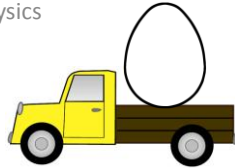


## Egg Crash Vehicle

Applied Physics



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## Forces

- A \_\_\_\_\_ is a push or pull.
- There are 2 types of forces we will be focusing on, \_\_\_\_\_ and \_\_\_\_\_ Forces
- Contact Forces require contact
  - Ex. \_\_\_\_\_
- Field forces do not require contact
  - Ex. \_\_\_\_\_
- Both of the forces can cause something to accelerate

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## What Forces are present?

**Contact, field, both, or none**

1. Pulling a wagon across a flat spot of ground
2. Picking up a box of Pokémon cards
3. A tape dispenser sitting on a desk

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What is the “Main” force acting on these objects?

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## What is a Force?

- A force can cause the motion of an object to change.
- For example, when you kick (apply a force) to a soccer ball, it moves




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## Balanced Forces

- Force does not always change velocity.
- When two or more forces act on an object at the same time, the forces combine to form the net force.

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## Net Force

- When you are finding net force you...
  - \_\_\_\_\_ the forces together if they are in the SAME direction.
  - \_\_\_\_\_ the forces together if they are in OPPOSITE directions.
- You MUST put a \_\_\_\_\_ on the net force
  - To the left, north, up...

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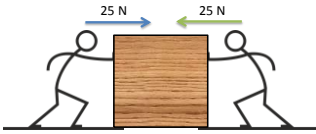
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### Balanced Forces

- Forces on an object that are equal in size and opposite in direction are called \_\_\_\_\_
- This interaction results in a net force of zero



25 N right + 25 N Left = \_\_\_\_  
 25 N + (-25 N) = 0 N

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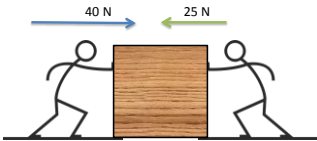
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### Unbalanced Forces

- When two students are pushing with unequal forces in opposite directions, a net force occurs in the direction of the larger force.
- They are considered to be \_\_\_\_\_.



40 N right + 25 N Left = \_\_\_\_  
 40 N + (-25 N) = 15 N **Right**

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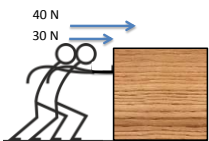
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### Unbalanced Forces

- The students are pushing on the box in the same direction.
- These forces are combined, or added together, because they are exerted on the box in the same direction.



40 N Right + 30 N Right = \_\_\_\_  
 40 N + 30 N = 70 N **Right**

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### Net force? Bal vs Unbal.

- A man pushes east with a 45 N force while a girl pushes west with a 30 N force.
- A boy pushes north with a 50 N force and a girl pushes north with a 20 N force.
- A horse pulls forward with a 300 N force and a wagon pulls with a 300 N force backwards
- If the net force applied to a box is 70 N north while a boys pushes north with 100 N, what force is the girl applying?

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### Newton's Laws

- The British scientist \_\_\_\_\_ was able to state rules that describe the effects of forces on the motion of objects.
- These rules are known as \_\_\_\_\_ law's of motion.

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### Newton's 1<sup>st</sup> Law

- Newton's first law of motion states that

OR

- An
- This law is sometimes called the law of \_\_\_\_\_.

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## Newton's 1<sup>st</sup> Law

- \_\_\_\_\_ is the tendency of an object to resist a change in motion unless an outside force acts on the object
  - It wants to keep moving or NOT move
    - Ex. catch
- Objects only change their motion when a \_\_\_\_\_ acts on them
  - i.e. at car stops because a force acts on it

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### What happens in a head-on collision?

- The law of inertia can explain what happens in a car crash.
- When a car traveling about 50 km/h collides head-on with something solid, the car crumples, slows down, and stops within approximately 0.1 s.




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### What happens in a head-on collision?

- Any passenger not wearing a safety belt continues to move forward at the same speed the car was traveling.
- Within about 0.02 s (1/50 of a second) after the car stops, unbelted passengers slam into the dashboard, steering wheel, windshield, or the backs of the front seats.

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## Seat Belts

- The force needed to slow a person from 50 km/h to zero in 0.1 s is equal to 14 times the force that gravity exerts on the person.
- The belt loosens a little as it restrains the person, increasing the time it takes to slow the person down.
- This reduces the force exerted on the person.
- The safety belt also prevents the person from being thrown out of the car.

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## Seat Belts

- Air bags also reduce injuries in car crashes by providing a cushion that reduces the force on the car's occupants.
- When impact occurs, a chemical reaction occurs in the air bag that produces nitrogen gas.
- The air bag expands rapidly and then deflates just as quickly as the nitrogen gas escapes out of tiny holes in the bag.

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## Newton's 2<sup>nd</sup> law

- Newton's second law of motion describes how the forces exerted on an object, its mass, and its acceleration are related
- **Newton's second law of motion** states

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## Equation Manipulation!!

$$\text{acceleration} = \frac{\text{Net Force}}{\text{mass}} \quad a = \frac{F_{net}}{m}$$

Manipulate the equation to solve for mass and for force.

$$m = \frac{F_{net}}{a} \quad F_{net} = ma$$

Force is measured in Newtons (N)

$$1 \text{ N} = 1 \text{ kg} \cdot \text{m/s}^2$$

## Practice

- How much force is applied to an 8 kg object when it undergoes an acceleration of 2.4 m/s<sup>2</sup>?
- What is the mass of an object if it experiences a 500 N force when it undergoes an acceleration of 4.5 m/s<sup>2</sup>?
- What is the acceleration of a 600 g object that experiences a force of 150 N?

## Weight

- The gravitational force exerted on an object is called the object's \_\_\_\_\_.
- Because the weight of an object on Earth is equal to the force of Earth's gravity on the object, weight can be calculated from this equation:

$$\text{Force (N)} = \text{mass(kg)} \times \text{gravity (m/s}^2\text{)}$$

$$F = mg$$

$$g = 9.8 \text{ m/s}^2$$

## Practice

- What is the weight (in N) of a 45 kg object?
- What is the weight of the same object if you put it on Jupiter? (Jupiter's gravitational force is 2.5 times larger than Earth's)
- If an object has a weight of 980 N, what is the object's mass?

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## Weight and Mass

- \_\_\_\_\_ and \_\_\_\_\_ are not the same.
- \_\_\_\_\_ is a force and mass is a measure of the amount of matter an object contains.
- \_\_\_\_\_ and mass \_\_\_\_\_ related.  
\_\_\_\_\_ increases as \_\_\_\_\_ increases.

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## Weight and Mass

- The \_\_\_\_\_ of an object usually is the gravitational force between the object and Earth.
- The \_\_\_\_\_ of an object can change, depending on the \_\_\_\_\_ force on the object.

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## Examples

- I move a box of salamanders from sea level to the top of Mt. Everest



- I remove 3 salamanders from a box of 10 salamanders




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## Newton's 3<sup>rd</sup> Law

- **Newton's third law of motion** describes action-reaction pairs this way.

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## Action Reaction Forces

- When a force is applied in nature, a reaction force occurs at the \_\_\_\_\_ time.
- When you jump on a trampoline, for example, you exert a downward force on the trampoline.
- Simultaneously, the \_\_\_\_\_ exerts an equal force \_\_\_\_\_, sending you high into the air.

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### Action Reaction Forces DON'T Cancel Out

- According to the third law of motion, action and reaction forces act on \_\_\_\_\_ objects.
- Thus, even though the forces are equal, they are \_\_\_\_\_ because they act on \_\_\_\_\_ objects.




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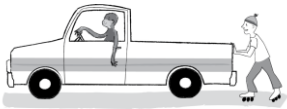
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### Example

- You push a car down the street
- You are applying a force to the car and the car is applying the \_\_\_\_\_ force back on you
  - Force you on car
  - Force car on you
  - The force is applied to \_\_\_\_\_ objects




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### Momentum

- A moving object has a property called \_\_\_\_\_ that is related to how much force is needed to change its motion.
- The \_\_\_\_\_ of an object is the product of its mass and velocity.

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## Momentum

- Compare momentums of...




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## Momentum

- Force is related to changes in momentum
  - Ex. Caching an egg
    - Moving hands vs. NOT moving hands

How can this apply to your project?

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## Momentum

- Momentum is given the symbol \_\_\_\_\_ and can be calculated with the following equation:
- The unit for momentum is  $kg \cdot m/s$ . Notice that momentum has a direction because velocity has a direction.

*momentum = mass x velocity*

$$kg * \frac{m}{s} = kg * m/s$$

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## Practice

- A 50 kg object is moving with a velocity of 2.7 m/s south. What is the momentum of the object?
- If an 250 kg object has a momentum of 40.6 kg\*m/s north, what is the velocity of the object?
- What is the mass of an object (in grams) that is moving with a velocity of 7.8 m/s east and has a momentum of 460 kg\*m/s.

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