Analyzing Running on Water: How do objects stay up?

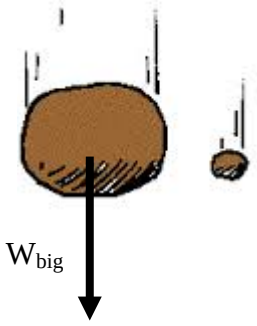
For an object to NOT accelerate downwards (fall down), any downward force must be cancelled out by an equal _____ force.

Gravity exerts a downwards force on all objects on Earth. We call this their _____.

Weight ≈ 10 x mass

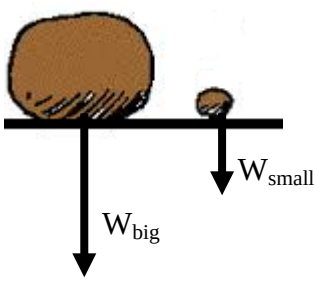
- Force of gravity. Forces are measured in Newtons (N)
- Acceleration of all objects due to gravity on earth, units of m/s^2
- Units of kilograms (kg)

1. The picture below shows two rocks in free fall, each only experiencing the downwards force of gravity (no air resistance). Draw and label an arrow showing the gravitational force (weight) on the little rock. Make sure the size of your arrow makes sense compared to the bigger rock's arrow.



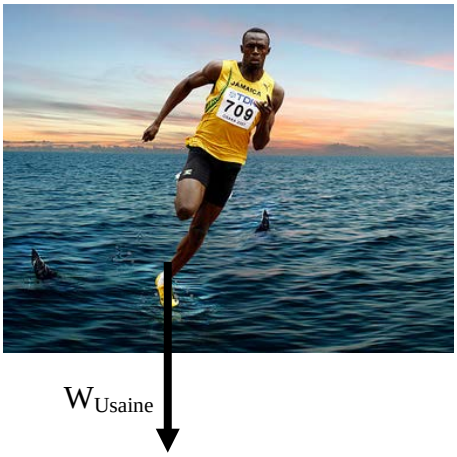
When an object is at rest on a horizontal, solid, stable surface, that surface exerts a vertical force fully opposing any downward force, causing the object to remain at rest. We call this the **Normal Force**.

2. Let's consider the same two rocks resting on a table top. Gravity is still pulling them down, what force is canceling it out? Draw and label it (twice) on the picture below, making your arrow size appropriate in each case.



3. The same two rocks from Question #2 have masses of 5.0 kg and 1.0 kg. Find the normal force exerted on them by the table. Show work, and remember to include units on your forces. Hint: see top of page 1.

4. Consider Usain Bolt running on water with one foot in contact with the water. Calculate the downwards gravitational force (weight) on Usain his mass is 94kg. Write this value on his weight arrow shown below.



Unlike a table, water is not a solid surface, so it *might not* exert enough of a normal force to cancel out Usain's weight. Let's explore possible upwards forces from water:

A) Surface tension – if the object *does not break through* the surface of the water, the water will exert an upwards force on the object. The maximum upwards force due to surface tension on Usain's sneaker would be less than 1 N.

B) Buoyant force - when an object *does break through* the surface and displaces water, it experiences an upwards (buoyant) force. This force is equal to the weight of the water that the object has displaced. Given that a very large completely submerged running shoe could displace a maximum of 1.5kg of water, at most the water could exert _____ upwards.

5. Is either of these forces big enough to keep the runner from sinking? Is it possible for someone to run on water like in the video? Explain, using a diagram showing the possible forces on Usain to support your answer.