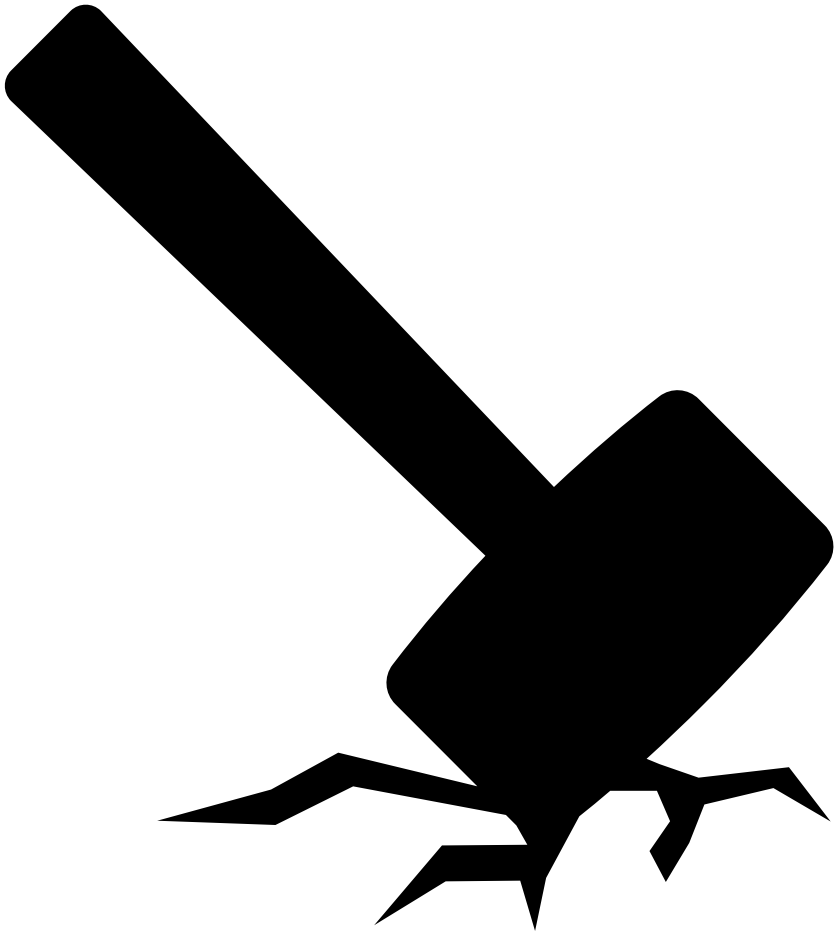
Forces



Name _____

Class _____

Teacher _____

L1 Contact and non-contact forces

A force is a push, a pull, or a twist. They can change the **speed, direction, or shape** of an object.

Forces are pushes, pulls or twist in a specific direction. An example of a force acting on an object is when we roll a ball down a ramp. A force called weight pulls the ball down the ramp and a force called friction pulls back in the opposite direction.

A **contact force** is one that acts when two objects are physically touching each other. Conversely, a **non-contact** force acts between objects that are not touching each other.

Force Name	Description	Contact or non-contact
Thrust	Forward push of an object moving on a solid surface	Contact
Magnetism	Attraction (pull towards) or repulsion (push away) of magnets and magnetic materials	Non- contact
weight	Attraction between two objects with mass (Gravity)	Non-contact
Upthrust	Upward push of water particles on an object	Contact
Normal contact	Upward push of a solid surface on a object	Contact
friction	Force which slows objects moving along a solid surface	Contact
Water resistance	Force which slows objects moving through water	Contact
Air resistance	Force which slows objects moving through air	Contact
lift	The force pushing up on a object as it moves through the air, caused by differences in air pressure.	Contact

Independent practice

Easy part 1

Use the text above to find the answers to the following questions and write them in your book:

1. What is a force?
2. What can forces do?
3. Give an example of a force in action?
4. What is the difference between a contact and a non-contact force?
5. Give some examples of contact forces.
6. Give some examples of non-contact force.
7. What is the normal contact force?
8. What is upthrust?
9. What is friction?

Easy part 2

Answer these questions in your book.

10. Imagine you have discovered a new force. With this force you are able to move objects using the power of your mind. Is this a contact or non-contact force? Explain your answer.
11. When we drop an object in oil it slows down. There is a force which stops it from travelling quickly caused by oil particles rubbing past the surface of the object. Is this force contact or non-contact? Explain your answer.

Medium

12. A ball rolls down a hill. Describe all of the forces on the object:
    Use this as help:
    The ball is pulled down a hill by…
    The force pulling it back is…..
    Another force which might push against it is……
13. A diver plunges into water. Describe all the forces acting on the diver.
14. An airplane takes off. Describe all of the forces acting on the airplane.
15. A boat floats in water. Describe all of the forces acting on the boat.

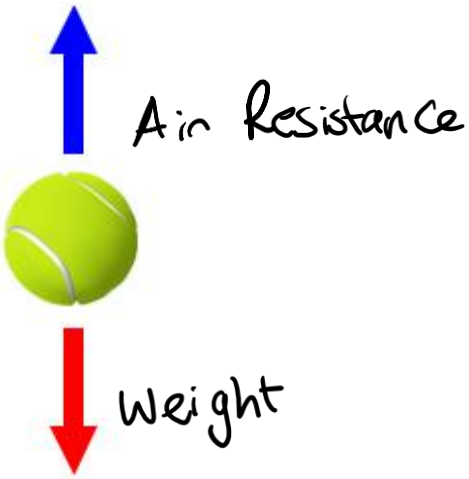
Hard

16. A student says:
    “Air resistance causes a boat to float, it is a non-contact force. Magnetism pulls the boat down.”
    Explain why they are wrong and re-draft the statement.

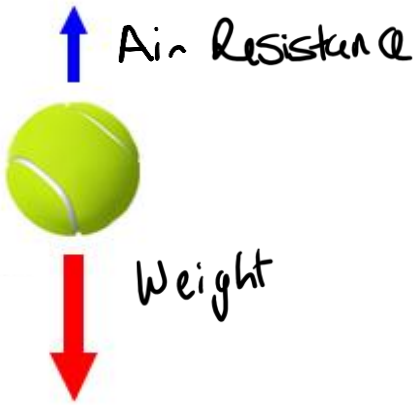
L2 Balanced and unbalanced forces

When a ball is dropped, we see that weight acts on the object in one direction and air resistance acts in the opposite direction. Weight pulls the ball down and speeds it up. The ball drops but air resistance slows it down. The motion (motion is the scientific word for movement) of the ball is affected by both forces. If one force is stronger than the other the balls motion would change. If the forces are the same size, then the objects motion will stay the same. When the forces are the same size, we say the forces are balanced. When the forces are different sizes, we say the forces are unbalanced.

Example 1: Forces are balanced



Example 2: Forces are unbalanced



If an object has already started moving (scientists call this “in motion”) and the forces on it are balanced then it remains in motion at the same speed. An example would be the falling ball in the first example above. The ball would continue to fall at the same speed because the forces are balanced.

If an object is standing still (scientists call this “stationary”) and the forces on it are balanced, then the object remains stationary. An example would be the falling ball in example 2. The ball speeds up (accelerates) because air resistance is slower.

If an object is in motion, and the forces on it become unbalanced, then the object might speed up or slow down.

If an object is stationary and the forces on it become unbalanced, then the object will begin to move.

And finally, if an object is stationary and the forces on it are balanced, it remains stationary.

Independent practice

Easy

1. What do we mean by the term motion?
2. What word do we use to describe two forces acting on an object which are the same size?
3. What word do we use to describe two forces acting on an object which are different sizes.
4. What happens to an objects motion when the forces are balanced?
5. What happens to an objects motion when the forces are unbalanced?

Medium

6. A brick is dropped in a swimming pool. The force of weight on the brick is greater than the opposite force of water resistance. Are the forces balanced or unbalanced.
7. Describe the motion of the brick. Use the following words to help you: speeds up, downward, falls.
8. A car is travelling forward pushed by the force of thrust. The driver applies the breaks and friction becomes greater than thrust. Are the forces balanced or unbalanced?
9. Describe the motion of the car.
10. A ball is stationary on a surface and remains stationary. Are the forces balanced or unbalanced.
11. A person is skydiving (jumping out of an airplane) and the forces on the person become balanced. Describe the motion of the person.

Hard

12. Explain why an airplane can fly at the same height on its journey. Refer to the forces of weight and lift.
13. Explain why a ball will roll when given a push.
14. Explain why a parachute slows down a sky diver.

L3 Force Diagrams

When we look at objects with forces acting on them, we can not see the size or direction of the forces. We can only see the effects which the forces have. It is very hard to talk to people about forces if we can not see them. Scientists use pictures to communicate what people can not see. For forces we use a picture called a free body diagram. Free body diagrams are pictures of objects and arrows which show the forces. The arrows have both a specific direction and a specific size. Here is an example of a free body diagram.

Let's look at the example above. There is a picture of the object which is a person and trolley, there are arrows and there are numbers. The arrows are both the same size and they start from a specific place and point in different directions.

- The arrows both start from the objects center of mass (stuff which the object is made up). The center of mass is where most of the objects mass is located.
- The arrows size shows the size of the force. Here the arrows are equal in size so the forces are equal.
- The direction of the arrows show there are two forces acting in opposite directions. They are balanced.
- The number shows the actual size of the force. Forces are measured in Newtons and have the symbol N. The numbers are the same showing that the forces are the same size.

The motion of an object will depend on the **resultant force**. The resultant force is the sum of all the different forces acting on an object. When more than one force acts on an object, the forces combine to form a resultant force. When resolving forces acting opposite to each other we subtract the smaller force from the bigger force. This will give us the resultant force

A resultant force of zero means that the object will either remain stationary or remain moving at the same speed. If all individual forces make a resultant force of zero, we say the forces **balanced**.

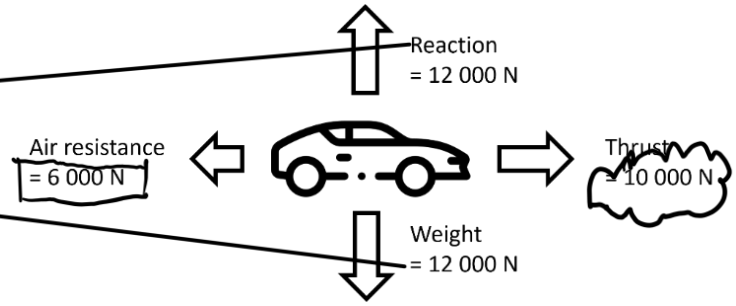
For example, the weight and the reaction force on the car are **balanced**.

12000N – 12000N = 0N

The thrust and the air resistance forces are **unbalanced** and there is a **resultant force** of

4 000 N to the right. The car will therefore **accelerate.**

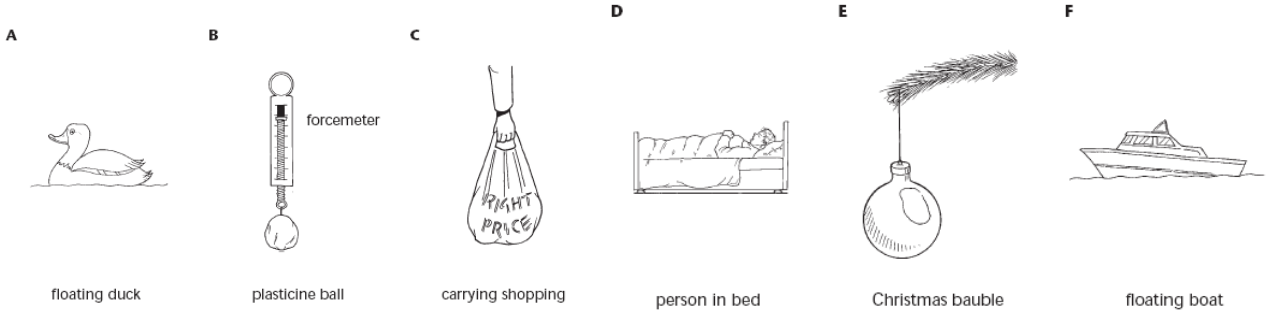
10,000N – 6000N = 4000N



<u>Independent Practice</u>

Easy

1. What information is missing when we look at forces acting on an object?
2. What do picture do scientist use to show the forces acting on an object?
3. What is in a free body diagram?
4. What do the arrows show?
5. Where do the arrows normally start?
6. What two features of the arrows are important in a free body diagram?
7. What are forces measured in?
8. What is a resultant force?
9. How are resultant forces calculated?
10. What happens when the resultant force is zero?
11. Draw free body diagrams to show the forces acting in the following scenarios:



Medium

12. Two people are competing in a tug of war. Use the force diagram to the right to answer the questions:

13. State whether the forces are balanced.
14. Calculate the resultant force.
15. A lorry is travelling on the motorway. Use the force diagram to the right to answer the questions:
16. State whether the forces are balanced.
17. Calculate the resultant force.
18. State what will happen to the lorry.

19. An airplane is on a flight. Use the force diagram to the right to answer the questions:

a. State whether the forces are balanced.
b. Calculate the resultant force.
c. State what will happen to the airplane.

20. A force diagram for a boat is shown.

a. Calculate the resultant force:
b. State what will happen to the boat.

L4 Measuring Forces

Which force is bigger: a sack of potatoes hanging from a string or a sack of bricks hanging from a string. How much bigger is the force produced by the sack of bricks? To answer this question, we need to measure the forces. Forces are measured in Newtons. We use a special device called a newton meter to measure forces. It looks like this:

There are different Newton meters to measure different amounts of force. To decide which newton meter to use to measure a force we must look at a specific part of the newton meter, the measurement scale.

The measurement scale helps us decide whether the newton meter is appropriate for the measurement of the force we are interested in. Let's say we are trying to measure how much force it takes to open a cupboard. This is small force which might be no bigger that 10-20 Newtons so we would use a newton meter which has a scale with numbers on it up to 50N. Let's say we now want to measure the force it takes to pull a car. If we tried to measure this with the newton meter with a maximum reading of 50N we would not be able to measure any higher than this. The car might take 1000N to pull but we would not be able to measure it as our meter would only get to 50N. We would need a newton meter which could measure 1000N and more.

We must also read the scale accurately. If we change the way we read the scale each time, we might introduce random errors and not get a result which is close to the truth. We must always read the scale at eye level, always measure from the top of the mark on the newton meter and pay attention to what each of the scale lines represent.

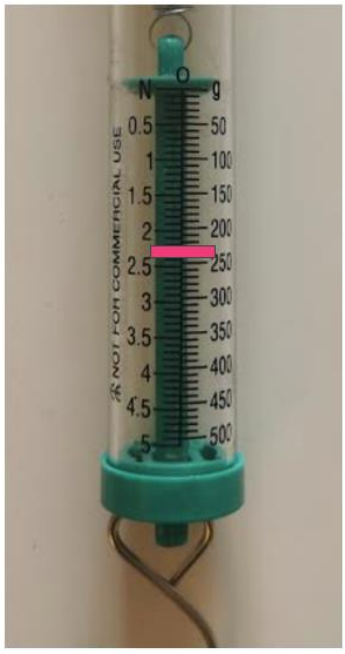
If you look at the newton meter in the picture the top of the line is just under the number 4 and the line is 2 small marks (graduations) under the number 4. The next number is 5 meaning we read the scale as increasing when we go down. There are 10 small graduations between each number so each one must count for 0.1. So, this Newton meter is reading 4.2N.

Independent Practice

1. What do we use to measure forces?
2. What are forces measured in?
3. What helps us decide which newton meter is the best for measuring our force?
4. Finish the sentences:
   a. To measure a small force you would use a newton meter with……
   b. To measure a big force you would use a newton meter with…..
5. If a force is around 90N what would be the maximum reading on the Newton meter you would use?
6. What happens if we change the way we read the scale each time?
7. How must we always use a newton meter?
8. What do we mean by graduation?
9. How do we work out what each graduation counts for?

Medium

10. Write down the size of each force on each newton meter.



11. A student uses a newton meter to measure a force but when they put the force on the newton meter the reading is beyond the maximum. What must the student do to solve this problem.
12. Three students measure a force with the same newton meter. One student gets the result 20.2N, one student gets the result 20.5N and one student gets the result 20N. What could be causing the error.
13. A student measures several forces with a newton meter and when they compare the result with a teacher the result is always 5N more that the teachers. What has happened?

L5 Friction and Resistance

When you kick a football the ball rolls on the ground, slows down and eventually stops. If you did this in space, where the ball does not touch the ground and there is no air the ball would move forward forever! The force which stops the ball is friction. Friction occurs when a force is applied and there are two surfaces touching. The friction is always in the opposite direction to the force applied.

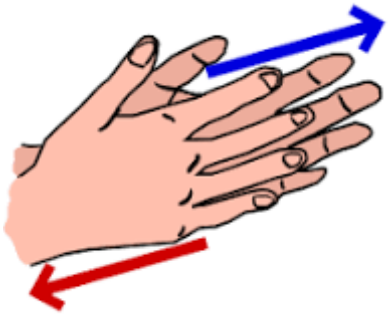
The amount of friction produced when an object moves depends on several things. The first is the speed of the object, the faster something moves the greater the frictional force produced.

The second is the surface itself, a smooth surface like ice will produce very little friction, hence so many accidents occur on ice, whereas a rough surface like carpet would produce much greater frictional forces.

The third factor is the mass of the object itself.

Friction also occurs when objects move in liquids and gasses. We call this type of friction air resistance or water resistance. The tiny particles which make up gasses and liquids are rub against the object and cause a tiny amount of friction. The object rubs against millions of particles when travelling and the friction builds up into an overall force.

If we want to reduce air resistance and water resistance we must reduce the objects surface contact with the air or water. We take flat surfaces and curve them so that the air or water travels over more easily without as much friction. We call this process streamlining.



Independent practice

1. Draw a particle diagram of a liquid
2. Draw a particle diagram of a gas
3. Gas pressure is caused by collisions between gas particles and containers. What is a collision?
4. If you move your hand through a gas, what does your hand collide with?
5. A student says that "if you move your hand through air, you are moving your hand through nothing." Explain why the student is wrong.
6. If you are in a car that is moving fast, what do you feel if you put your hand outside the window?
7. A submarine is moving through water. Its thrust is bigger than water resistance. Draw a free body diagram for the submarine.
8. A car is moving along a road. What two forces are acting against it?
9. A boat is moving through water. What two forces are acting against it?
10. A spaceship is moving through space. Explain why there is no air resistance acting on it.
11. A boat is in a river. A person is standing on the bank (side) of the river, and using a rope to pull the boat. What forces are acting on the boat?
12. Draw a free body diagram for the boat.
13. Explain what causes air resistance.
14. Explain why for objects moving slowly, air resistance is very small.
15. A car is driving along a road. If it speeds up, what will happen to the friction acting against it?
16. If it speeds up, what will happen to the air resistance acting against it?
17. Draw a free body diagram for a boat moving slowly through water. Label all forces.
18. The person sailing (driving) the boat, puts her foot on the pedal to make the boat move faster. Draw another free body diagram for the boat. Explain every change you have made to your diagram.