

February 25, Week 7

Today: Chapter 5, Applying Newton's Laws

Homework Assignment #5 - Due March 1.

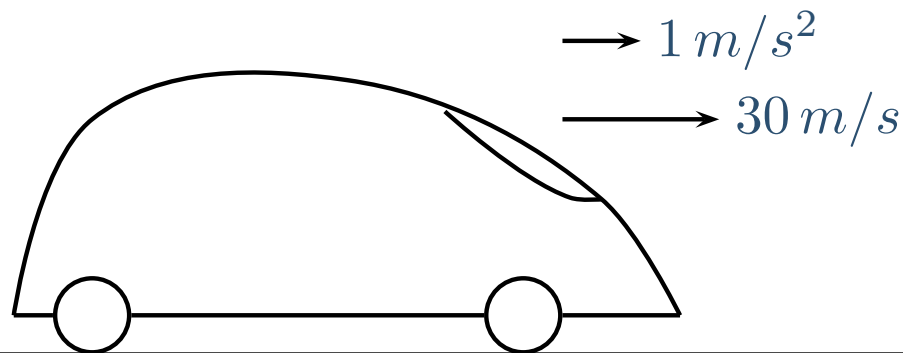
Mastering Physics: 10 problems from chapters 4 and 5.

Written Questions: 5.74

Thursday Office Hours: 12:00-2:30, 4:00-5:00(???)

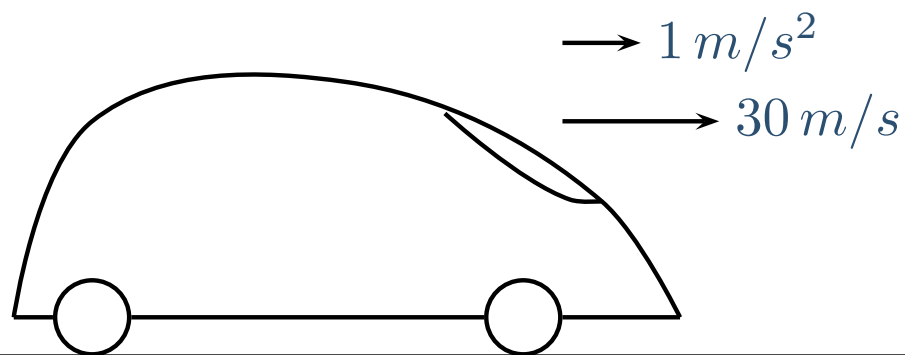
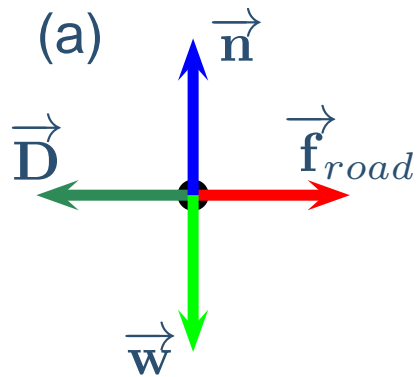
Dynamics Exercise II

A minivan is traveling with speed of 30 m/s and accelerating at 1 m/s^2 . Which of the following is the correct free-body diagram for the minivan?



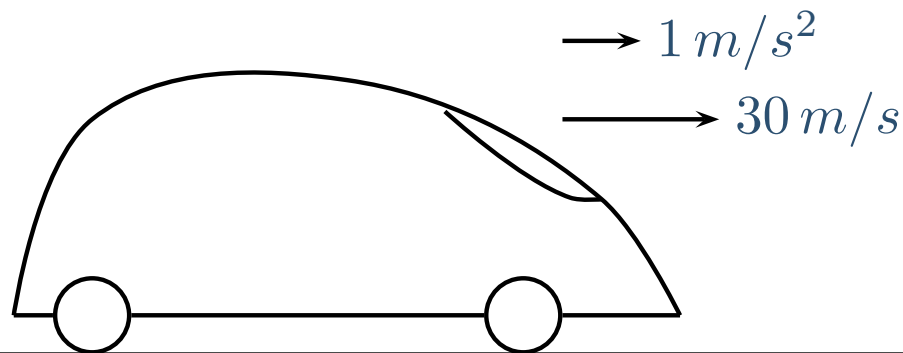
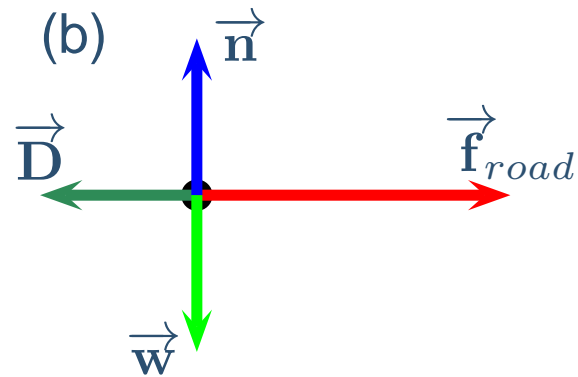
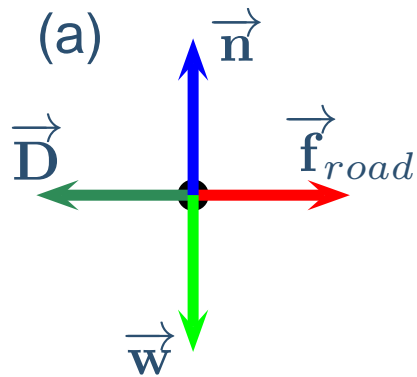
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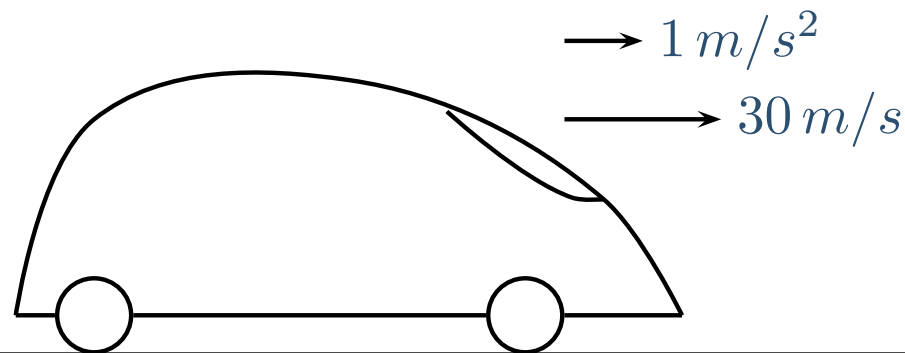
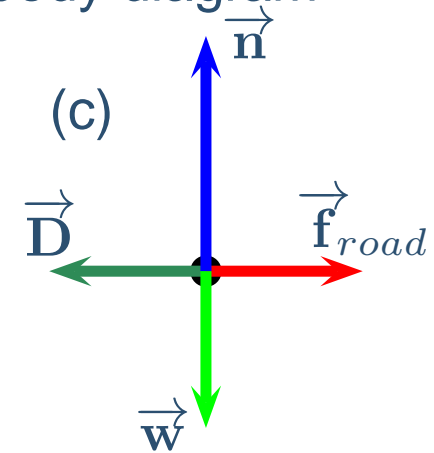
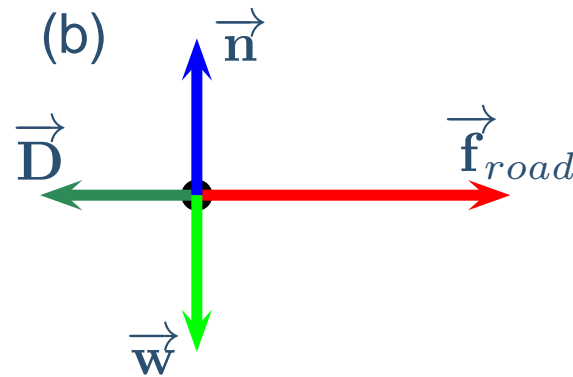
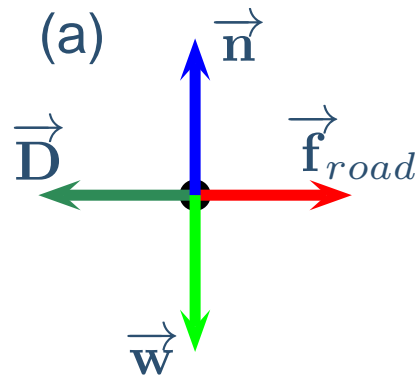
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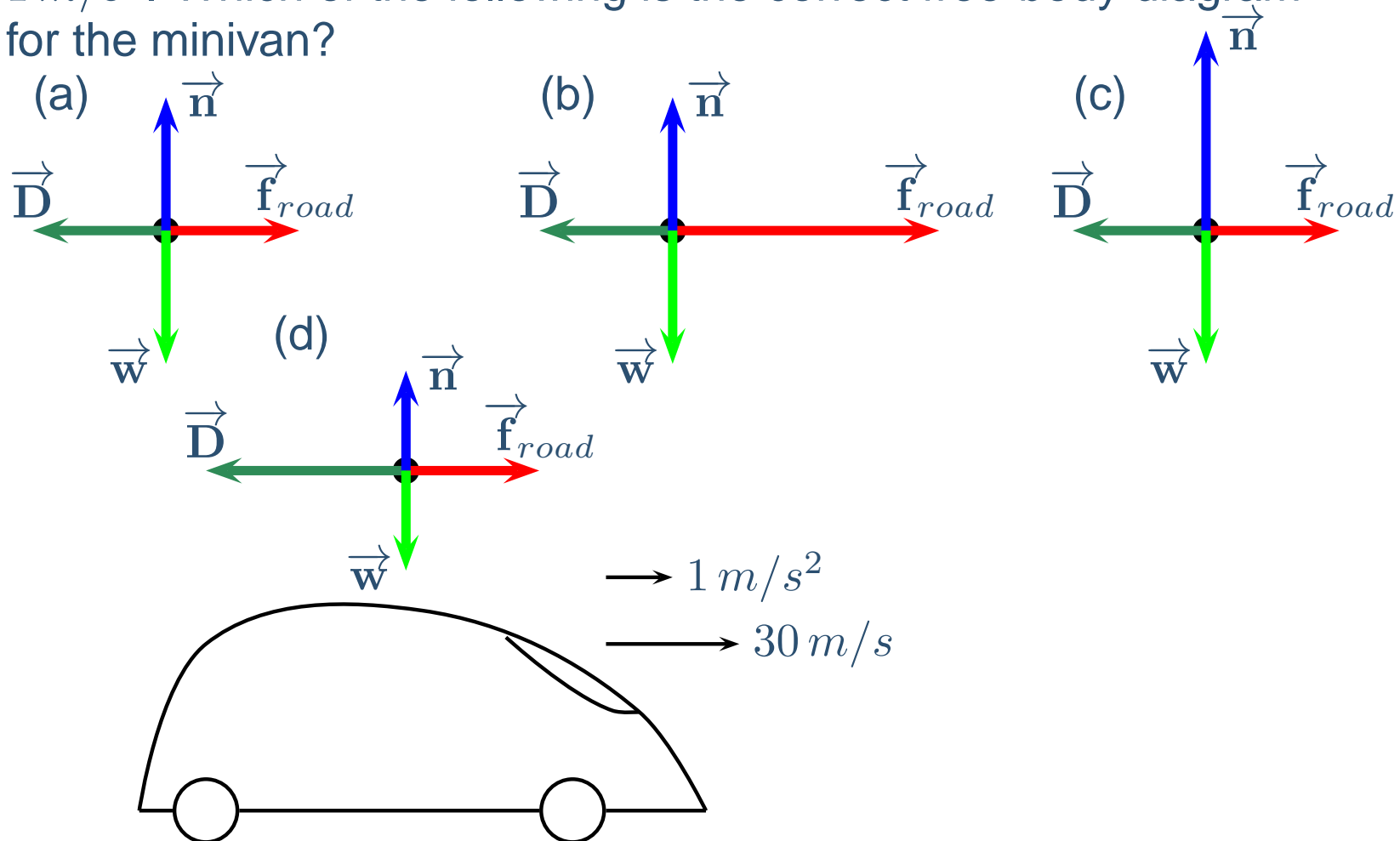
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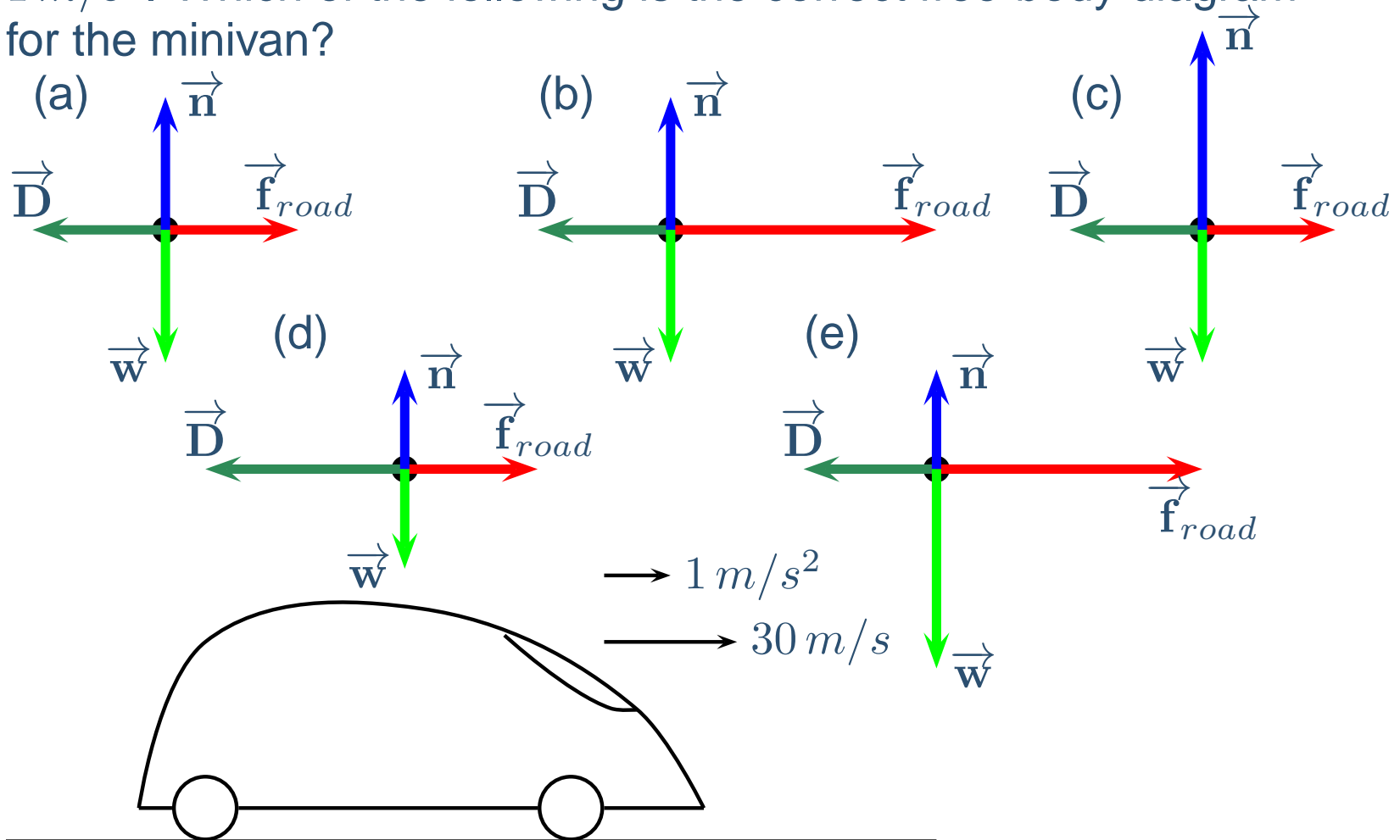
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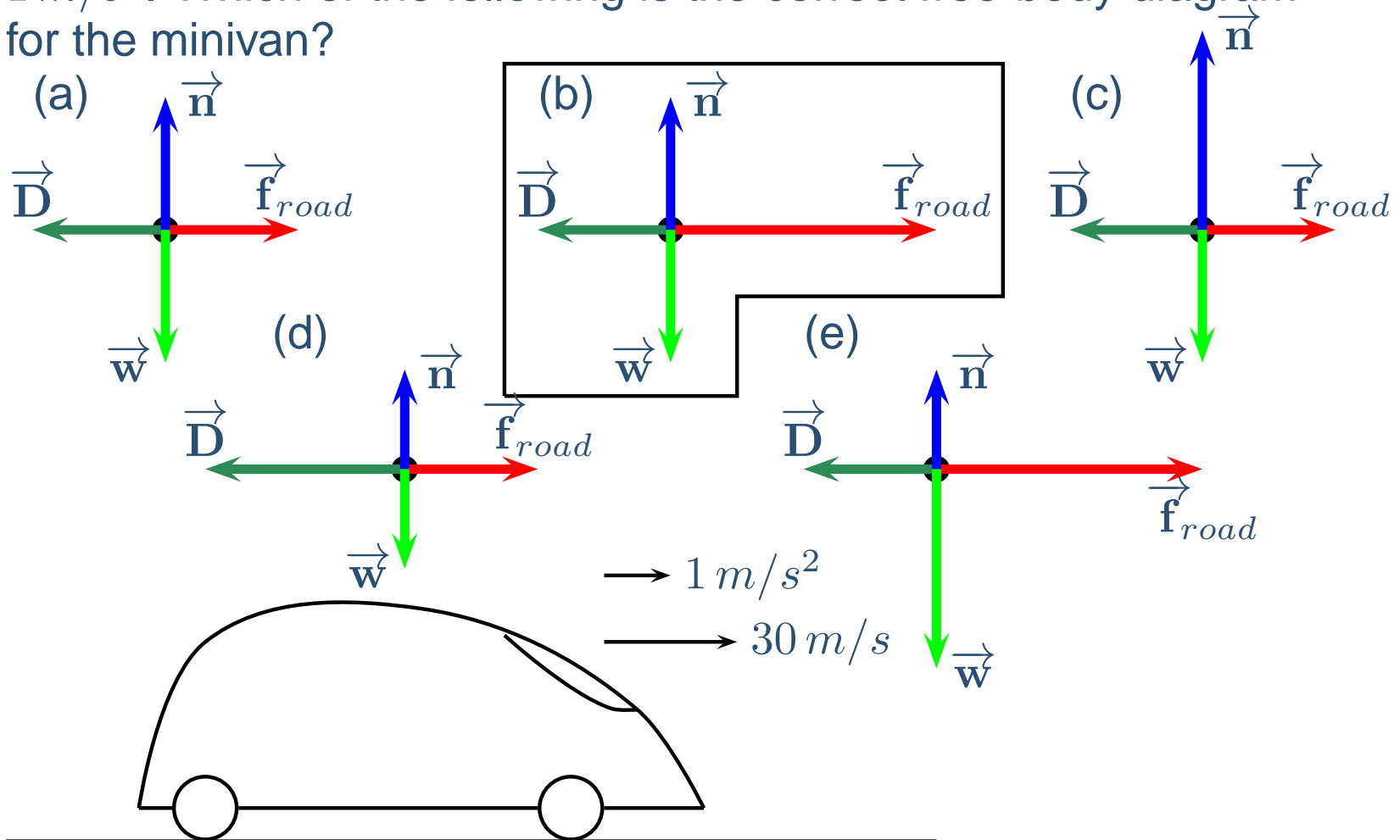
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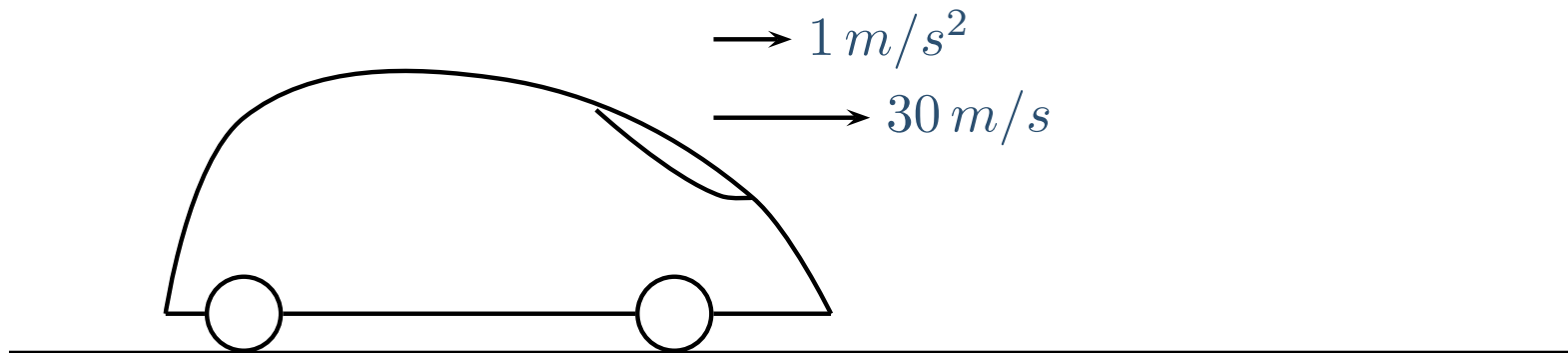
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Dynamics Exercise III

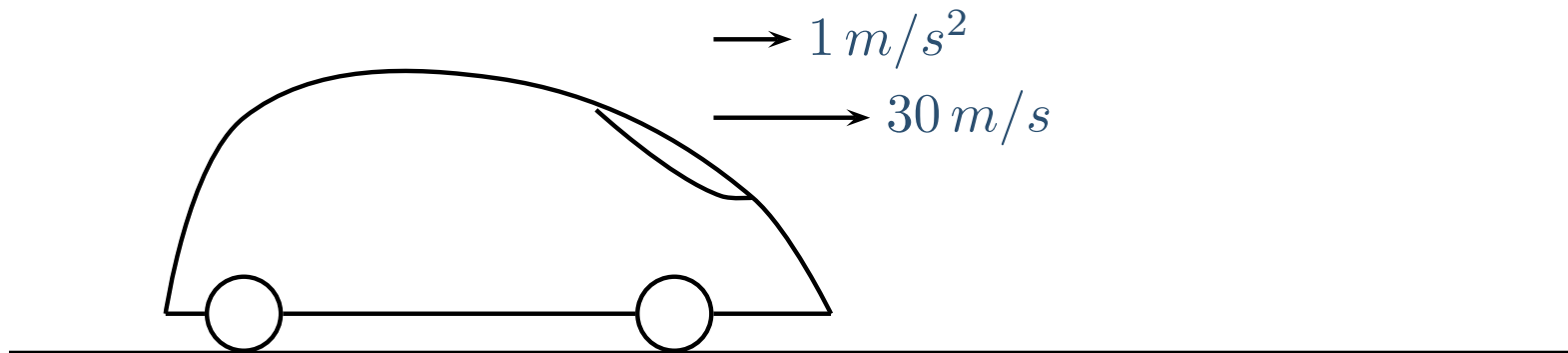
A 700 kg minivan is traveling at 30 m/s and accelerating at 1 m/s^2 . If there is a 300 N drag acting against the car, what force is the road exerting on the minivan?



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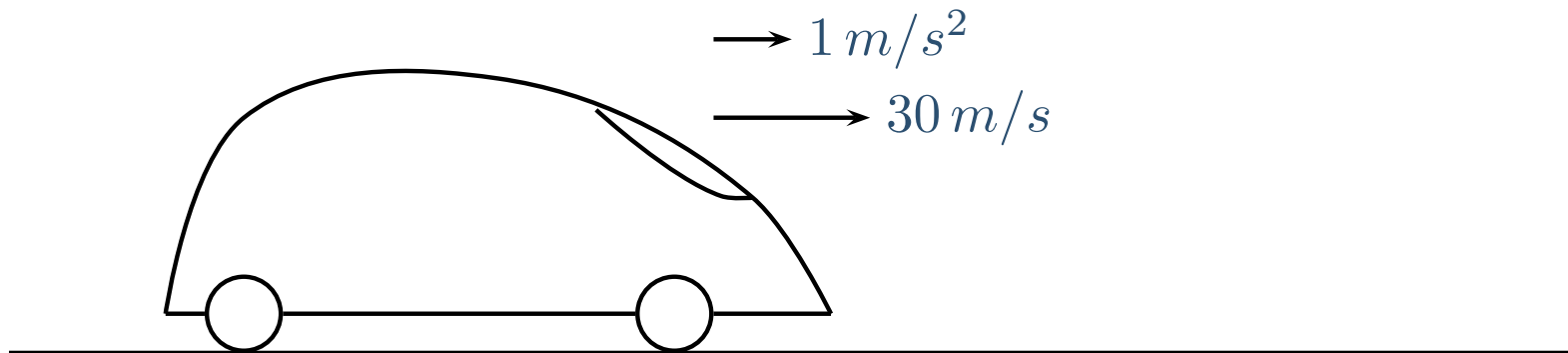
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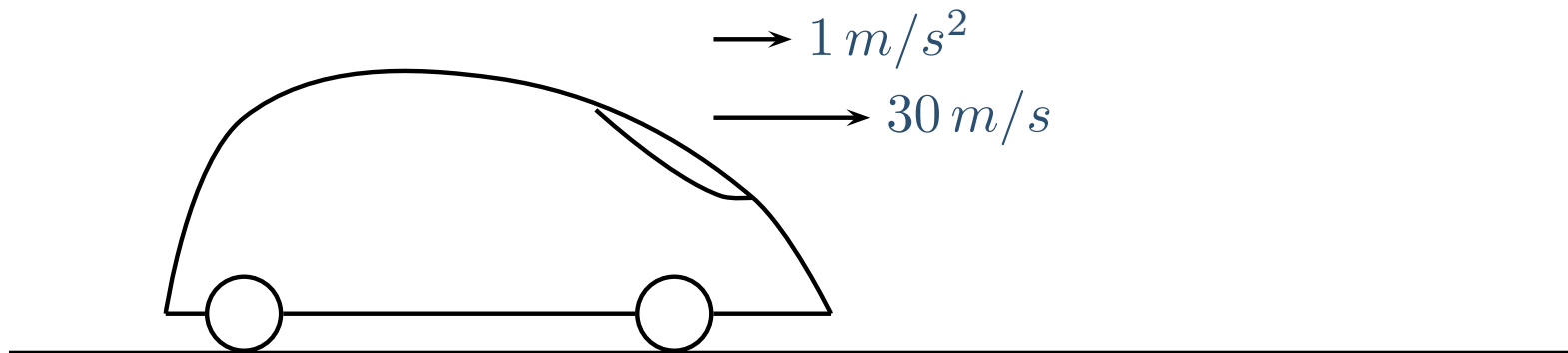
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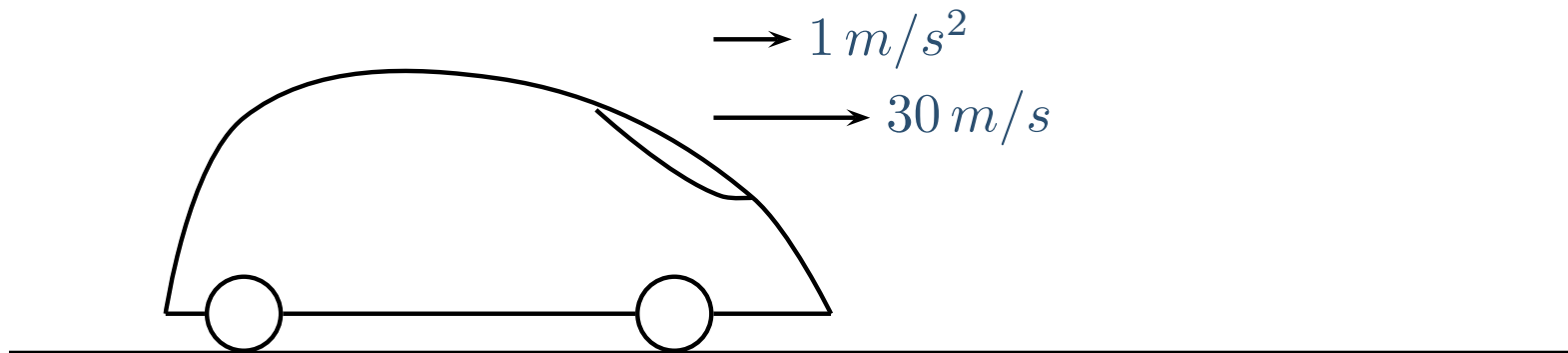
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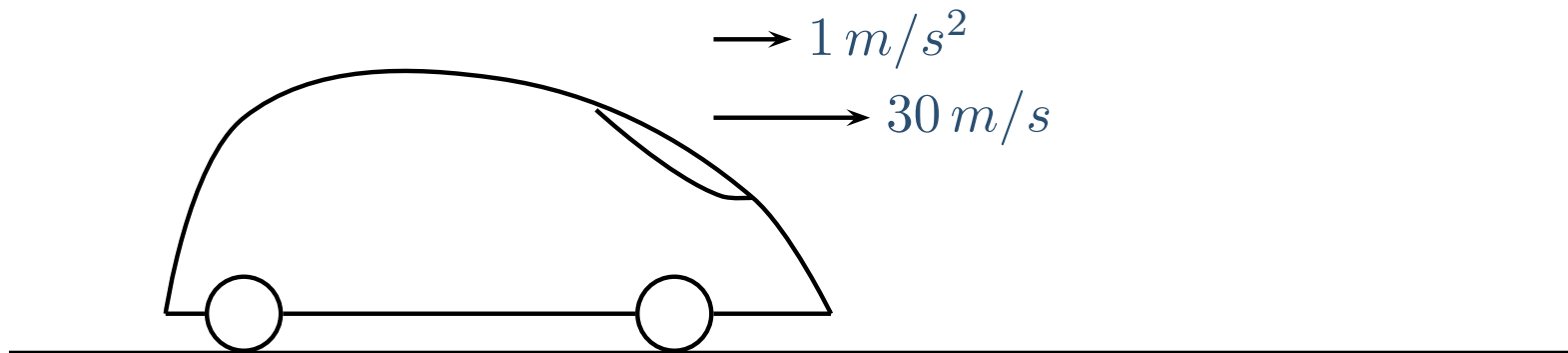
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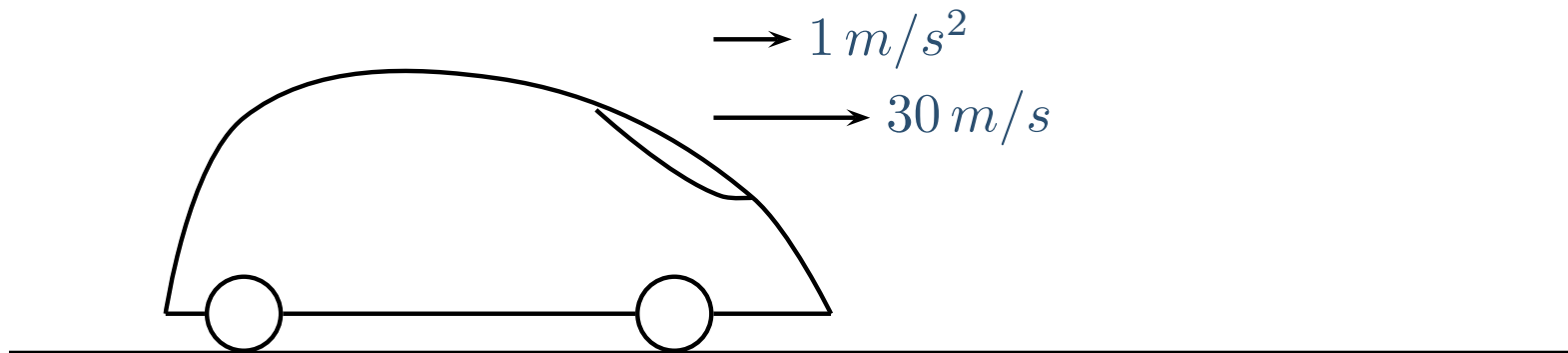
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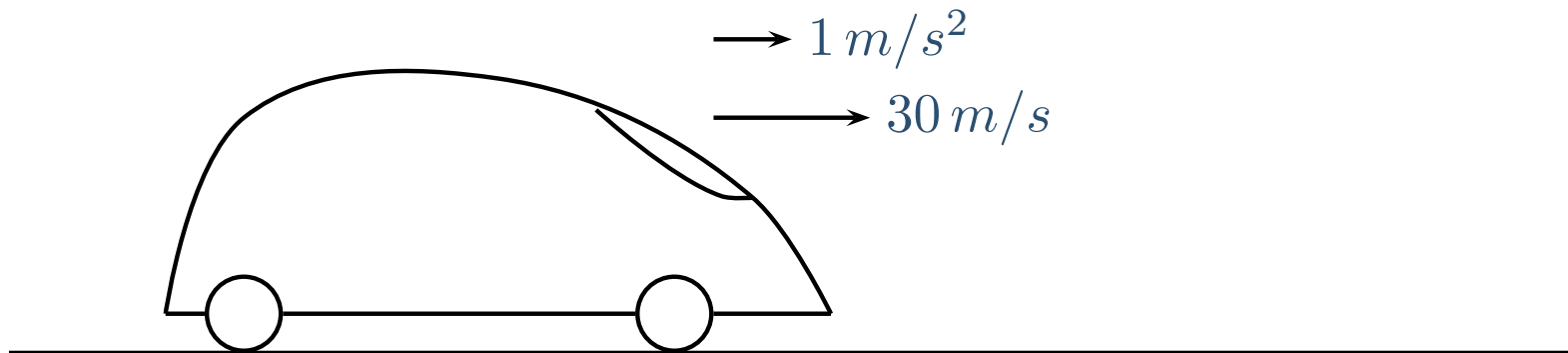
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$$\sum F_x = Ma_x \Rightarrow$$

$$f_{road} - D = Ma_x$$

$$f_{road} - 300 \text{ N} = (700 \text{ kg})(1 \text{ m/s}^2)$$

(c) 1000 N



Apparent Weight

Scales do not measure weight, they measure normal force.

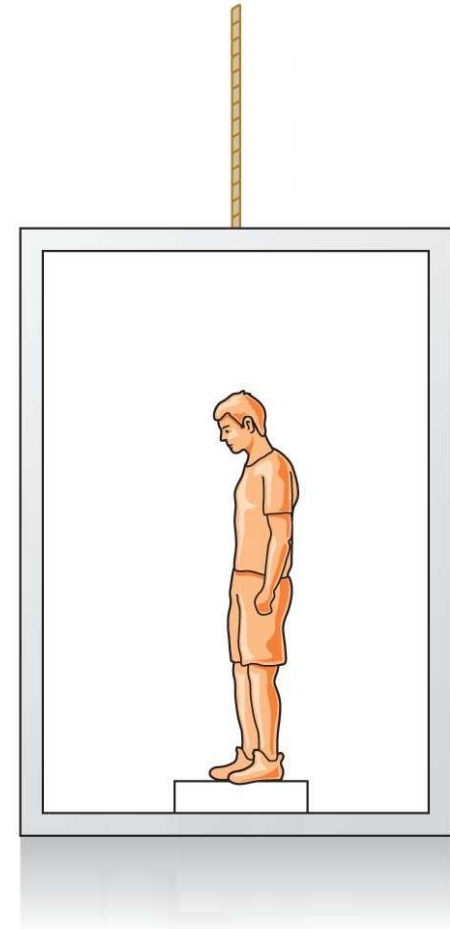
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Example: An 80 kg man steps on a bathroom scale. In his bathroom, what does the scale read?

Apparent Weight Exercise

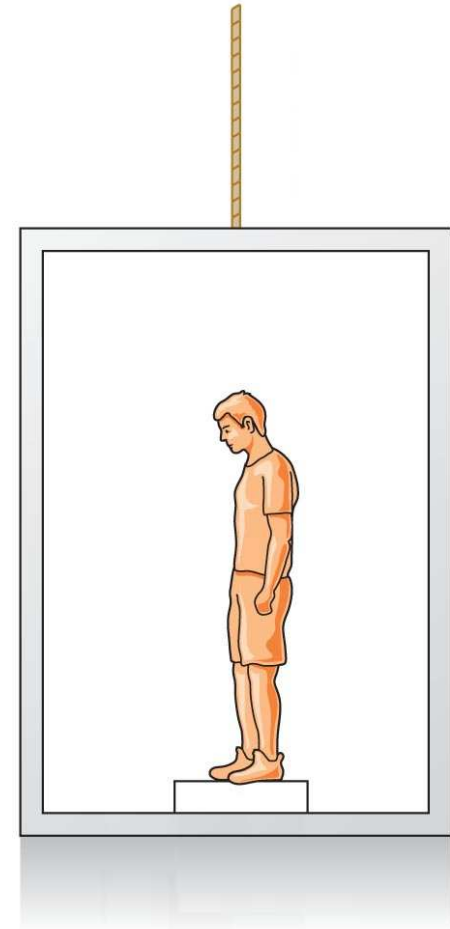
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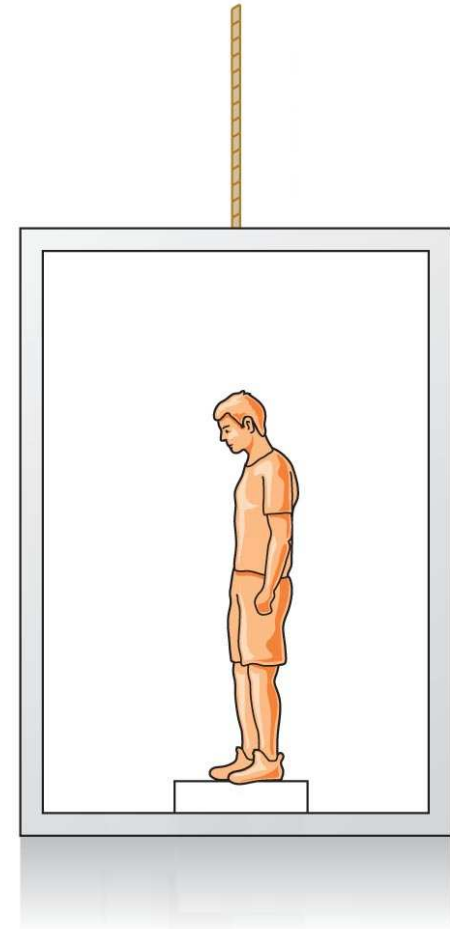


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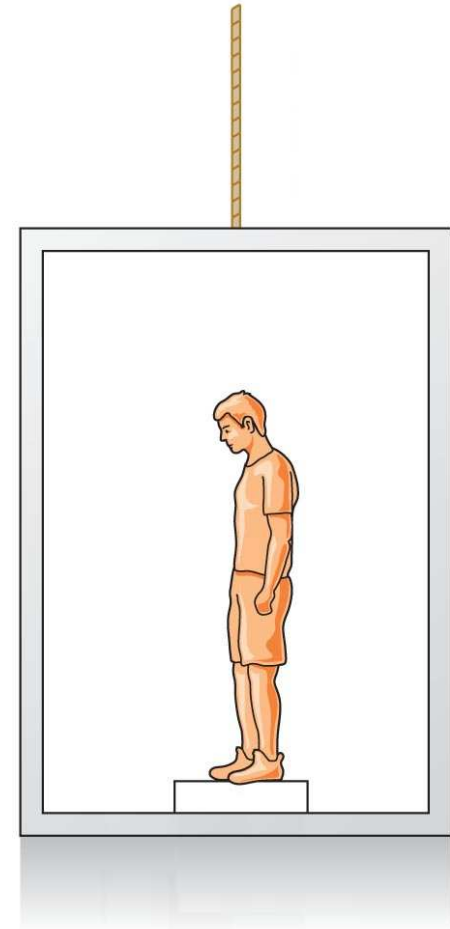
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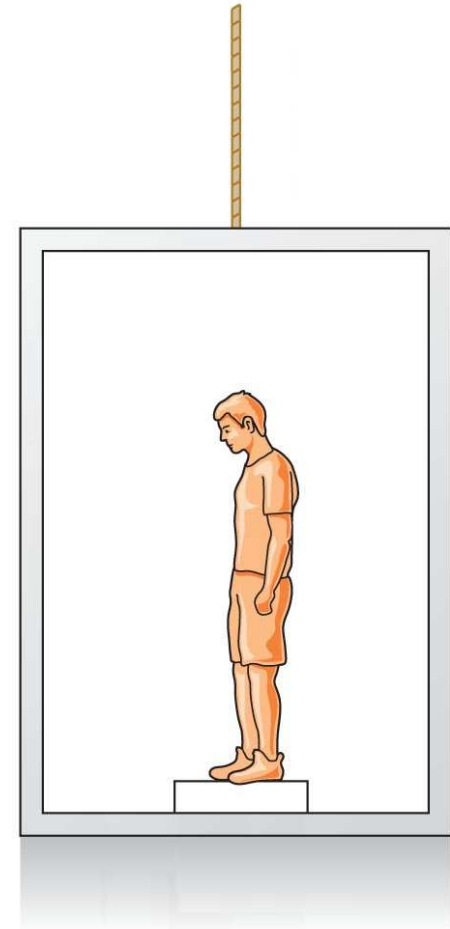
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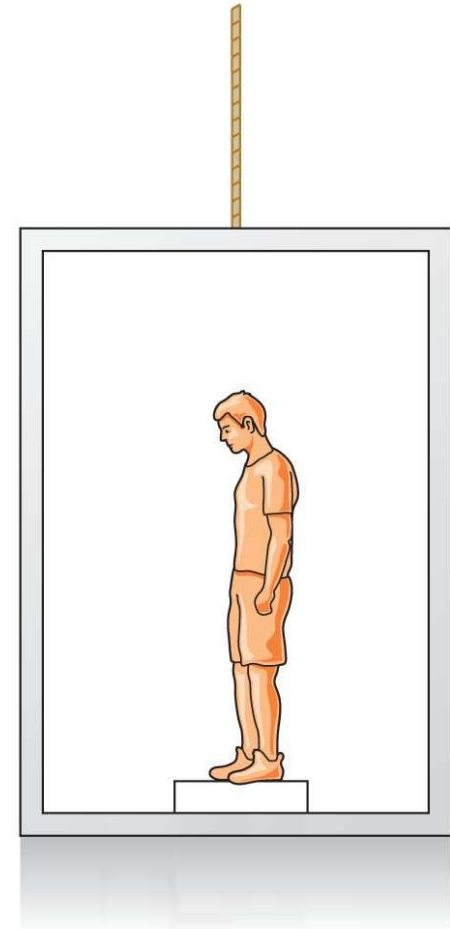
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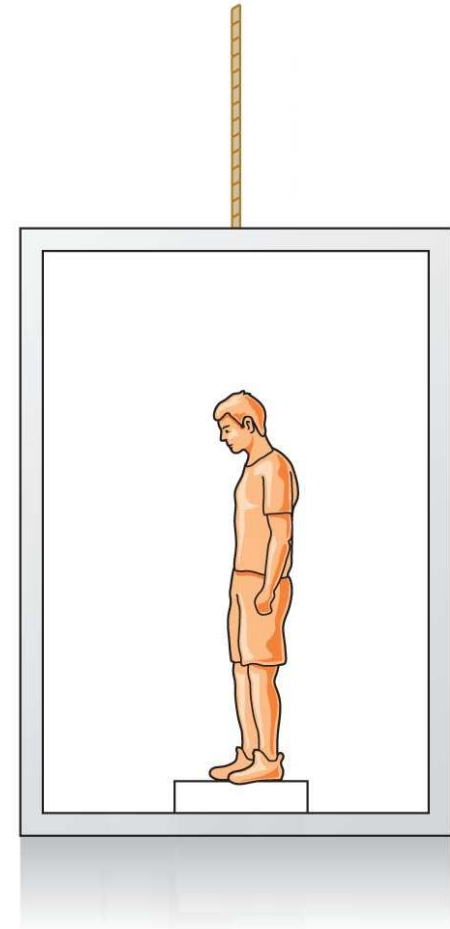
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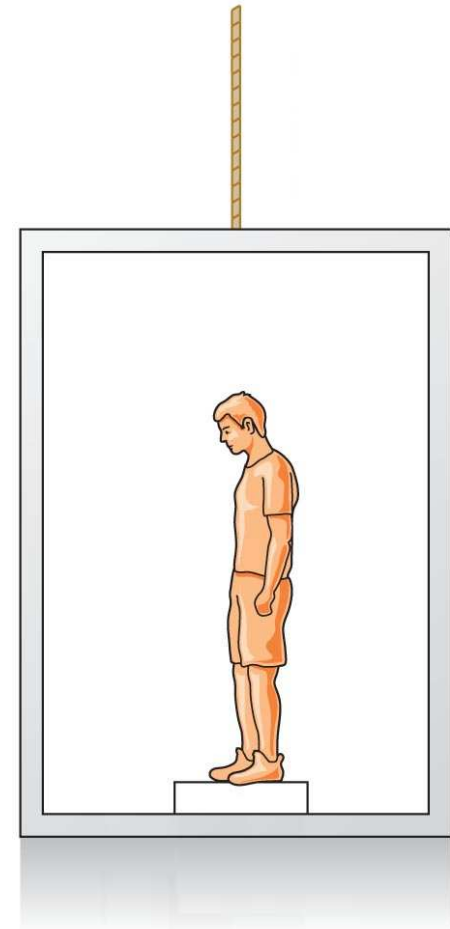
$$\sum F_y = Ma_y \Rightarrow$$

$$n - w = ma_y$$

$$n - mg = ma_y \Rightarrow n = m(g + a_y)$$

$$(d) (80\text{ kg})(9.8\text{ m/s}^2 + 2.5\text{ m/s}^2) = 984\text{ N}$$

Scale's reading = n = apparent weight



Friction

We use a simplified model of friction that works fairly well for flat, solid objects in contact with each other. In this model, the amount of friction depends on the type of materials and whether they objects are in motion (relative to each other).

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Static Friction - \vec{f}_s , Force on a stationary object that keeps it at rest.

Incline Example

Example: A mass is placed on an incline with angle α . It does not move. What is the magnitude of the static frictional force (and normal force) acting on it?

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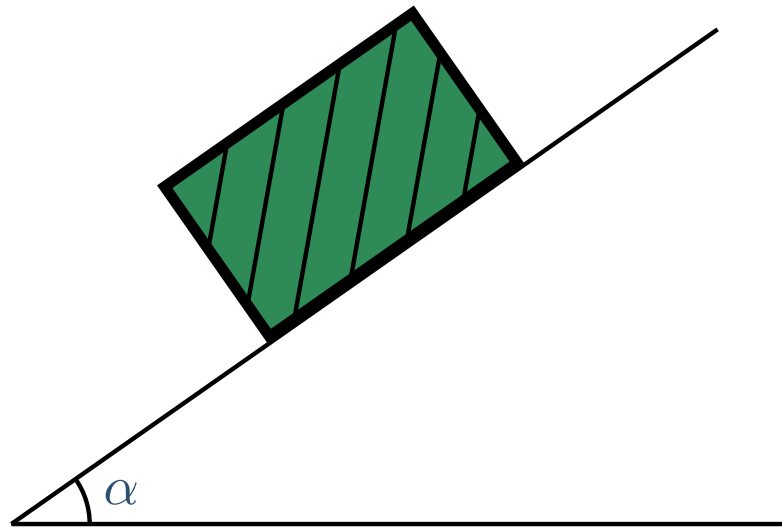
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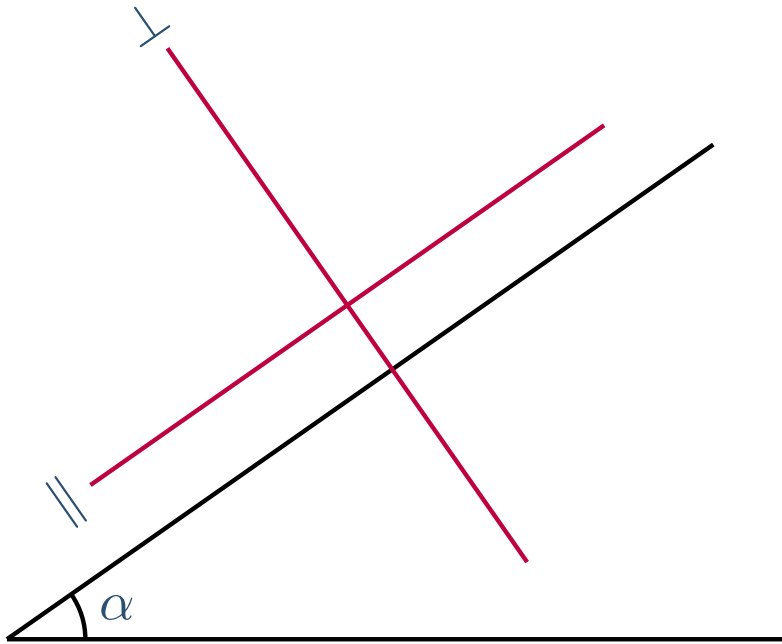


Parallel and Perpendicular Components

For incline problems, it is usually more convenient to use coordinates parallel (\parallel) and perpendicular (\perp) to the incline.

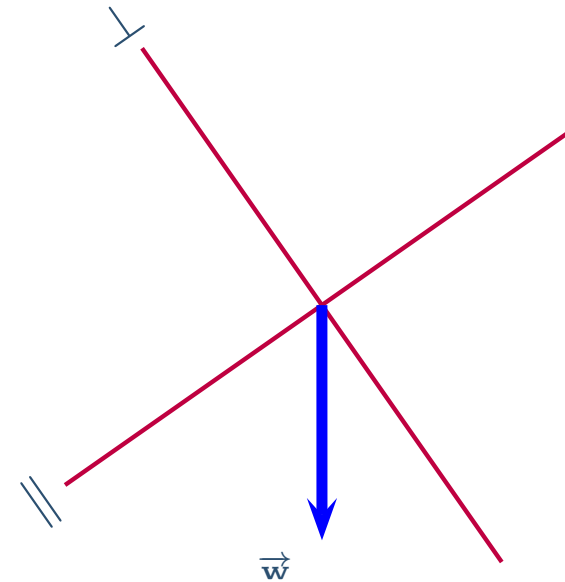
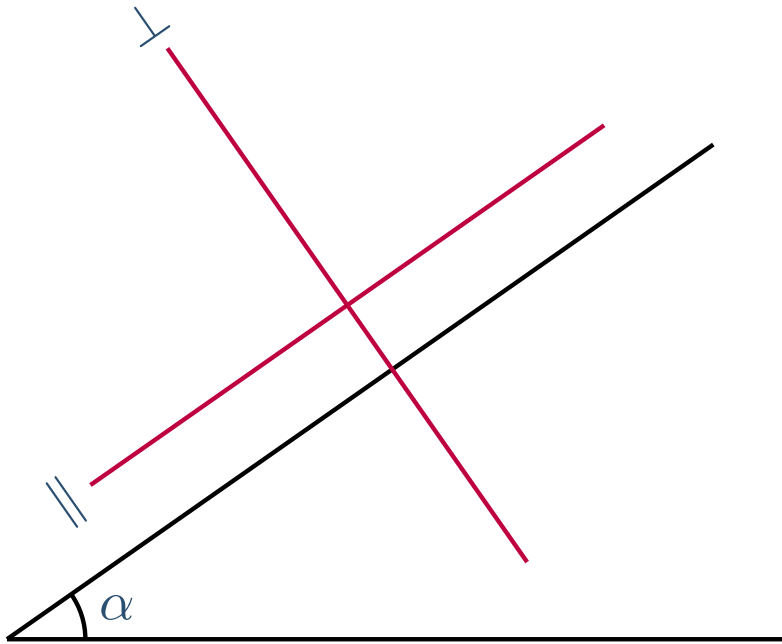
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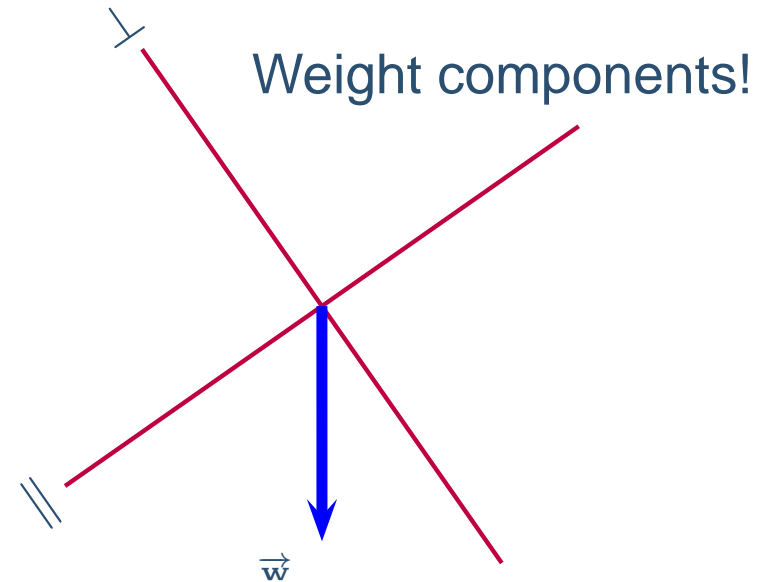
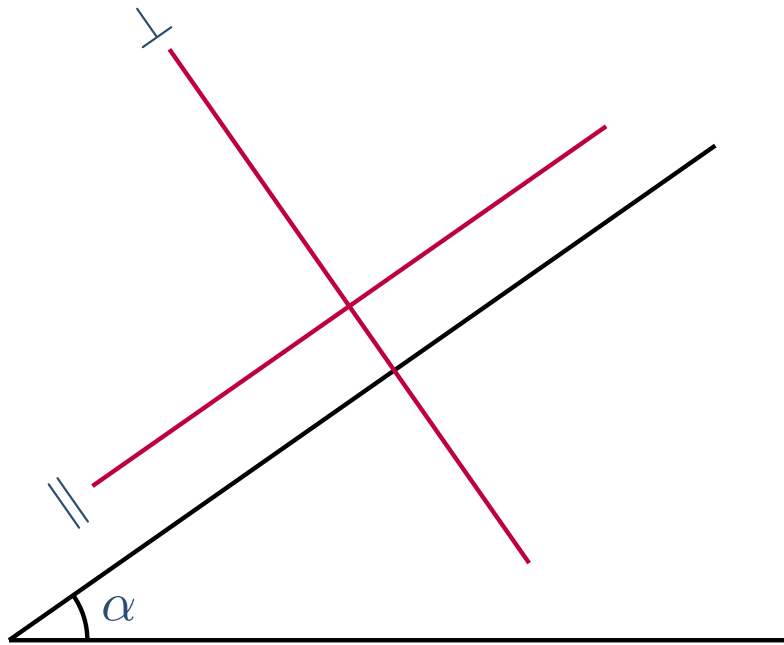
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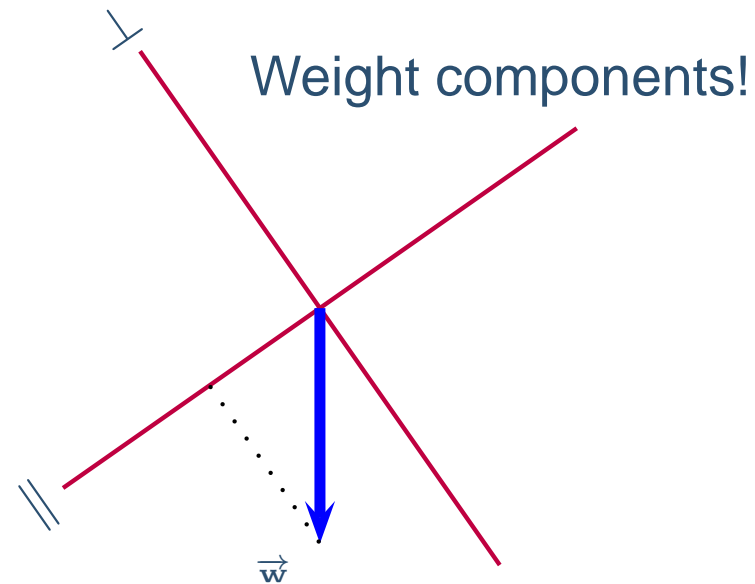
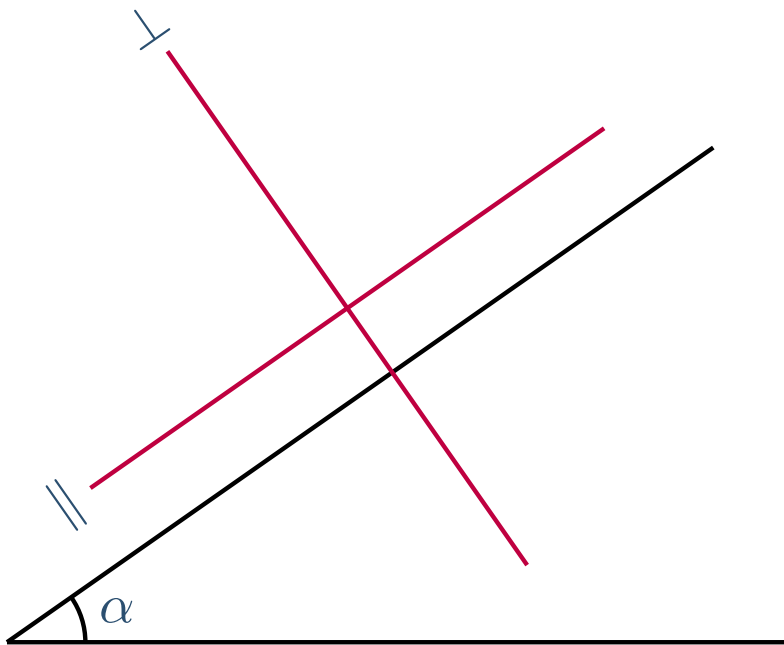
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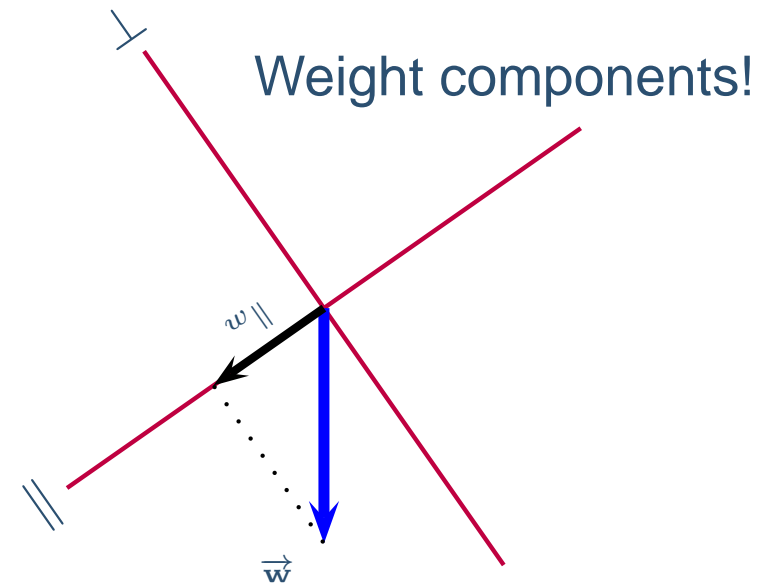
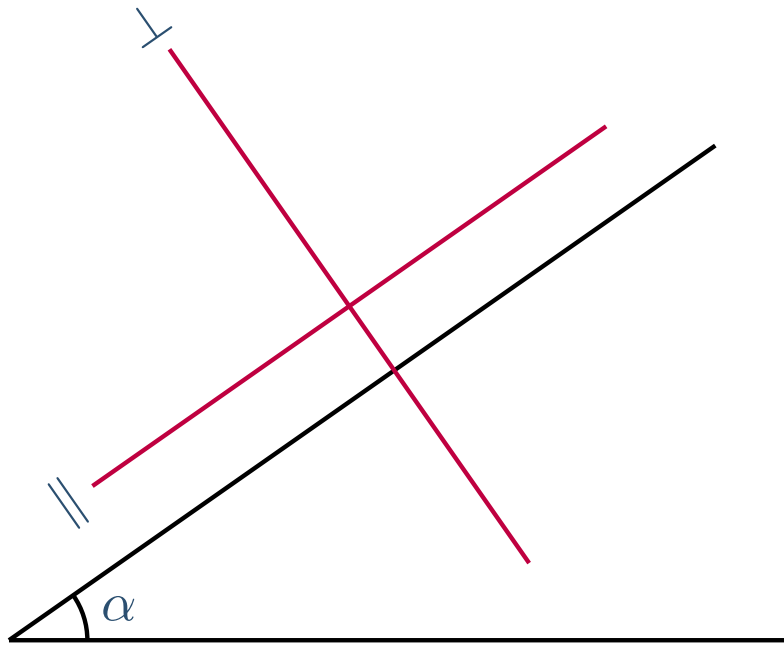
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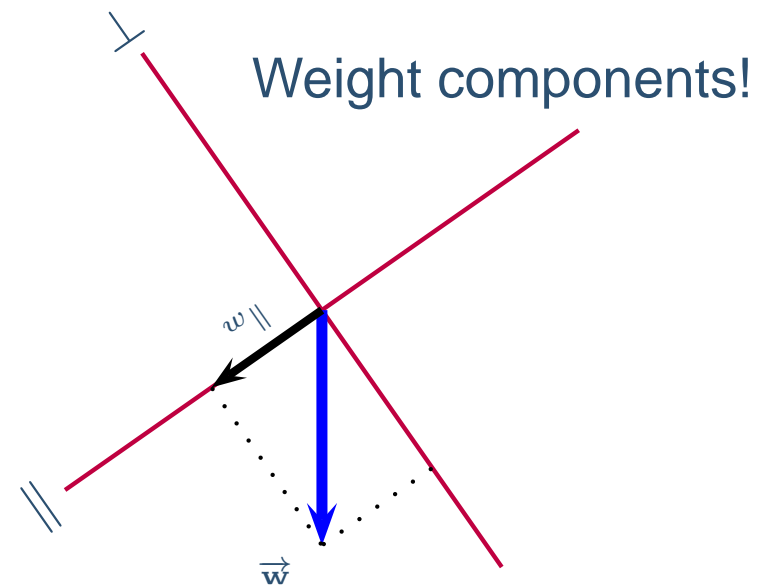
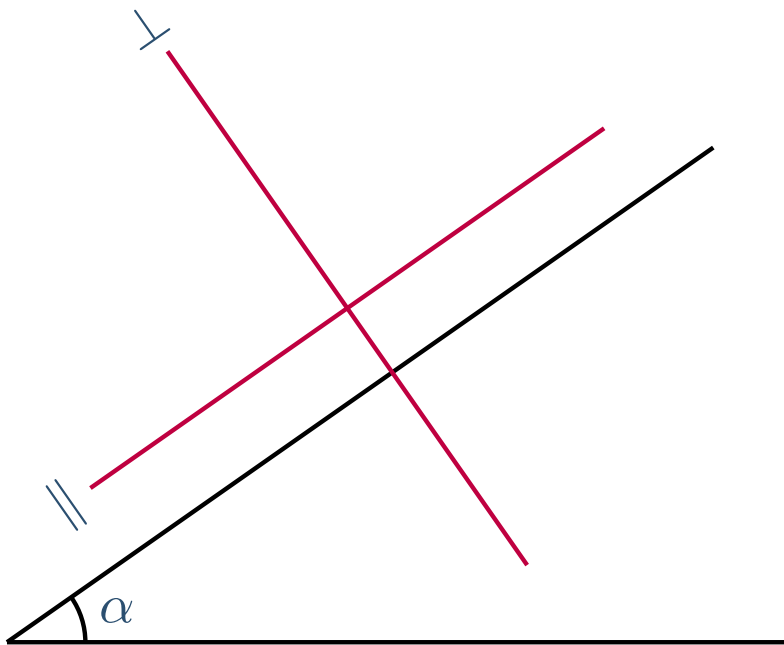
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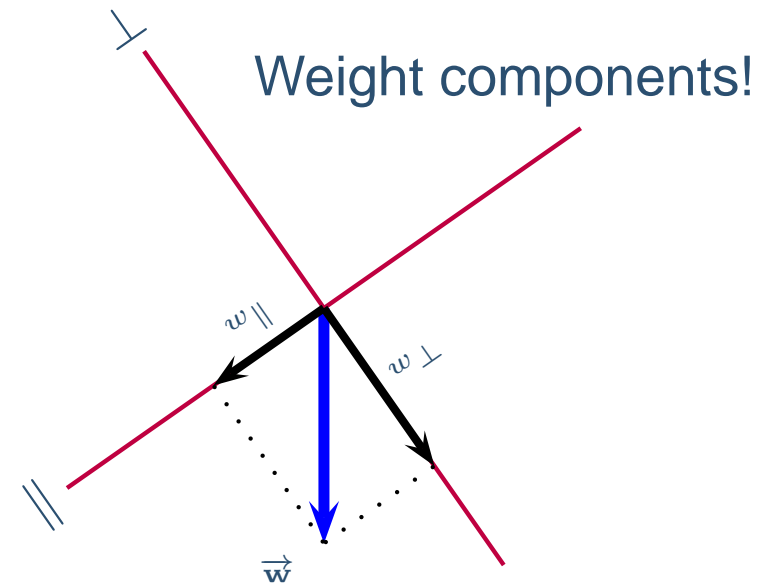
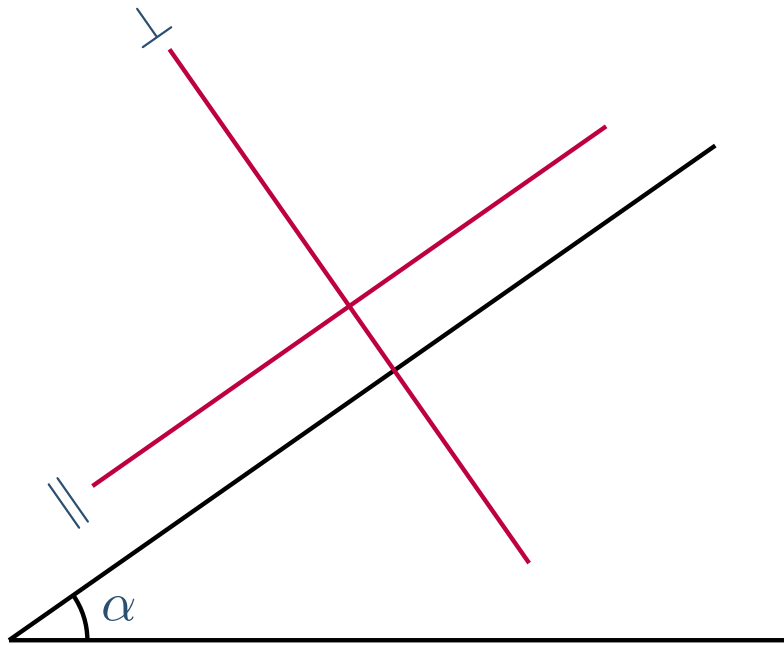
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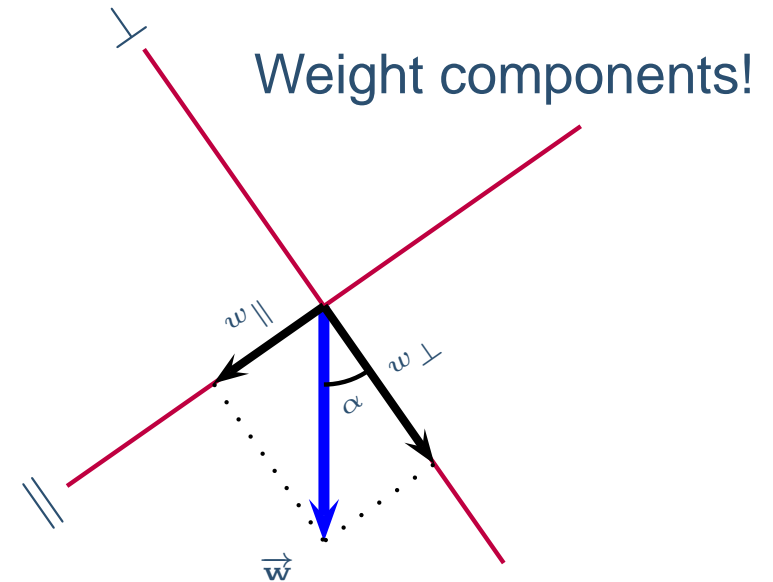
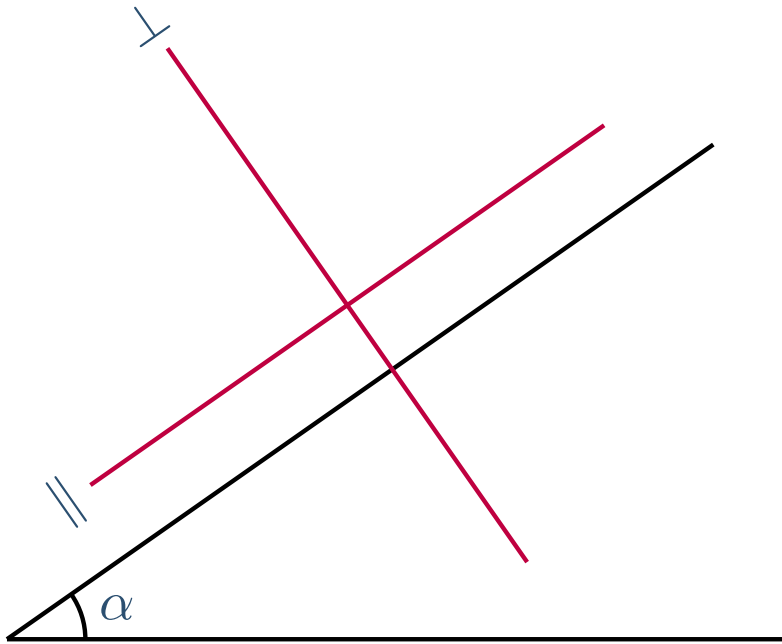
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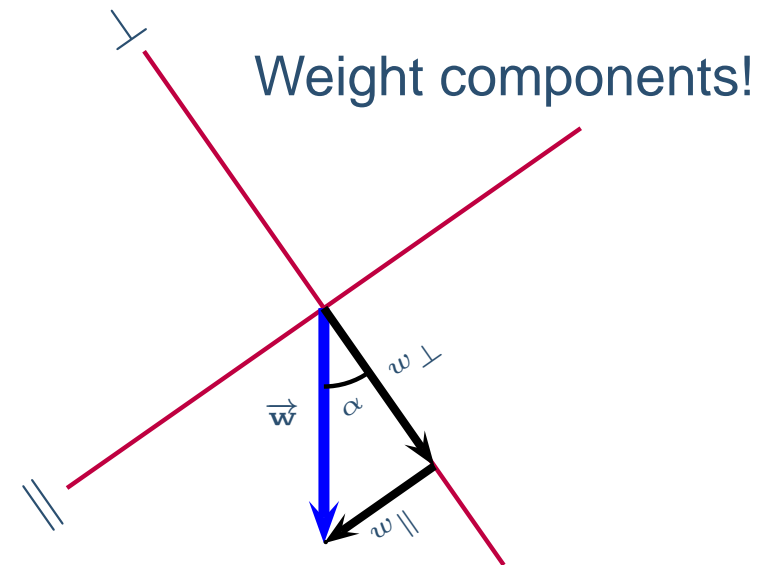
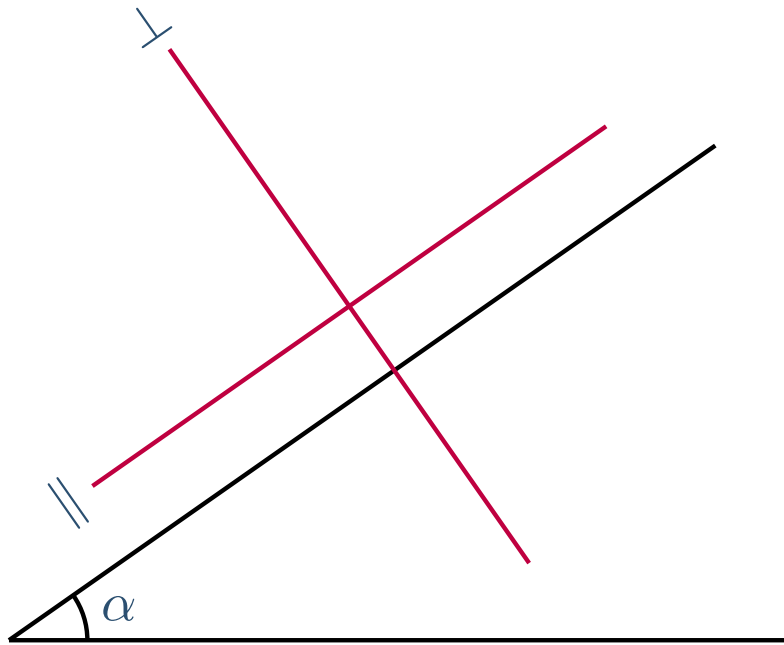
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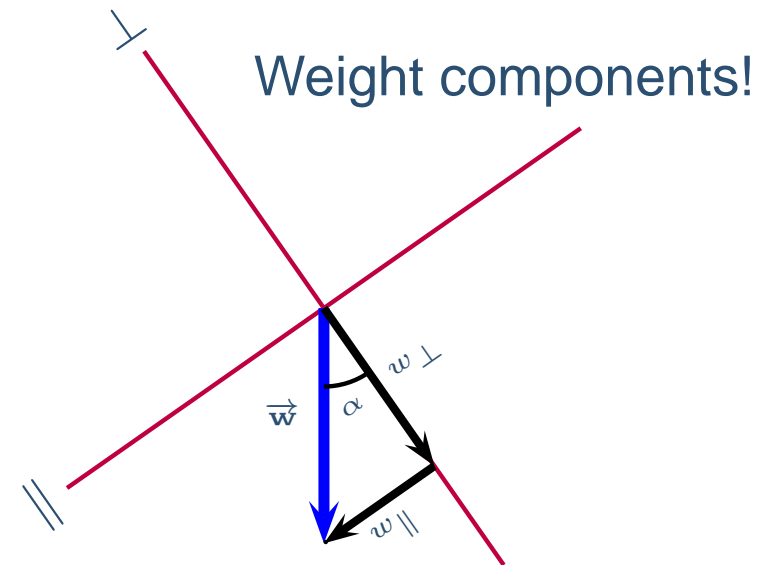
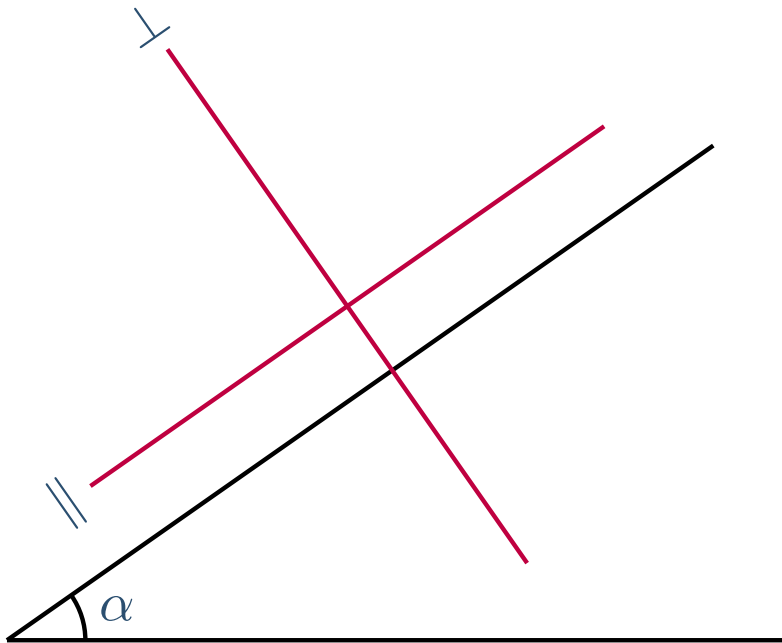
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$$w_{\parallel} = w \sin \alpha = Mg \sin \alpha$$

$$w_{\perp} = w \cos \alpha = Mg \cos \alpha$$

Maximum Static Friction

Experiments show that the static friction's maximum value obeys a simple equation.

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TABLE 5.1 Coefficients of friction

| Materials | Static μ_s | Kinetic μ_k | Rolling μ_r |
|--------------------------------|--------------------------------------|---------------------------------------|---------------------------------------|
| Rubber on concrete | 1.00 | 0.80 | 0.02 |
| Steel on steel (dry) | 0.80 | 0.60 | 0.002 |
| Steel on steel (lubricated) | 0.10 | 0.05 | |
| Wood on wood | 0.50 | 0.20 | |
| Wood on snow | 0.12 | 0.06 | |
| Ice on ice | 0.10 | 0.03 | |

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Example: A wooden block is placed on a wooden ramp which is initially horizontal. When the ramp is slowly raised, at what angle will the block begin to slide?