Grade 6 Science

Week of January 11 – January 15

Net Forces

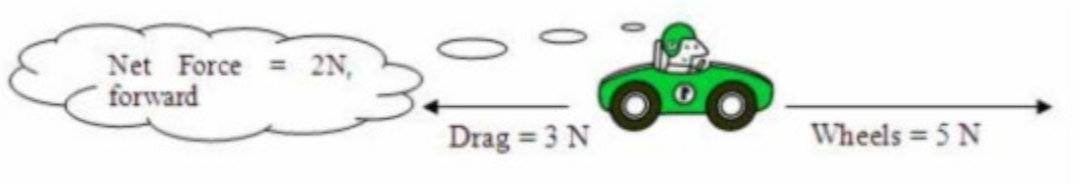
Net Force

There is almost always more than one force acting on an object at any given time. For example, if you **push a ball down a hill**:

- **You** applied a push force to the ball
- **Gravity** is pulling the ball down the hill
- The grass is applying **friction** which is slowing it down
- Air resistance is also applying **friction** and slowing the ball down.

That's a lot of forces at play! If we took all of these forces into account and calculated **the total force being applied to the ball,** we would be calculating the **Net Force**.

Physics – Net Force: https://youtu.be/z506qGc4RlQ



Tug of War

Let's begin by getting a feel for what F_{net} looks like in a Tug-of-War.

Forces and Motion Intro: https://youtu.be/bzwnWvuyvS0

F_{net} is the sum of all the forces. When forces acting on a body are balanced (or there are none), there is no net force.

Examples

Consider the images below and discuss whether or not they represent **balanced** or **unbalanced** forces.

Example 1:

A tug of war takes place on a school playground. There are three students per team. Both teams pull with 300N of force in opposite directions as shown below.

Question: Balanced or unbalanced forces? How can you tell?

Question: Describe the motion.

Example 2:

Now the team on the left digs in and starts to pull harder as shown below.

Question: Balanced or unbalanced forces? How can you tell?

Question: Describe the motion.

Answers: Example 1 – Since the forces are EQUAL and OPPOSITE we say that they are balanced (since they cancel each other out); When forces are balanced we know that the motion must not be changing.. In this case the system (which includes the rope and both teams) remains at rest. Example 2 – Since the forces are no longer equal and opposite we say that they are unbalanced (since they no longer cancel each other out); We see that the left team has the larger force creating an unbalanced force to the left. This will cause the motion of the system to change towards the left. The team on the left will move back while the team on the right will be pulled forward. The unbalanced force will be 100N to the left.

Gravity

Let's take a closer look at the force of gravity.

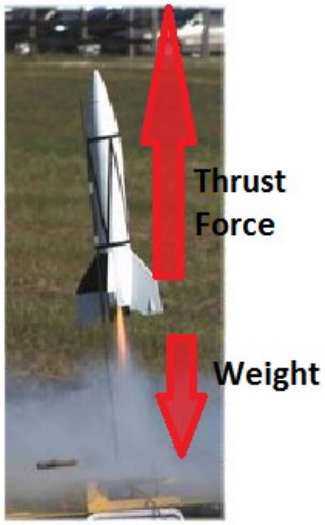
Net Forces with Gravity: https://youtu.be/tOnGP5TA_Ak

Toy Rocket

When **forces do NOT cancel** one another out we say that they are **UNBALANCED**.

Let's look at the forces that act on a model rocket as it is fired into the sky.

At "take-off" we have the following two scenarios.

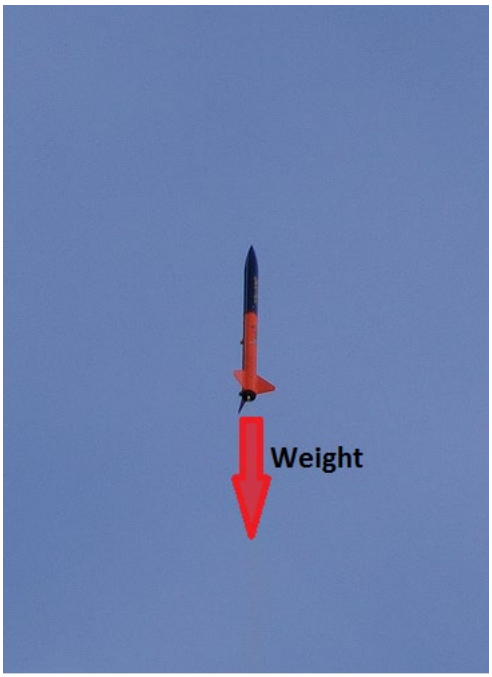


Picture on the left: Before we fire the rocket's engine we have a system that is at rest. This must mean that the forces acting on the rocket at this point are **BALANCED**. We can see that the upward force of the launch pad holding up the rocket called the "***Reaction Force***" is exactly balanced by the ***"weight"*** of the rocket down. If these forces were not balanced, the rocket would change its motion.

Picture on the right: As the engine is ignited, the rocket starts to climb and pick up speed. Since the rocket's motion is changing (speeding up) we say that the forces must be **UNBALANCED**. We can see that the upward "***Thrust Force***" is larger than the "***weight***" of the rocket. This causes the rocket to rise.

*note: Physicists would say that the **Net Force is ZERO** for the picture on the left and the **Net Force is UP** for the picture on the right.*

What happens when the rocket runs out of fuel? Without fuel there can be no upward thrust force. What happens now?

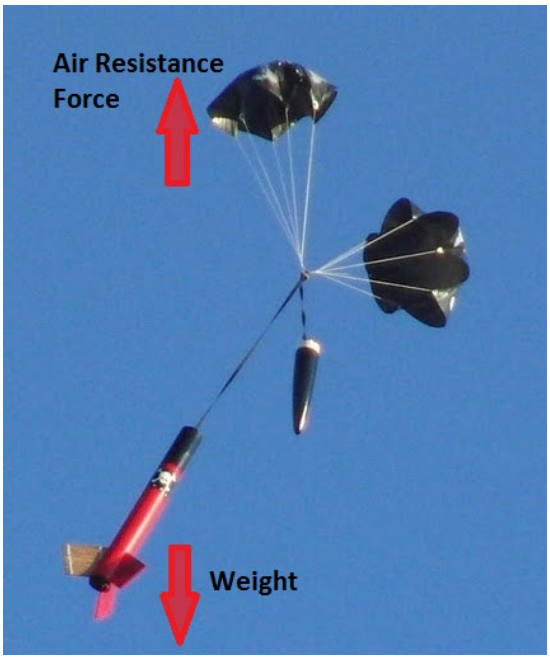


Clearly we no longer have a balanced system since we no longer have an upward Thrust Force. We say that the force is UNBALANCED in the downward direction.

With an UNBALANCED FORCE our rocket's motion changes and it begins to slow down.

*note: Physicists would say that the **Net Force is down**.*

Finally our rocket begins to fall and deploys its parachute as shown below:



Notice that our picture shows an upward "Air Resistance Force" that is exactly the same size as the downward "Weight" of the rocket. The forces are once again BALANCED and the rocket maintains this slow falling speed. We say that the ***Net Force is zero***.

*note: just because the forces are **BALANCED** does not mean that rocket must be stationary (not moving). It simply means that the rocket will **maintain a steady speed** (its motion will not change)*

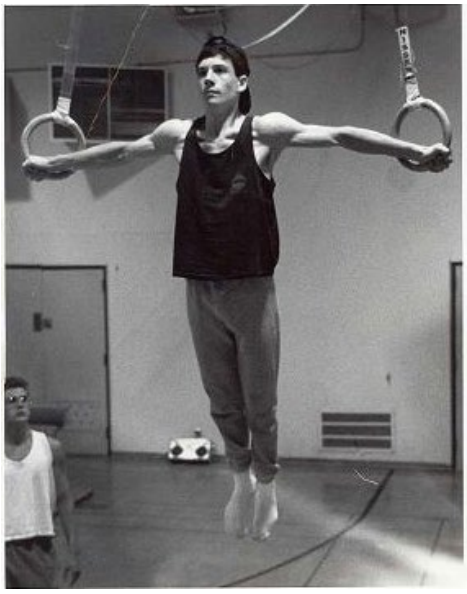
Katherine Johnson: https://youtu.be/-2gCsxUGkNs

Examples

Two people are being pulled up out of the water by a helicopter. The force of gravity pulls down on them with a force of 1 000 Newtons. The helicopter pulls up on them with a force of 1 200 Newtons. Draw a FBD then determine their net force (remember direction).

Example 2:

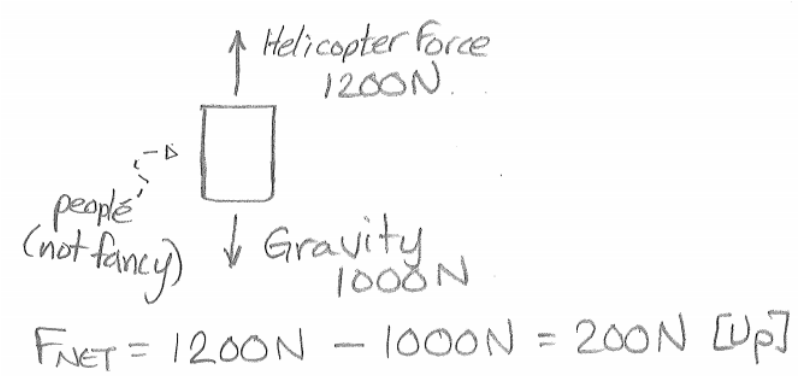
A gymnast on the rings extends both arms out into the "iron cross" position. He holds this position for 5 seconds as shown below.



Question: Balanced or unbalanced forces? How can you tell?

Question: Describe the motion.

Answers:



Since the gymnast is not moving we can conclude that all forces must be EQUAL and OPPOSITE. We say that they are balanced (the upward force generated by his arms and shoulders is balancing his downward weight).

If forces are balance then we can conclude that his motion will not be changing. Since he is already at rest (stationary), he will remain at rest.

Normal Force

Net Forces and Normal Forces: https://youtu.be/YwpT0ZBxcys

Your seat holds you up while the force of gravity pulls you down towards the floor. Without the seat doing this, the force of gravity would make you fall. If you don't believe this, remove your seat and you'll suddenly need to find another way to keep from falling down.

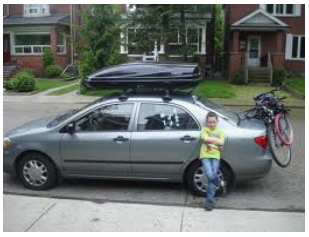
Also, when you're standing, the ground is pushing up on you to keep you from falling into the Earth. Step off a ledge to see what happens when the Earth isn't holding you up.

Examples

Test your understanding of normal force by trying the following examples on your own, laying out the problem in your notes. After giving each example a good try, check the answer and/or solution.

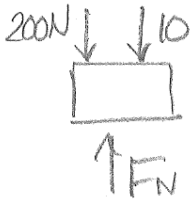
Example #1:
If you put a 10 000 N car on a scale (reading Newtons), what would it say? ie. what is the normal force supporting a 10 000 N car?

Example #2:
What is the normal force supporting a 10 000 N car with a 200 N person luggage rack on it's roof?



Answers:

FBD



$F_{NET} = 0$

$F_N = 10000 + 200$

$= 10200\,N$ [UP]

(balanced)

FBD

Since it's sitting still (no change in motion)

$F_{NET} = 0$

$F_N = 10000\,N$ [UP]

(balanced)

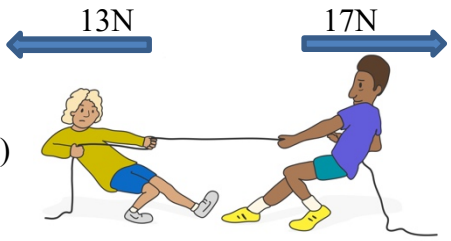
30. What is Net Force?

_____

31. Fill in the blank: There will only be a net force for _____.

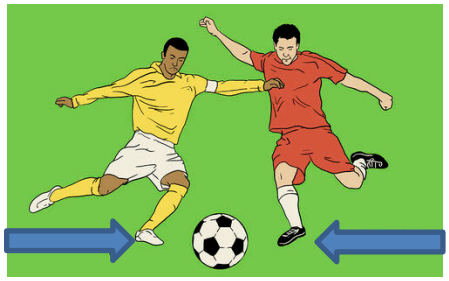
32. Calculate the Net Force for the following scenarios below. Show **all** of your work.

a)



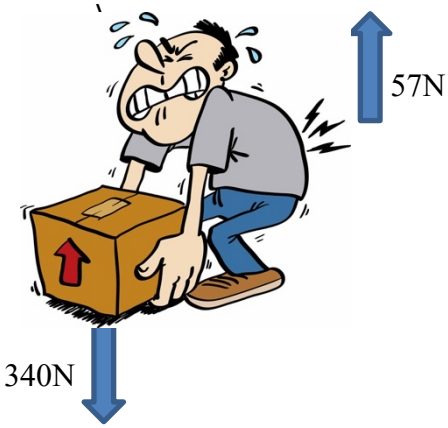
Net Force:

b)



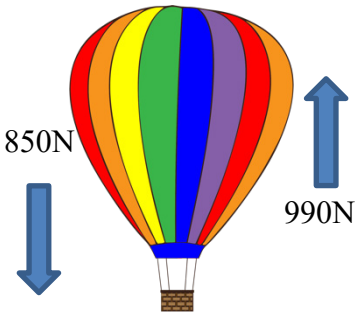
Net Force:

c)



Net Force:

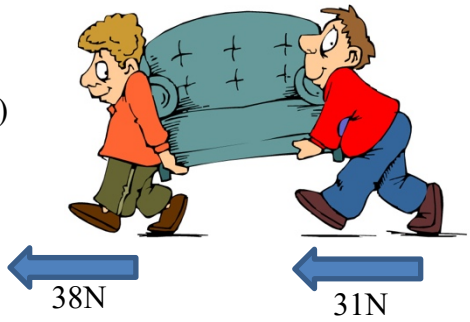
d)



Net Force:

What force would be pulling the balloon down?

a)

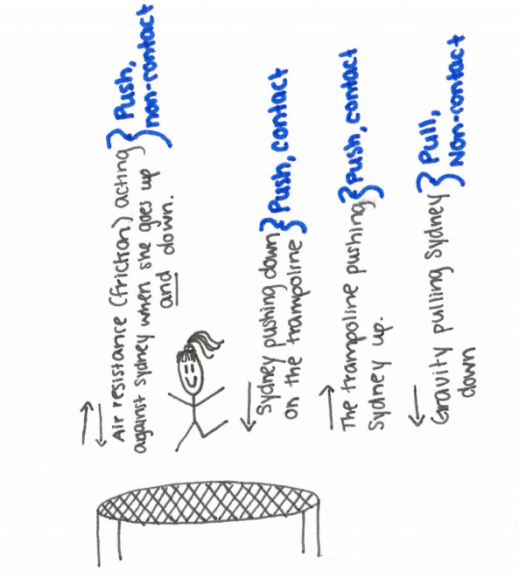


Net Force:

33. In the following questions, you will be given a scenario.

- **Sketch** what is being described, then indicate all the forces that could possibly be acting on the object; include their direction.
- Indicate if each for is **contact** or **non-contact**
- Indicate if each force is a **push** or a **pull**

a. EXAMPLE: Sydney is jumping on her trampoline.



b. Max, the skydiving dog, is parachuting out of a plane.

c. You are paddling your canoe on a lake.