
Using
FORCE
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Inertia review...

"The vis insita, or innate force of matter is a power of resisting, by which every body, as much as in it lies, endeavors to preserve in its present state, whether it be of rest, or of moving uniformly forward in a straight line."

In English, please!

Inertia is the resistance of an object to a change in its state of motion.

More inertia

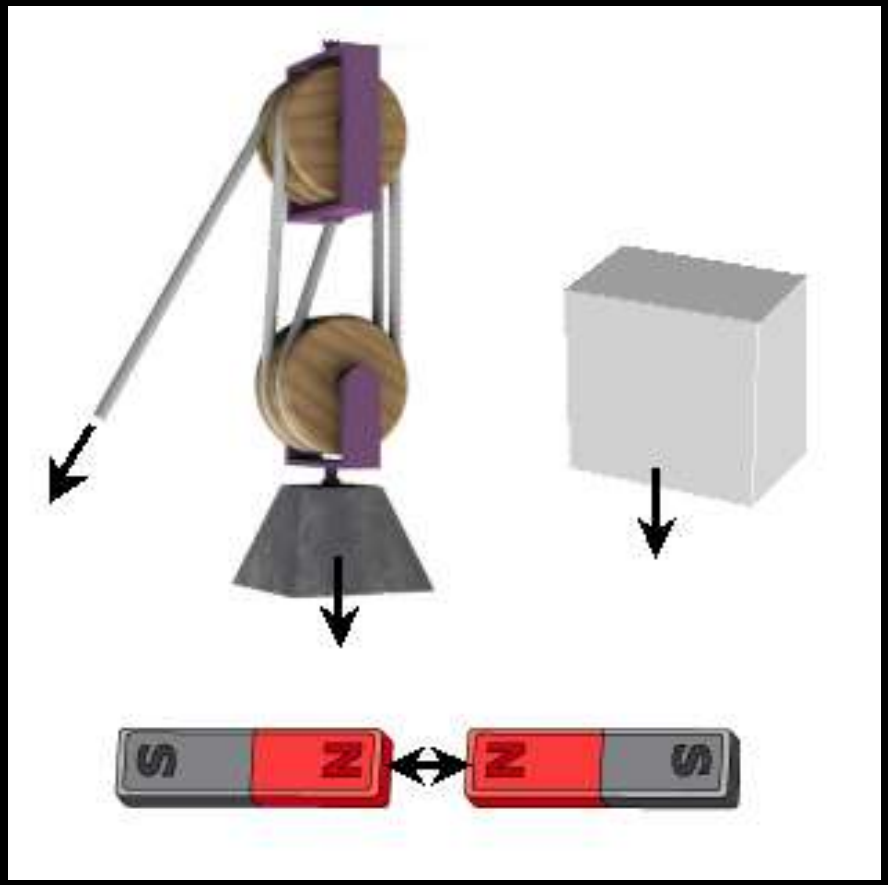
A bowling ball has more inertia than a soccer ball.
Don't believe me?
Kick the bowling ball, then kick the soccer ball.

More mass = More inertia

Less inertia

Force?

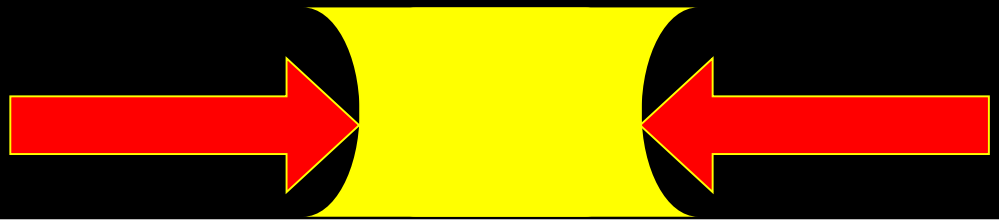
A force is a push or pull upon an object resulting from the object's *interaction* with another object.



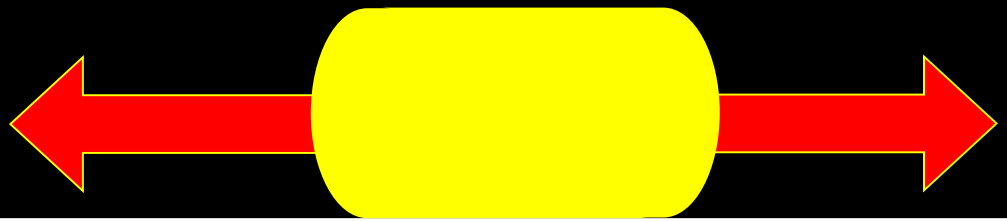
Forces only exist as a result of an interaction.

Force has both direction and magnitude

“A force is a push or pull upon an object”



When a force “pushes” on an object, it creates <u>compression</u>, a force that squeezes materials together.



When a force “pulls” on an object, it creates <u>tension</u>, a force that pulls materials apart.


“Why should I care about compression and tension?”
I’ll leave it to you to be the judge of that…

Balanced vs. Unbalanced forces

A soccer ball sits alone on the field, quiet and still…

Ground pushing up

Gravity pulling down

Forces are balanced so ball does not move

Balanced vs. Unbalanced forces

Suddenly….

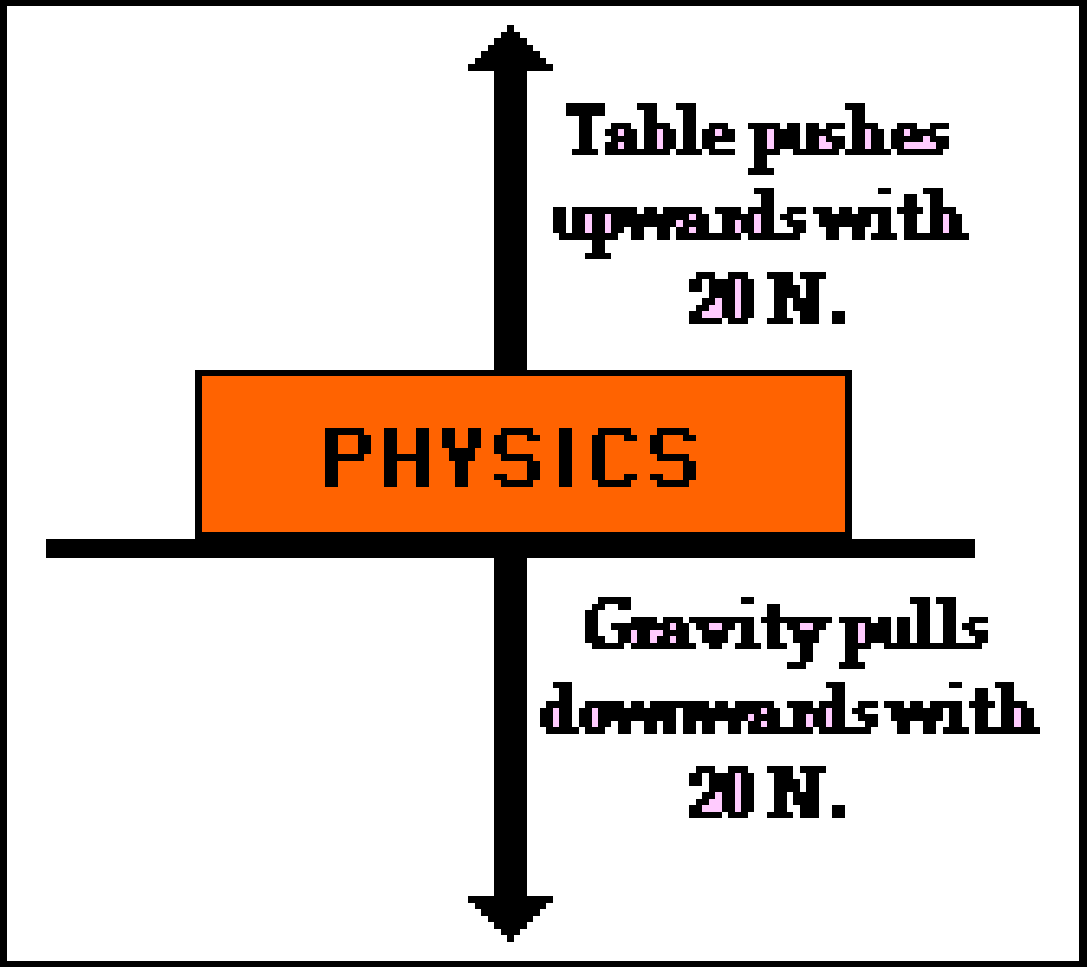
An unbalanced force is exerted on the ball in the direction of the arrow, causing it to move in that direction until…

Balanced vs. Unbalanced forces

…its motion is stopped by an interaction with another force!

Once again, the forces are balanced and all is well in the universe.

Balanced Forces

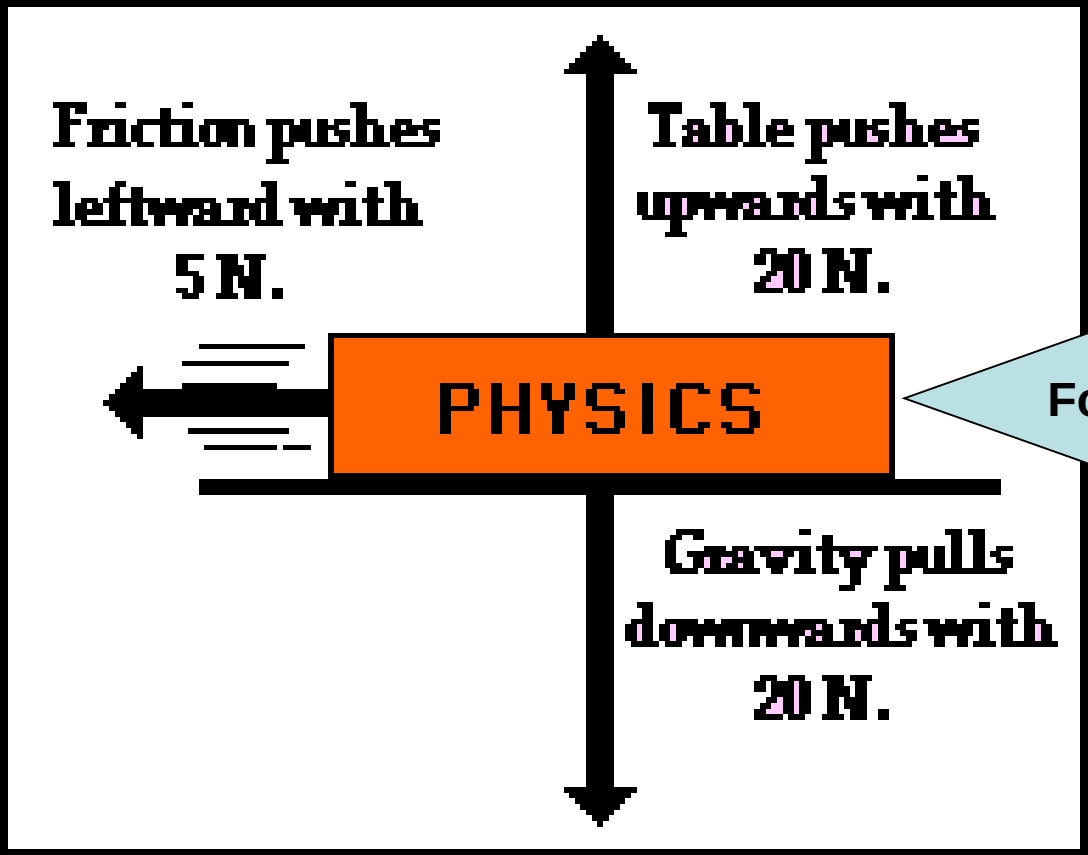


If the forces acting on an object are balanced, the object is at rest.

We say the "Net Force" = 0

Net force = sum of all forces acting on an object

Unbalanced Forces

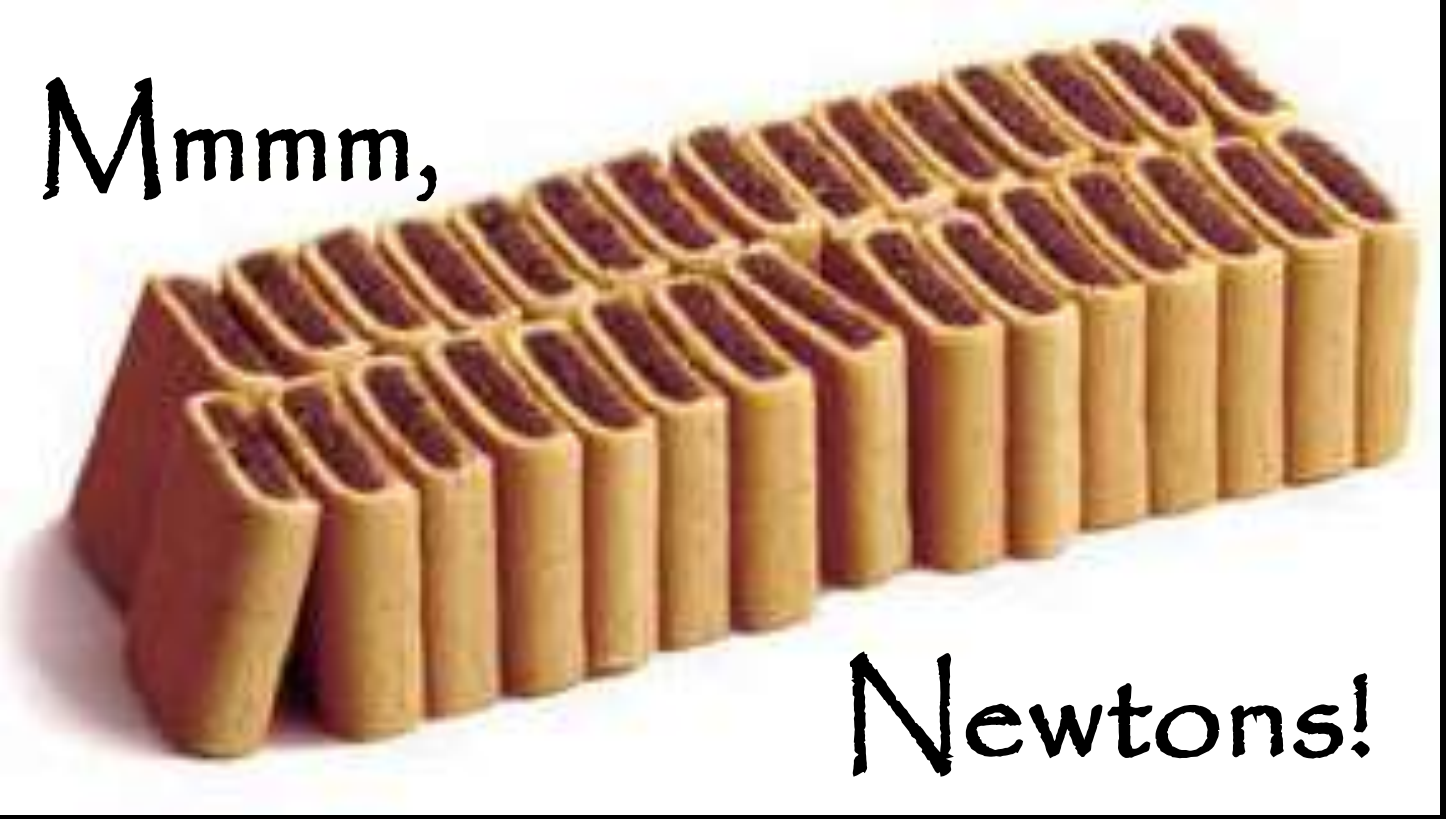


If the forces acting on an object become unbalanced,

Force applied in this direction

the object moves in the direction of the greatest net force.

In this case, the “Net Force” = 5 Newtons to the left



Oh, sorry, wrong Newtons

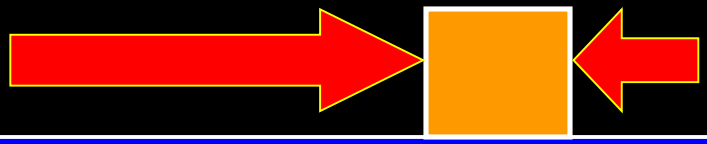
The *newton* is a unit of force that is defined as the amount of force required to accelerate a mass of one kilogram at a rate of one meter per second per second.

Algebraically: $1\ N = 1\ \frac{kg \cdot m}{s^2}$

Diagramming Forces

If you were paying attention, you would have noticed that forces were illustrated using arrows. The *size* and *direction* of the arrow represents the relative strength and direction of the force.

Balance forces - arrows equal in length



Unbalanced forces - arrows not equal, Movement is to the right

Diagramming Forces

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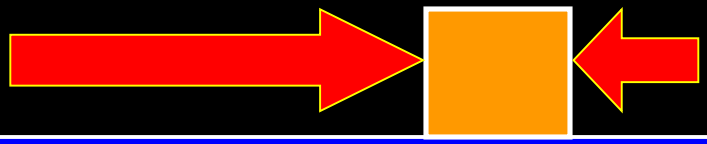
Balance forces - arrows equal in length

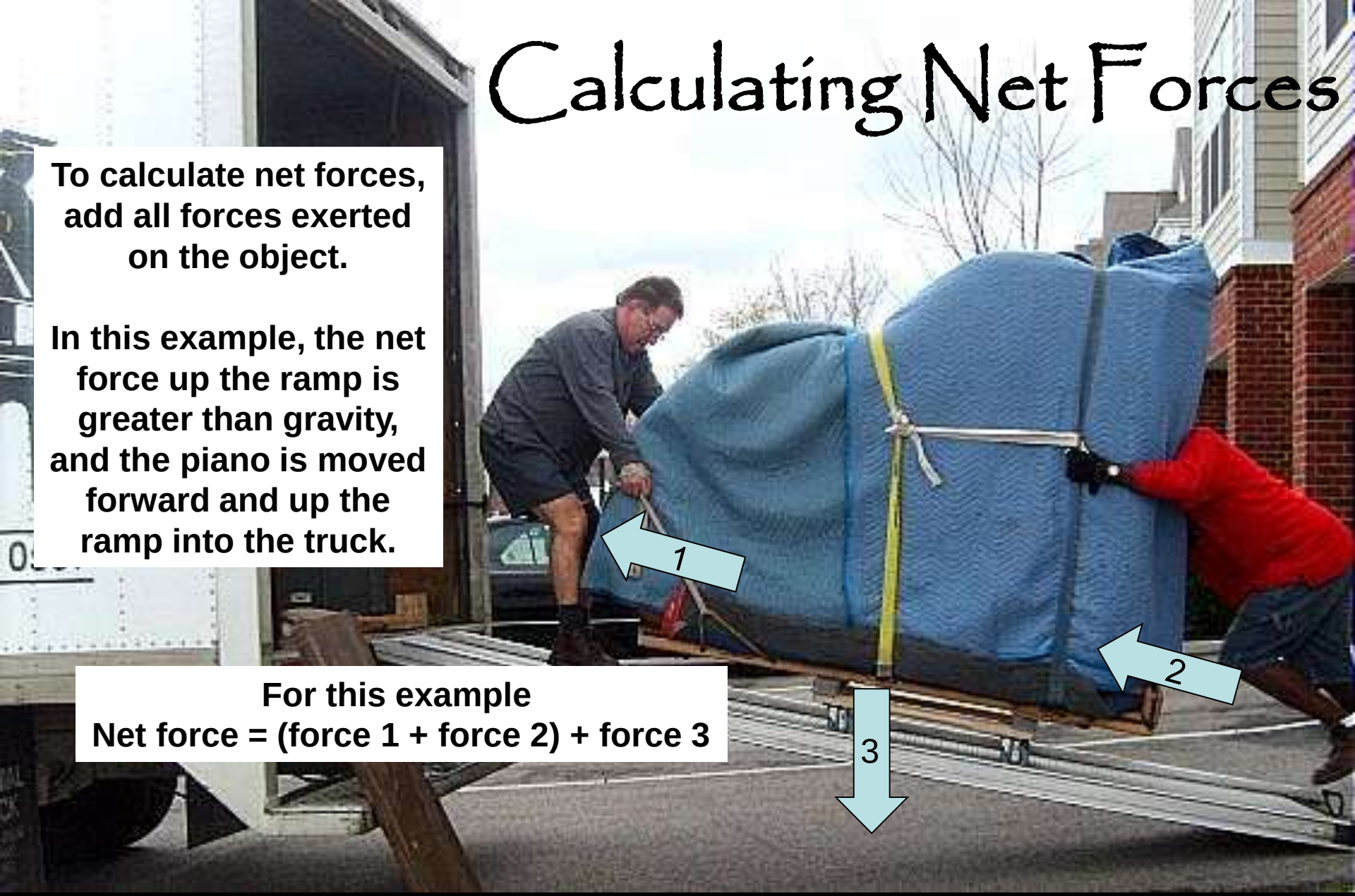


Unbalanced forces - arrows not equal, Movement is to the right

Calculating Net Forces

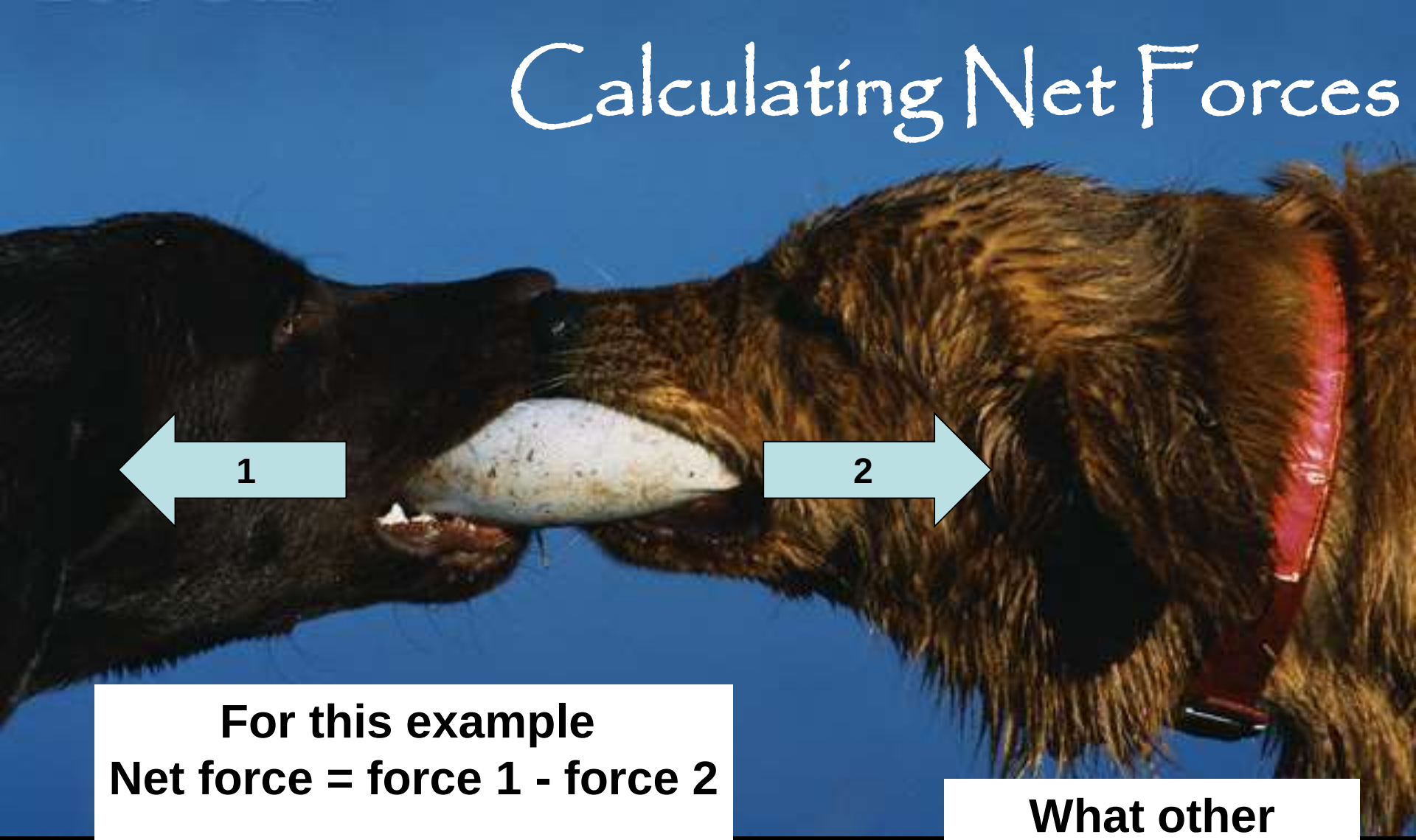
To calculate net forces, add all forces exerted on the object.

In this example, the net force up the ramp is greater than gravity, and the piano is moved forward and up the ramp into the truck.



For this example
Net force = (force 1 + force 2) + force 3

Calculating Net Forces

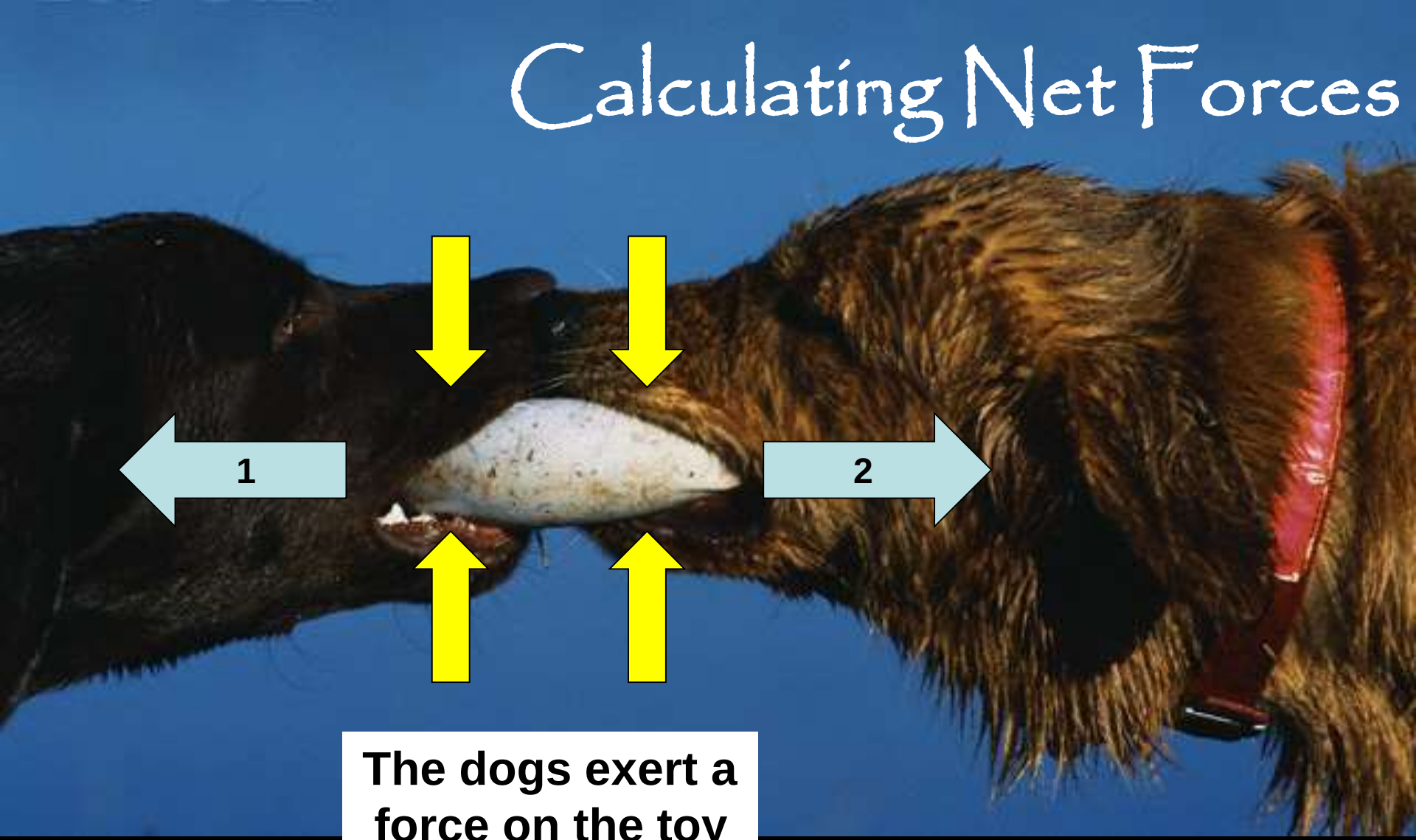


For this example
Net force = force 1 - force 2

The force due to gravity in this example is negligible

What other forces can you identify in this picture?

Calculating Net Forces



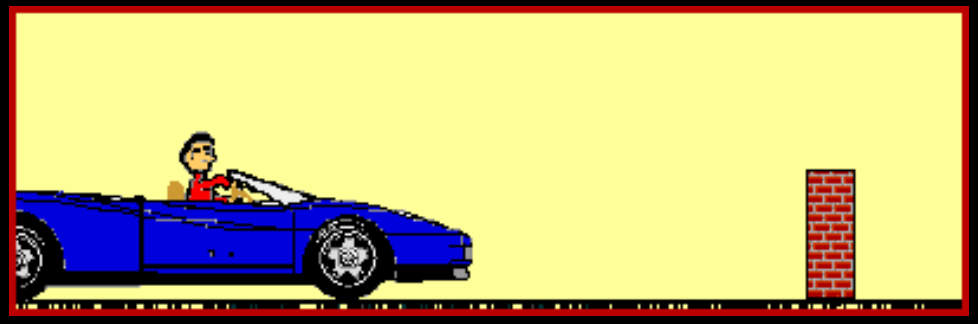
The dogs exert a force on the toy as they bite down on it

Feeling the Force

Which ram seems to have the advantage? Why?

Newton's First Law of Motion

"Every body perseveres in its state of being at rest or of moving uniformly straight forward, except insofar as it is compelled to change its state by force impressed."



Not again!
One more time…
English, please!

"An object at rest will remain at rest unless acted on by an *unbalanced force*. An object in motion continues in motion with the same speed and in the same direction unless acted upon by an *unbalanced force*."

AKA - The Law of Inertia

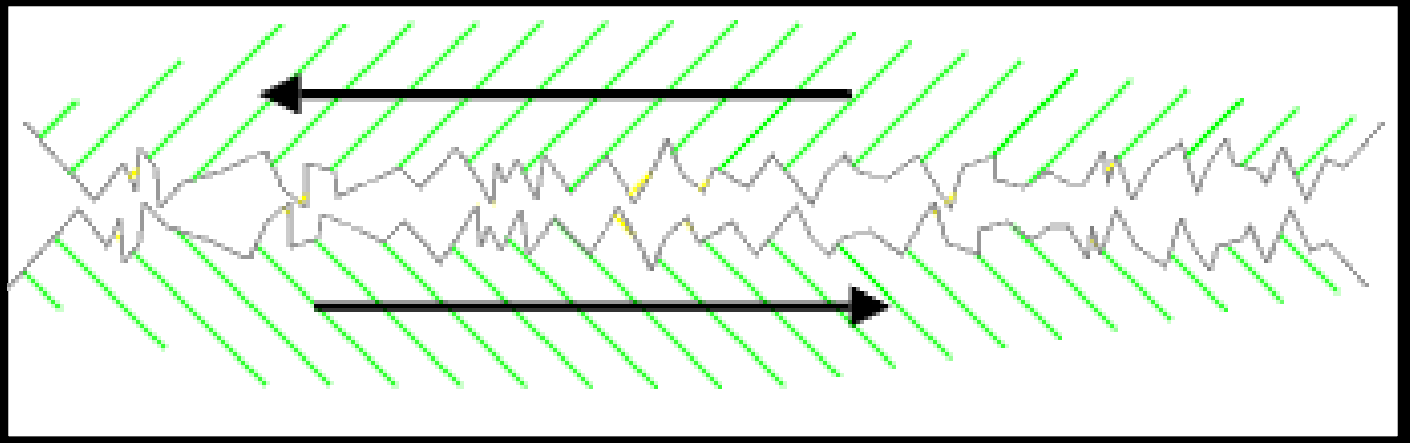
Newton's First Law of Motion

Said another way, Newton's First Law of Motion states that a moving object moves in a straight line with constant speed unless a force acts on it.

- ✓ An object will not start moving unless a force acts on it
- ✓ An object will not stop moving unless a force acts on it
- ✓ An object will not change speed unless a force acts on it
- ✓ An object will not change direction unless a force acts on it

Friction

A force that opposes motion between two surfaces that are touching



Even surfaces that seem to be extremely smooth have microscopic hills and valleys, and when two surfaces are in contact, the hills and valleys of one stick to the hills and valleys of the other, causing friction to resist the force of motion

Friction

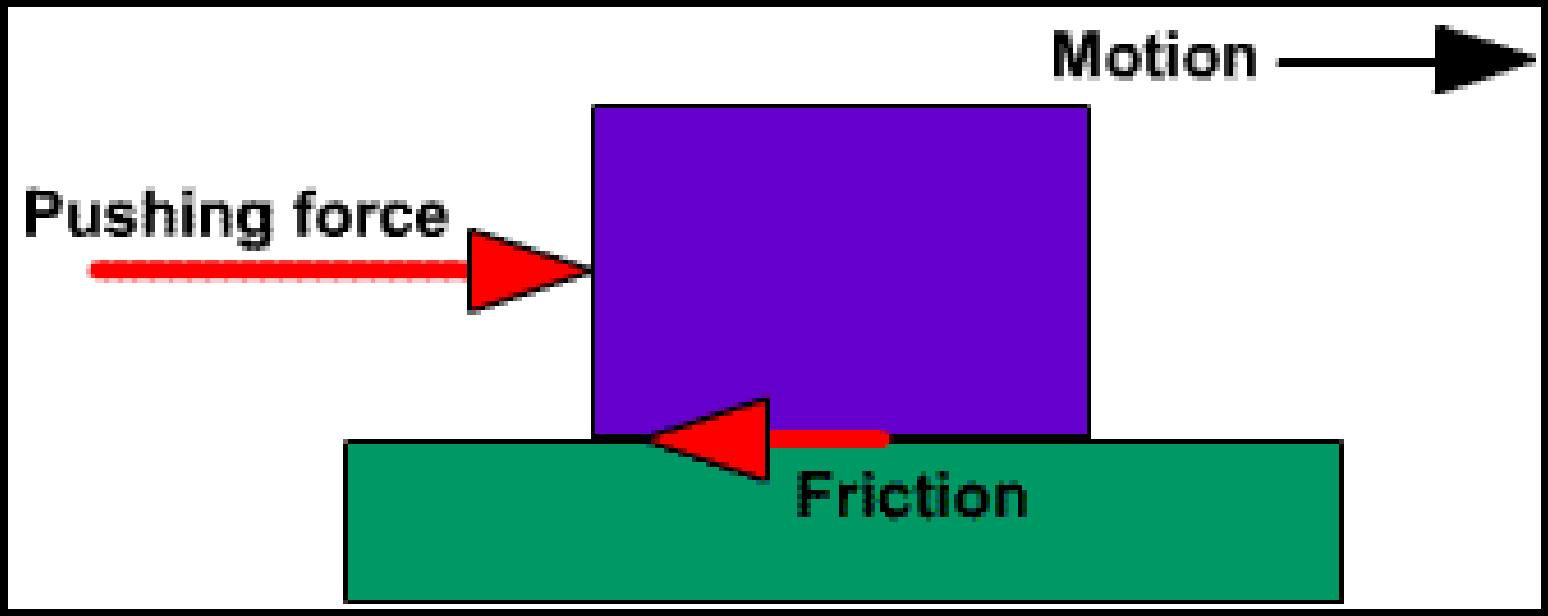
Static friction

The friction that exists between two objects in contact

Friction

Sliding friction

When force is applied that is strong enough to break the bonds of static friction and movement starts, sliding friction acts to slow that object down



Friction

Rolling friction
The resistance that occurs when a round object such as a ball or tire rolls on a flat surface

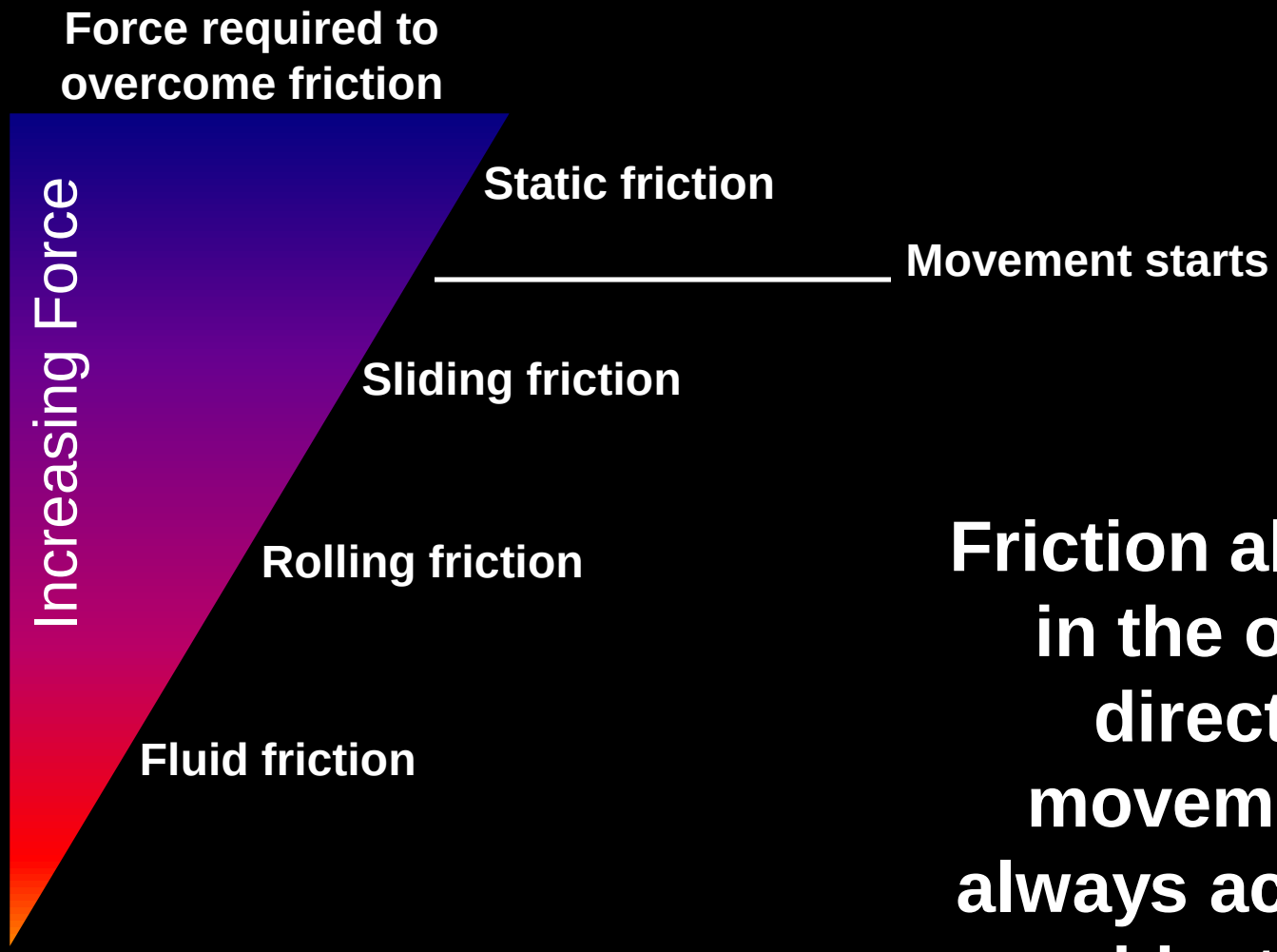
Friction

Fluid friction

Fluid friction occurs when a solid object travels through a liquid or gas.

Wake turbulence and wingtip vortices from jet airliner passing through a layer of clouds, showing the fluid nature of air

Friction



Friction always acts in the opposite direction of movement, and always acts to slow object down.

Force and Newton's Laws note-taking sheet

Section 1

A. Force
    1. net
    2. balanced
    3. unbalanced

B. first law

C. Friction
    1. slows down
    2. Static
    3. Sliding
    4. Rolling

Newton's Second Law of Motion

Force equals mass times acceleration ($F = ma$)

The net force on an object is equal to the mass (m) of the object multiplied by its acceleration (a)

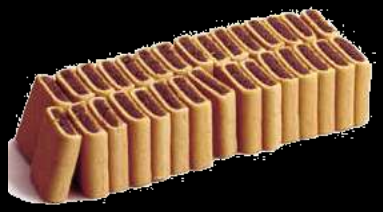
<u>Units of Force</u>

Mass = kilograms (kg)

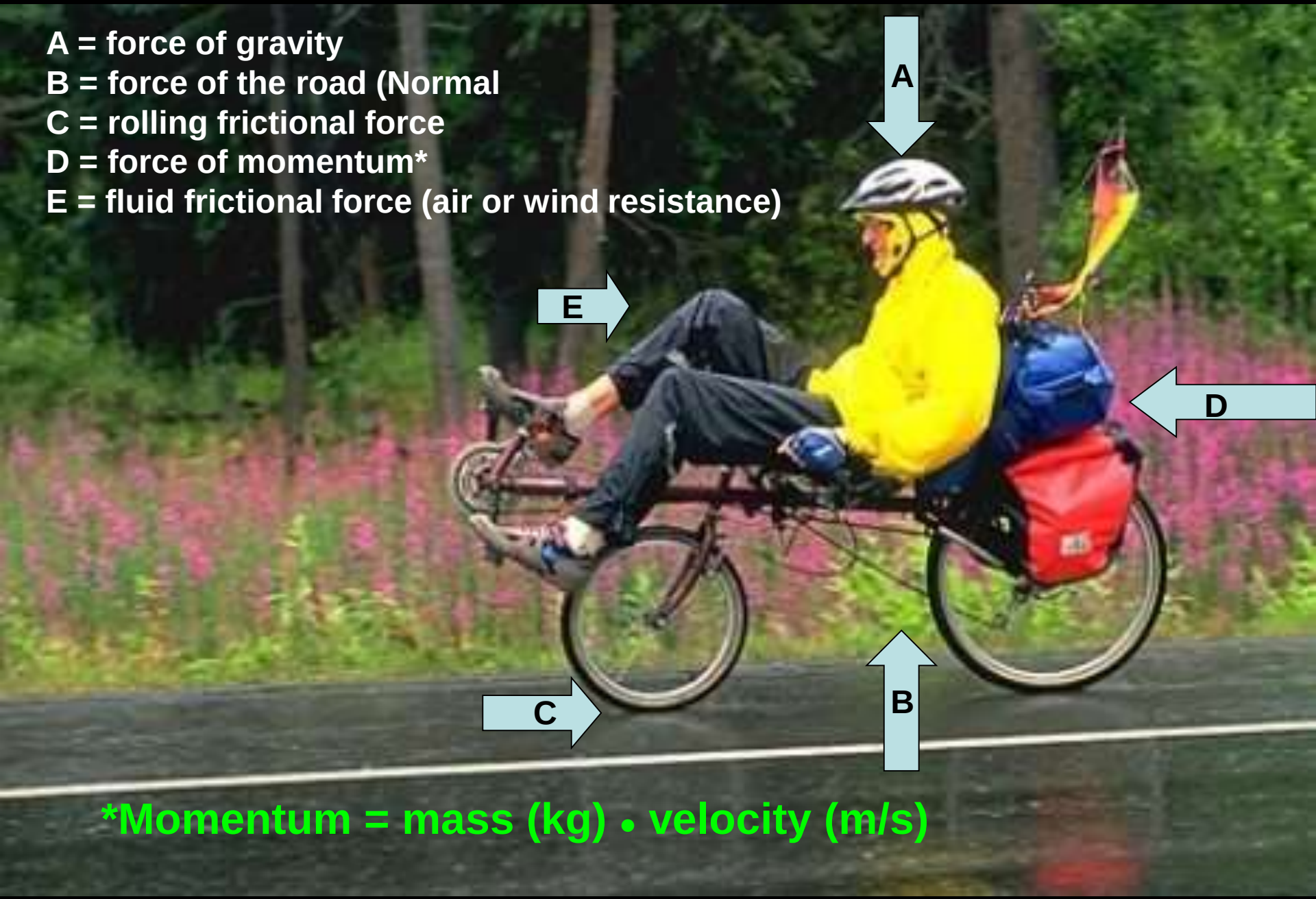
Acceleration = (m/s^2)

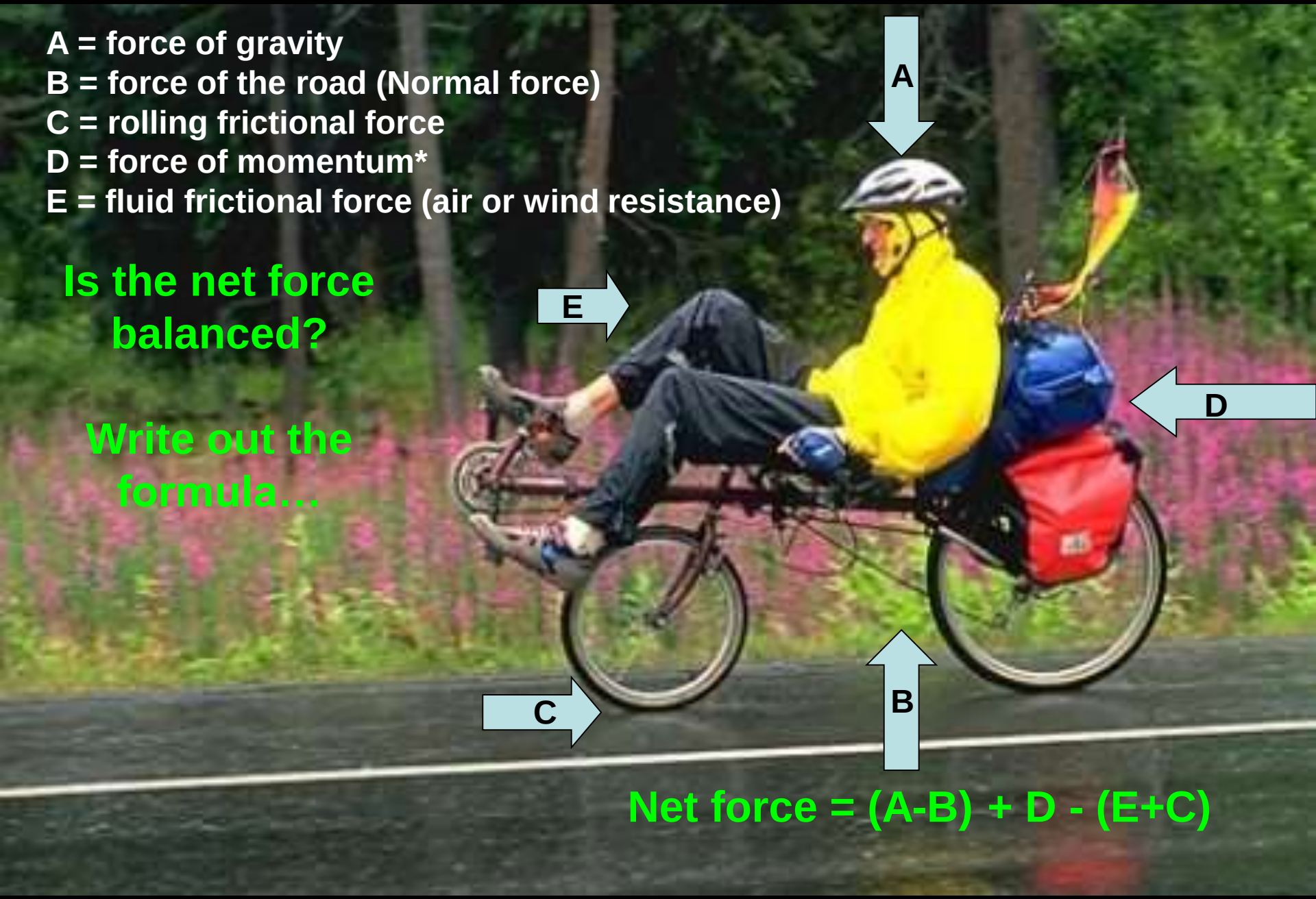
Therefore….

$F = kg \cdot m/s^2$

Force is measured in  **(Newtons, that is)**

What are the forces acting on this bicycle and rider, coasting along at 25 km/h on this flat, wet, Alaskan road?


A = force of gravity
B = force of the road (Normal
C = rolling frictional force
D = force of momentum*
E = fluid frictional force (air or wind resistance)
A
E
D
C
B
*Momentum = mass (kg) • velocity (m/s)


A = force of gravity
B = force of the road (Normal force)
C = rolling frictional force
D = force of momentum*
E = fluid frictional force (air or wind resistance)
Is the net force balanced?
Write out the formula…
A
E
D
C
B
Net force = (A-B) + D - (E+C)

Can an object be in motion and the net force = 0?

Yes. Once an object is in motion, if no other forces such as friction are acting on it, the object will remain in motion in a straight line.

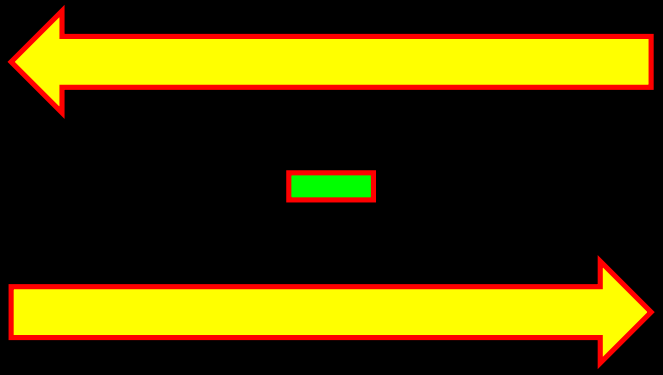
Point of clarification:

Forces do not cause motion
forces cause accelerations.

Calculating Net Force

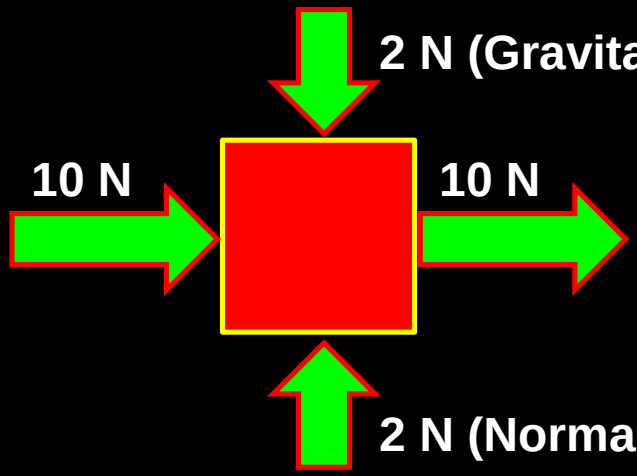
When the forces are acting on an object from the same direction, you add

When the forces are acting on an object from different directions, you subtract



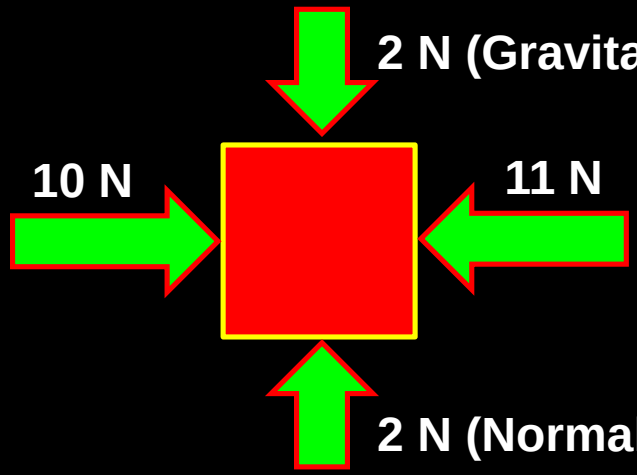
Calculating Net Force

When the forces are acting on an object from the same direction, you add



(2N – 2N) + (10 N + 10 N) = 20 N to the right

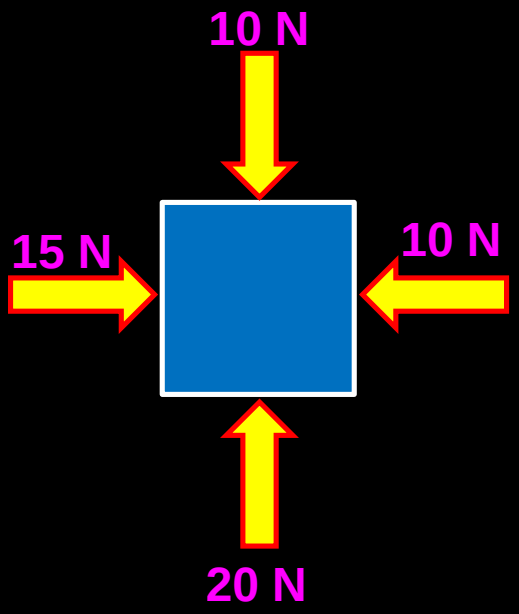
When the forces are acting on an object from different directions, you subtract



(2N – 2N) + (11 N - 10 N) = 1 N to the left

Today – complete worksheets on forces (trays 1-4) and then the Friction Poster

Note – On the "Identifying Forces" worksheet, you will see some problems in which the vertical forces and horizontal forces are not balanced.



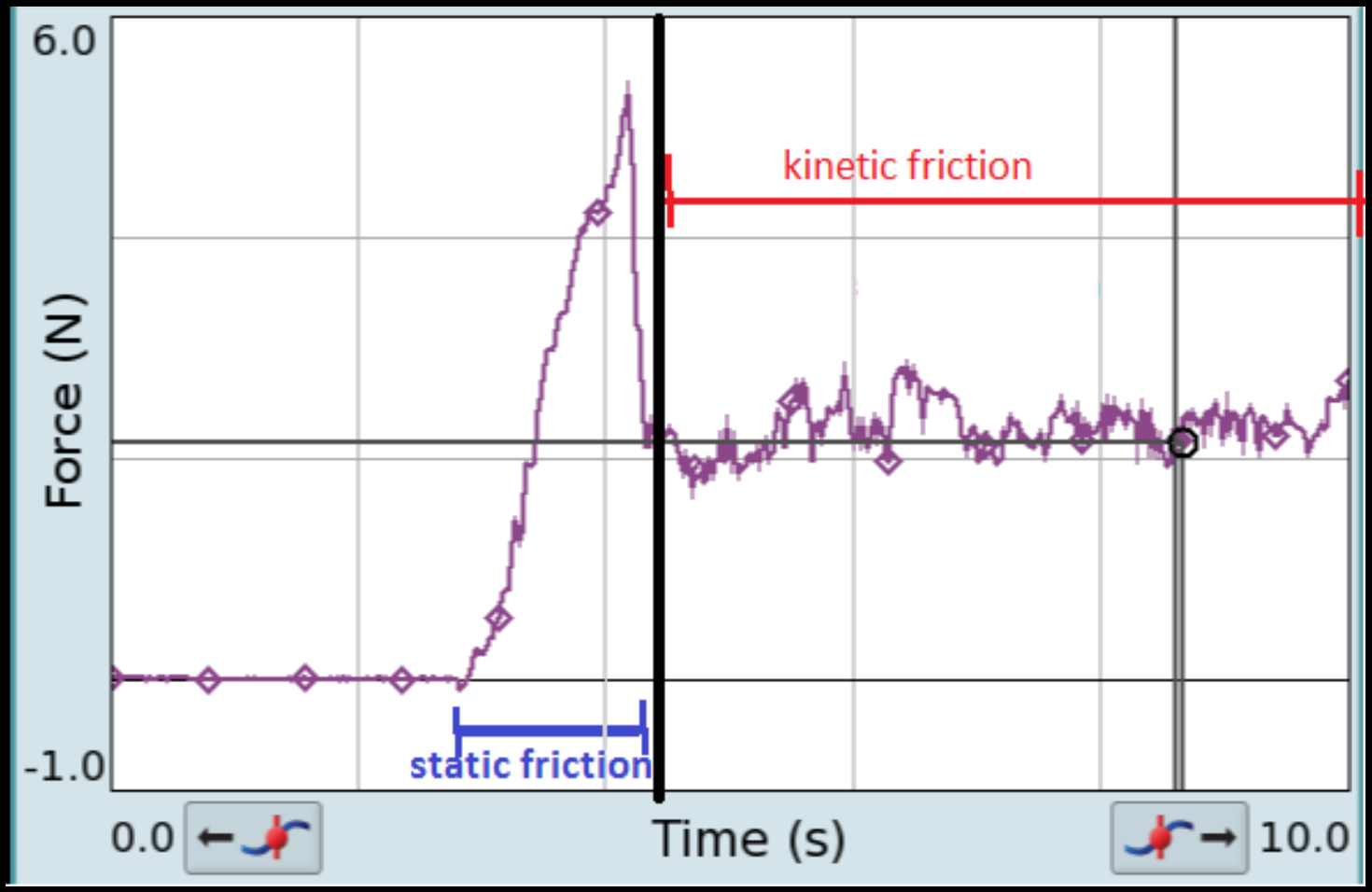
In these problems, solve for the net force and indicate direction. For example, using the diagram to the left you would have

(20 N – 10 N) + (15 N – 10 N) = 10 N up, 5 N right
Motion would be up and to the right

~ Make sure you have completed your beetle lab conclusion and have turned in the data sheet and questions (answered, of course!)

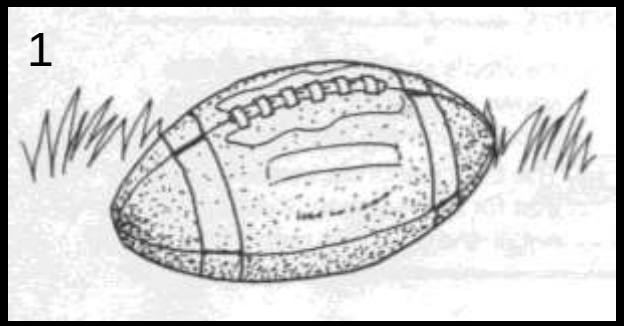
~ Force worksheets 1 – 4 are due Friday, 30-Sep

~ Friction Poster is due Monday, 3-Oct



When the mass is not moving, the object experiences static friction. The friction increases as the applied force increases until the block moves. After the block moves, it experiences kinetic friction, which is less than the maximum static friction.

1



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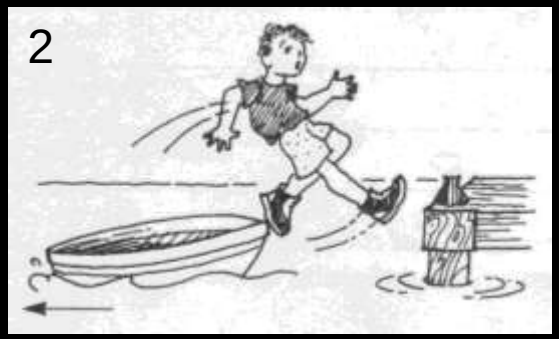
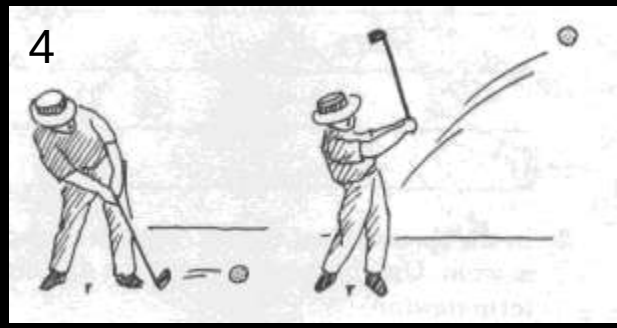


Look carefully at these illustrations. Decide which of Newton's laws is illustrated in each example. Explain how the situation illustrates the law you chose.

3

4



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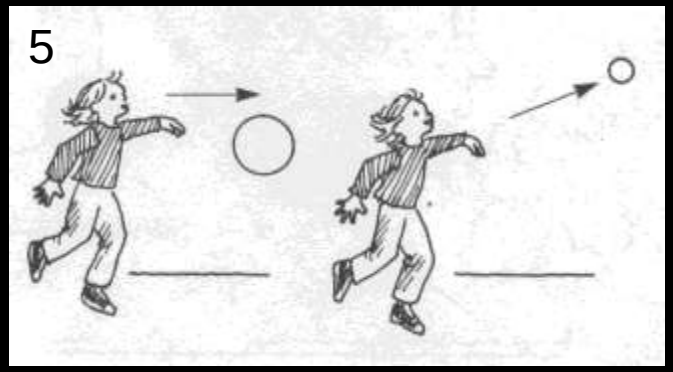

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