L03 - Net Force and Acceleration

Newton's Second Law of Motion: When an external non-zero net force acts on an object, the object accelerates in the direction of the net force.

The magnitude of the acceleration is directly proportional to the magnitude of the net force and inversely proportional to the mass of the object.

$$\vec{a} = \frac{\vec{F}}{m} \Rightarrow \vec{F} = m\vec{a}$$

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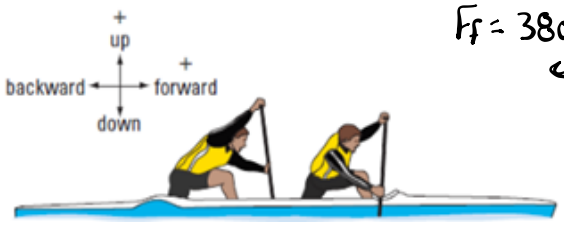
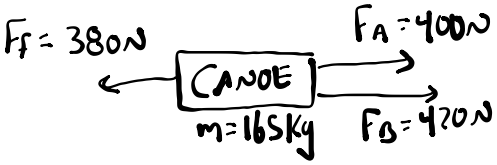
Net Force, Mass, and Acceleration

Q1: Two athletes on a team, A and B, are practicing to compete in a canoe race. Athlete A has a mass of 70kg, B a mass of 75kg, and the conoe a mass of 20kg. Athlete A can exert an average force of 400N [forward] and B an average force of 420N [forward] on the canoe using the paddles. During paddling, the magnitude of the water resistance on the canoe is 380N. Calculate the initial acceleration of the canoe.





$$\vec{a} = \frac{\vec{F}}{m}$$

$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \dots$$
$$= (+400) + (+420) + (-380)$$
$$= 440N \text{ [forward]}$$

System

$$a = \frac{F_{net}}{m} = \frac{440N}{165kg} = 2.\bar{6}\ m/s^2$$

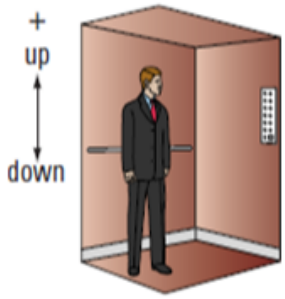
(B) What is acceleration on Athlete A?

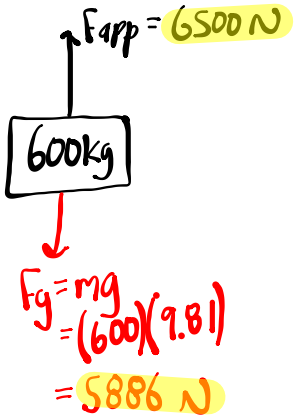
$2.\bar{6}\ m/s^2$

Net Force, Mass, and Acceleration

600kg

Q2: A person and an elevator have a combined mass of 6.00 x10^2 kg. The elevator cable exerts a force of 6.50 x10^3 N [up] on the elevator. Find the acceleration of the person.





$$\vec{a} = \frac{\vec{F}}{m}$$

$\vec{F}_{net} = \vec{F}_{app} + \vec{F}_g$

$= 6500 + (-5886)$

$= 614\,N\,[up]$

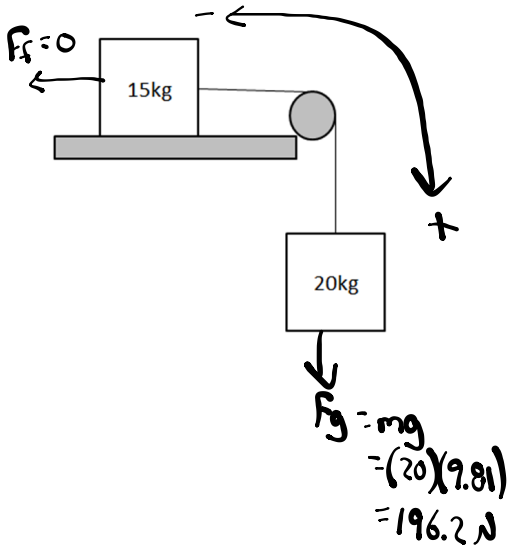
$\vec{a} = \frac{\vec{F}_{net}}{m} = \frac{614\,N\,[up]}{600\,kg} = 1.02\bar{3}\,m/s^2\,[up]$

Net Force, Mass, and Acceleration

Q3: A grey table has an extremely smooth surface (frictionless). If a 15kg mass on the table is tied to a 20kg mass just off the edge of the table...

(a) How quickly will the *system* accelerate?

(b) What is the tension in the rope?



System

$F_{net} = F_g + F_f$

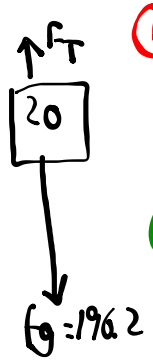
$= 196.2 + (-0)$

$= 196.2\ N$

$a = \frac{F_{net}}{m} = \frac{196.2}{35} = 5.61\ m/s^2$

NOTE:

Itm



① $F_{net} = ma$

$= (20)(5.61)$

$= 112.1\ N$

② $F_{net} = F_g + F_T$

$+112.1 = +196.2 + F_T$

$-84.1 = F_T$

$F_T = 84.1\ N$

Practice

Pg 150 #1

Pg 152 #1-2

Pg 153 #3 (Two buckets)

HINT: Draw a Free-Body Diagram for the bottom bucket

Pg 157 #1-2

Challenge

Pg 158 #9

HINT: To find the Tension, draw a Free-Body Diagram for the 2kg mass.