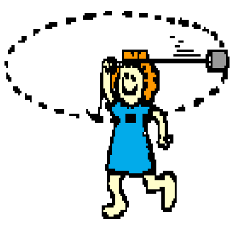
Newton's Third Law



EQ: How can we describe forces without words and numbers?
EQ:Is the sum in all of the forces in the universe an odd or even number? Why?

Enduring Understandings
- A net force is required to change an object's velocity.
- No force is required to explain constant velocity.

Learning Targets
- Identify and apply Newton's Laws of Motion to a variety of qualitative and quantitative problems.
- Draw free body diagrams (FBD)
- Analyze position versus time, velocity versus time and acceleration versus time graphs for regions that represent Newton's 1st & 2nd Laws.
- Apply Newton's Laws of Motion to a variety of problems.
- Identify when an object experiences frictional forces

Place the palms of your hands together in front of your chest.

While keeping the palms of your hand at the center of your chest, push your hands towards one another while gradually increasing the amount of force.

Which hand applied the greatest amount of force on the other? RIGHT and/or LEFT Neither! Same force!

Newton's Third Law of Motion
When two bodies interact, the forces on the bodies from each other are always equal in magnitude and opposite in direction. These are referred to as Action-Reaction pairs of forces.

The two bodies interacting are the right and left hands.

Complete the sentence below by circling either RIGHT or LEFT.

The force on the RIGHT/LEFT hand from the RIGHT/LEFT hand is equal in magnitude and opposite in direction to the force on the RIGHT/LEFT hand from the RIGHT/LEFT hand.

This is a wordy expression and can be simplified with some common notation. Up to this point we have only expressed what type of force is acting ON AN OBJECT with a subscripted letter such as "g" for the force of gravity, F_g. Since all of our past problems dealt with just one object there was no need for a better notation. But, what if there is more than one object of interest in a problem. How can the forces acting on each of the objects be clearly notated to prevent confusion and incorrect force identification? Simple, with the following notation

$$F_{\text{TYPE, ON, FROM}}$$

For example - Gravity is pulling downward on you. Where is the force of gravity emanating from? The force of gravity acting on you is coming from the earth. This force has been expressed in the past as F_g but can be expressed more precisely as $F_{g,\text{YOU, EARTH}}$. This reads as the force of **GRAVITY** acting **ON YOU, FROM the EARTH.**

Express the forces acting on each of your hands using this notation.

$$F_{\text{App},\ \text{RH},\ \text{LH}} = F_{\text{app},\ \text{LH},\ \text{RH}}$$

There are 3 conditions each pair of action-reaction forces must satisfy.
1. The forces must be the same type.
2. The forces must act on different objects. (The forces are drawn on different FBDs.)
3. The subscripts must be reversible, i.e. $F_{\text{on,from}} = F_{\text{from, on}}$

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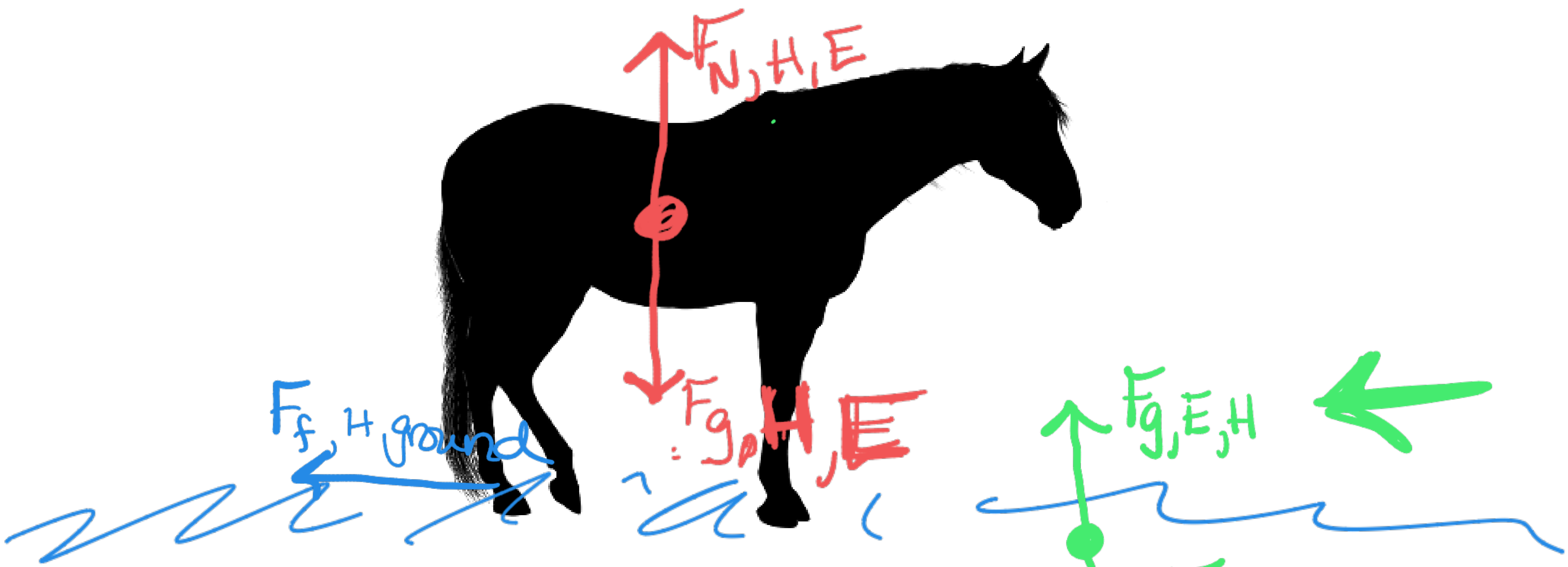
Horse and Cart

A horse is walking along a rough level road as shown. Draw and identify all the action-reaction forces acting on the horse and the earth and complete the chart below.



Type of Force	ON	FROM	$F_{TYPE,ON,FROM}$
gravity	H	E	$F_{g,H,E}$
gravity	E	H	$F_{g,E,H}$
normal	H	E	$F_{N,H,E}$
normal	E	H	$F_{N,E,H}$

If the horse and earth are considered to be one object, what is the net force acting on the horse/earth system? $\Sigma F = \emptyset$

All the forces acting on the horse/earth system are referred to as internal forces. Internal forces come in pairs (action-reaction) and cancel one another. Therefore, the sum of internal forces is always equal to zero. So, can the horse, apart from the earth, change its motion; can the horse accelerate?

If the horse is the only object of interest, then examine only the forces acting on the horse and ignore the forces acting on the earth.

What is the net force acting on the horse?

Where did this net force originate from?

The net force acting on an object is the sum of all external forces. An external force is a force that originates from outside the object.

weight → force of gravity acting on an object

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$$F_g = \underset{(N)}{W} = \underset{(kg)}{m} \cdot g$$