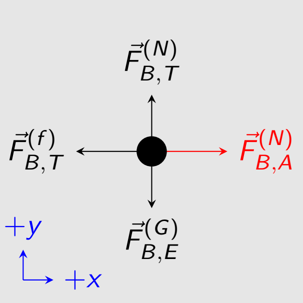
Part II. Varying speed

Same as Part I, except μ_k decreases. What forces change, and how?

System A



System B



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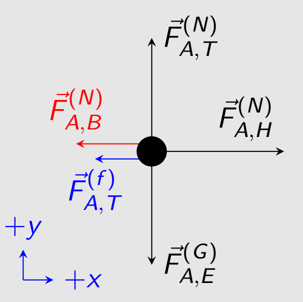
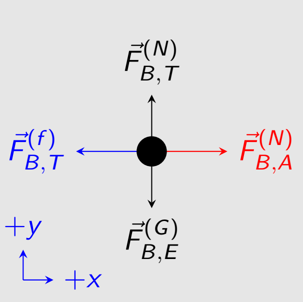


System B

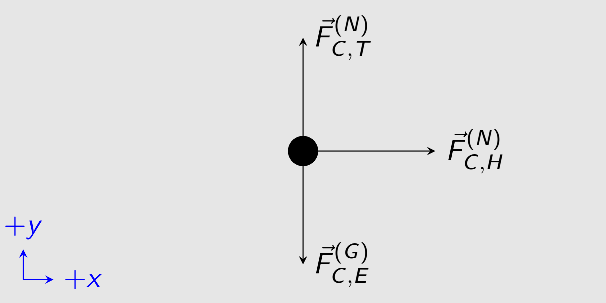


Only the frictional forces should decrease

Part III. Dealing with systems

Same as Part II, acceleration is constant and *to the right*

System C



Corresponding forces:

$$\vec{F}^{(N)}_{C,T} = \vec{F}^{(N)}_{A,T} + \vec{F}^{(N)}_{B,T}$$
$$\vec{F}^{(f)}_{C,T} = \vec{F}^{(f)}_{A,T} + \vec{F}^{(f)}_{B,T}$$
$$\vec{F}^{(G)}_{C,E} = \vec{F}^{(G)}_{A,E} + \vec{F}^{(G)}_{B,E}$$

Missing Forces:

- $\vec{F}^{(N)}_{A,B}$
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- These are *internal* to the system

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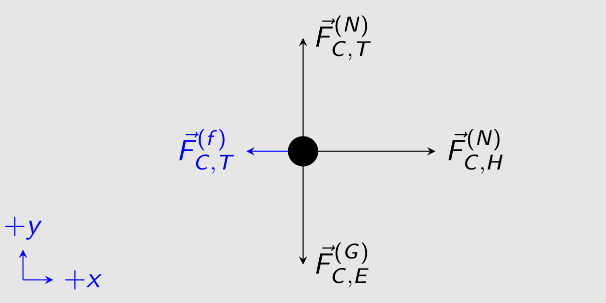

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