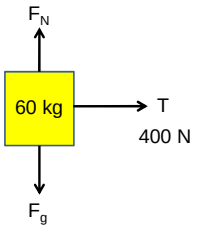
Horizontal Forces

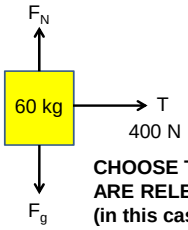
Sample 1

The amazing water skiing gazelle (mass = 60 kg) can ski behind a boat (mass = 1000 kg) when the engine provides 5000 N of force. The maximum tension of the ski rope is 400 N. What is the maximum acceleration of the gazelle.

Draw the FBD for the Gazelle



Write the Net Force Equations (both X and Y)



ΣF_x : $T = ma$

ΣF_y : $F_N - F_g = ma$ → 0

CHOOSE THE NET FORCE EQUATIONS THAT ARE RELEVANT TO THIS PROBLEM (in this case they are the x net force equations)

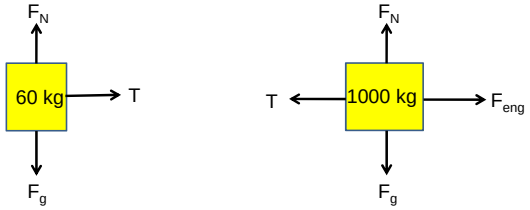
ΣF_x : $400\ N = (60kg)\ a$

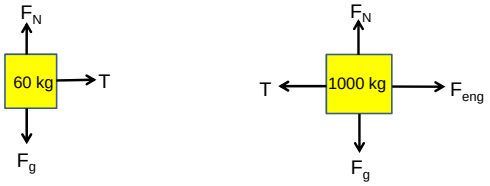
$a = 6.67\ m/s^2$

Sample 2

The amazing water skiing gazelle (mass = 60 kg) is again skiing behind a boat (mass = 1000 kg) when the engine provides 5000 N of force. What is the acceleration of the gazelle and the boat? What is the tension in the rope between the gazelle and the boat?

Draw the FBD's for the Gazelle and the boat





Write net force equations (X and Y) for the gazelle and the boat

ΣF_x : $T = ma$	ΣF_x : $F_{eng} - T = ma$
ΣF_y : $F_N - F_g = ma$ → 0	ΣF_y : $F_N - F_g = ma$ → 0
ΣF_x : $T = (60\ kg)a$	ΣF_x : $5000\ N - T = (1000\ kg)a$
ΣF_y : $F_N - (60\ kg)(9.8m/s^2) = 0\ N$	ΣF_y : $F_N - (1000\ kg)(9.8m/s^2) = 0\ N$

CHOOSE THE NET FORCE EQUATIONS THAT ARE RELEVANT (in this case they are the x net force equations)

ΣF_x : $T = (60\ kg)a$ $\quad$ ΣF_x : $5000\ N - T = (1000\ kg)a$

SUBSTITUTE ONE EQUATION INTO THE OTHER TO SOLVE FOR a

$5000\ N - \mathbf{(60\ kg)a} = (1000\ kg)a$

$5000\ N = (1060\ kg)a$

$a = 4.72\ m/s^2$

Plug a into the one of the original equations and solve for T

$T = (60\ kg)a$

$T = (60\ kg)(4.72\ m/s^2)$

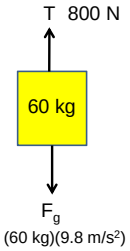
$T = 283\ N$

Vertical Forces

Sample 1

Star Flight, in an attempt to rescue an injured gazelle, lowers a cable which can withstand a maximum tension of 800 N to the 60 kg gazelle trapped at the bottom of a canyon. What is the maximum acceleration that Star Flight can use to lift the gazelle?

Draw the FBD for the Gazelle



Write the Net Force Equation

ΣF_y : $T - F_g = ma$

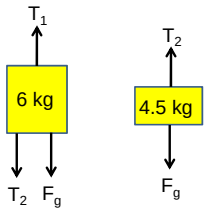
ΣF_y : $800\ N - (60\ kg)(9.8\ m/s^2) = (60kg)a$

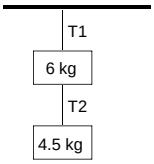
$a = 3.53\ m/s^2$

Sample 2

Two hanging plants are suspended from the ceiling of an elevator as shown in the picture. What are the tensions in the two cables if the elevator is accelerating **downward** at 3 m/s²?

Draw the FBD's





Write net force equations (Y) for both objects

NOTE: you MUST use a NEGATIVE sign with the acceleration because the elevator is going down!!!!

ΣF_y : $T_1 - T_2 - F_g = ma$

ΣF_y : $T_1 - T_2 - (6\ kg)(9.8m/s^2) = (6\ kg)(-3\ m/s^2)$

ΣF_y : $T_2 - F_g = ma$

ΣF_y : $T_2 - (4.5\ kg)(9.8m/s^2) = (4.5\ kg)(-3\ m/s^2)$

Solve for T_2

ΣF_y : $T_2 - (4.5\ kg)(9.8m/s^2) = (4.5\ kg)(-3\ m/s^2)$

$T_2 = 30.6\ N$

Substitute and solve for T_1

ΣF_y : $T_1 - 30.6N - (6\ kg)(9.8m/s^2) = (6\ kg)(-3\ m/s^2)$

$T_1 = 71.4\ N$

Review for Unit 4

Terms to know:

- Force
- Contact Force
- Field Force
- Inertia
- Acceleration
- Mass
- Weight (Fg)
- Action-reaction forces

- Concepts to Know:
  - Know Newton's three laws of motion
    - Law of Inertia
    - Law of Acceleration (and its mathematical representation)
    - Law of Interactions
  - Know what a force is and what it does to an object
  - Know the two types of forces, be able to describe the differences and classify examples as either field or contact forces
  - Understand the relationship between force, mass and acceleration

- Be able to:
  - Draw and label free-body diagrams and determine net force
  - Calculate the net force
  - Calculate force, mass, weight and acceleration
  - Determine net force: $\Sigma F = ma$
  - Weight/Force gravity: $F_g = mg$ ($g = +9.8\ m/s^2$)
  - Write net force equations
- There will be multiple choice questions as well as force problems.