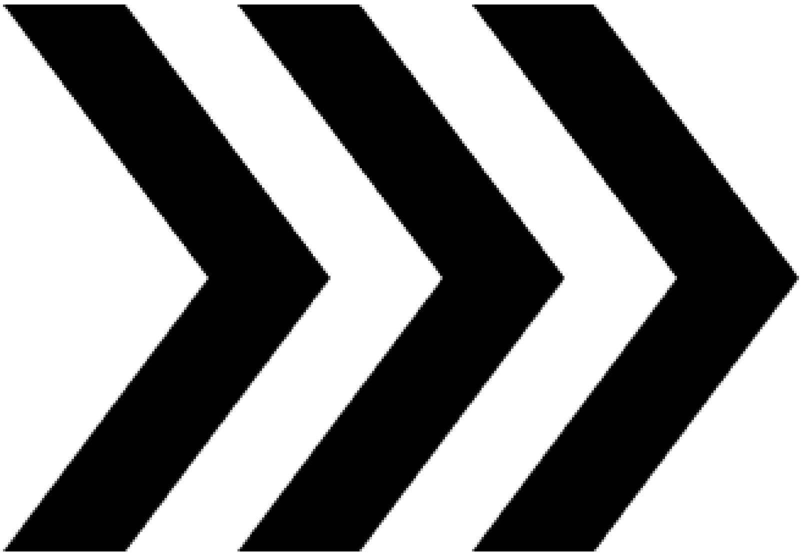
Motion



L1 Speed

Speed is an important concept in science, and it's something we encounter every day, whether we're walking to school, riding a bike, or watching a car zoom by. Speed is a measure of how fast something is moving, and in this explanation, we'll explore what speed is, how to calculate it, and why it's crucial in the world of science.

Speed is the rate at which an object moves from one place to another in a given amount of time. Think of it as how quickly you can get from point A to point B. Speed can be fast, like a cheetah sprinting, or slow, like a snail crawling. It's essential to understand that speed is not just about going fast; it's also about how long it takes to cover a specific distance.

To calculate speed, you need two things: distance and time. The formula for speed is straightforward:

Speed = Distance ÷ Time.

Worked example:

Let's say you're riding your bicycle to school, and it takes you 15 minutes (0.25 hours) to cover a distance of 5 kilometres. To find your speed, use the formula:

Speed (S) = Distance (D) / Time (T)

Speed (S) = 5 km / 0.25 hours = 20 km/h

So, your speed while riding your bicycle to school is 20 kilometres per hour. For example, if you walk 300 meters in 5 minutes, your speed would be 300 ÷ 5 = 60 meters per minute (m/min). We can use different units like kilometres per hour (km/h) or miles per hour (mph) for larger distances or longer periods.

Speed can be measured in various units. For instance, cars usually display their speed in miles per hour (mph) or kilometres per hour (km/h), while runners might use meters per second (m/s). Each unit tells us how far an object travels in one hour (mph, km/h) or one second (m/s).

Speed plays a vital role in many scientific disciplines. In physics, it helps us understand how objects move, and in biology, it's crucial for studying animal behaviours and the mechanics of organisms. In everyday life, it's essential for transportation, sports, and even predicting weather patterns.

Speed is all around us. It's used in designing faster cars, predicting when a spacecraft will reach its destination, and even in designing sports equipment. Scientists use speed to explore the world and make our lives better.

Velocity is a close cousin of speed. While speed tells us how fast something is moving, velocity adds a direction to it. For instance, a car moving at 60 mph north has both speed and velocity. Understanding velocity is essential in fields like navigation and astronomy.

Independent practice

1. What is speed in science?
2. How is speed typically measured?
3. What is the formula for calculating speed?
4. If you travel 300 meters in 20 seconds, what is your speed?
5. If you cover a distance of 120 miles in 2 hours, what is your speed in mph?
6. Why is it important to know the speed of vehicles on the road?
7. How can speed be helpful in planning your daily activities?
8. Give an example of a sport where speed plays a crucial role.
9. Why do engineers need to consider speed when designing vehicles?
10. How does speed relate to time and distance?
11. If a car travels 150 kilometres in 2.5 hours, what is its speed in km/h?
12. Explain why it's essential to understand speed in everyday life.
13. Can you think of a situation where knowing an object's speed would be important for safety?
14. What units are commonly used to measure speed?

L2 Distance Time graphs

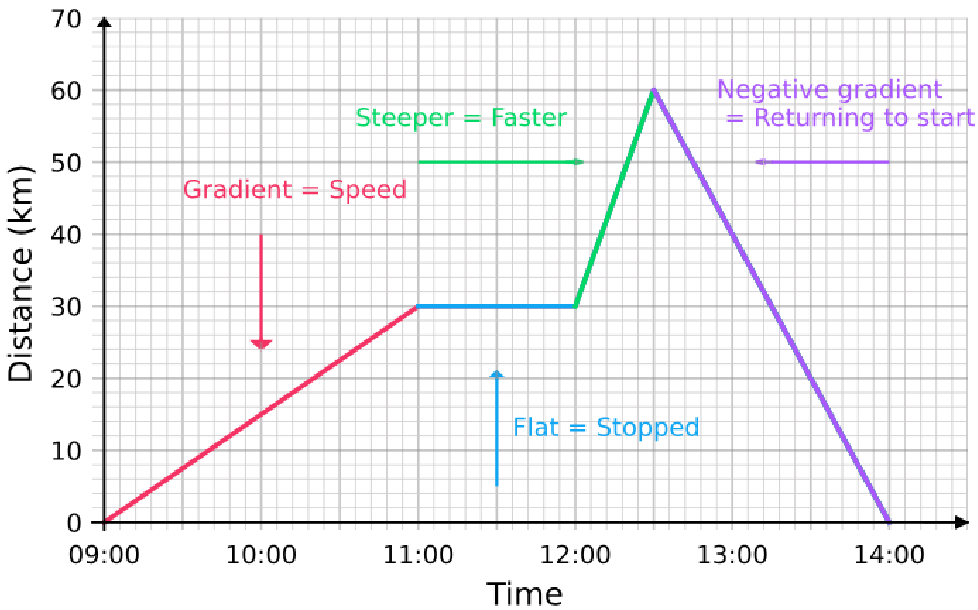
Distance-time graphs are a fundamental concept in science and physics that help us understand how objects move. If you're a 13-year-old studying KS3 science, you're about to embark on an exciting journey into the world of graphs, motion, and speed. In this explanation, we'll break down the basics of distance-time graphs, making them easy to understand. By the end of this, you'll be able to read and interpret these graphs and even answer some questions about them.

A distance-time graph, often called a D-T graph, is a way to show how an object's position changes over time. The graph has two axes – the horizontal one represents time (in seconds, minutes, or hours), and the vertical one represents distance (in meters or kilometres). When an object moves, its position changes, and the graph helps us see how fast or slow it's moving and in which direction.

Imagine you're looking at a distance-time graph. If you see a straight line sloping upwards from left to right, it means the object is moving away from its starting point at a constant speed. The steeper the line, the faster it's moving. If the line is flat, it means the object isn't moving because the distance isn't changing with time. A downward sloping line indicates the object is coming back towards its starting point. So, distance-time graphs are like a visual story of how things move.

To calculate speed from a distance-time graph, you can use this simple formula: Speed (m/s) = Distance (m) ÷ Time (s). So, if you know the distance and time from the graph, you can find out how fast the object is moving. If you have a straight line on the graph, the speed is constant, but if the line is curved, the speed is changing.

Acceleration is how quickly an object's speed changes. If the distance-time graph has a curved line, it means there's acceleration. A curve going upwards shows the object is speeding up, while a curve going downwards means it's slowing down.



Independent practice

1. What is a distance-time graph, and what does it show?
2. What do the horizontal and vertical axes represent in a distance-time graph?
3. How can you tell if an object is moving on a distance-time graph?
4. What does a straight line on a distance-time graph indicate about an object's motion?
5. How can you determine the speed of an object from a distance-time graph?
6. What does it mean if a distance-time graph has a flat line?
7. If the line on a distance-time graph slopes upwards, what does it tell you about the object's motion?
8. How can you calculate speed from a distance-time graph if you know the distance and time?
9. What is acceleration, and how can you identify it on a distance-time graph?
10. If a distance-time graph has a curve going upwards, what does it indicate about the object's motion?
11. What does a curve going downwards on a distance-time graph suggest?
12. How does the steepness of a line on a distance-time graph relate to an object's speed?
13. Can you have acceleration if the distance-time graph shows a straight line? Explain.
14. What are some real-life examples where distance-time graphs can be useful in understanding motion?

L3 Relative motion

Relative motion is a fascinating concept in science that helps us understand how objects move in relation to one another. Imagine you're sitting in a moving car, and you see another car on the road. Have you ever wondered how fast the other car is moving relative to yours? Or what if you're on a train and you toss a ball in the air? How does its motion look from inside the moving train? These are the kinds of questions we'll explore in this explanation.

Relative motion is all about how we perceive the motion of one object compared to another, especially when both objects are moving. It's like trying to figure out how fast your friend is riding their bike when you're also on a bike, moving at a different speed. To understand relative motion, we need to consider both the motion of the object we're observing and our own motion.

To calculate relative motion, we often use the concept of velocity. Velocity is a measure of an object's speed and direction. When we talk about relative velocity, we're looking at how two objects move relative to each other. Here's a simple formula to calculate relative velocity:

Relative Velocity (VR) = Velocity of Object A (VA) - Velocity of Object B (VB)

If object A and object B are moving in the same direction, you subtract their velocities. If they're moving in opposite directions, you add them. This helps us find out how fast one object is moving concerning the other.

Let's say you and your friend are both riding bikes in the same direction. Your bike is moving at 15 miles per hour (mph), and your friend's bike is moving at 10 mph. To calculate your relative velocity concerning your friend, you would subtract your friend's velocity from yours:

VR = VA - VB

VR = 15 mph - 10 mph

VR = 5 mph

So, your relative velocity concerning your friend is 5 mph. This means you're moving 5 mph faster than your friend.

<u>Independent practice</u>

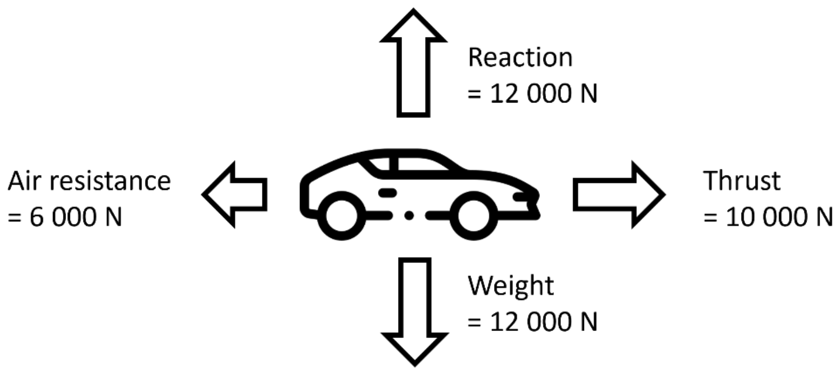
1. What is relative motion, and why is it important to understand?
2. How do you calculate relative motion?
3. What is velocity, and how is it related to relative motion?
4. When would you subtract velocities to calculate relative motion, and when would you add them?
5. Can relative motion only be calculated for objects moving in the same direction? Why or why not?
6. Imagine two cars on the highway, one going at 60 mph and the other at 70 mph. What is their relative velocity if they're both moving in the same direction?
7. If two friends are running towards each other on a track, one at 8 m/s and the other at 6 m/s, what is their relative velocity?
8. What happens to relative motion when objects are moving in opposite directions?
9. How would you calculate relative velocity if you're on a train moving at 50 mph, and you throw a ball upward at 10 mph?
10. Can you think of a real-life situation where understanding relative motion is crucial?
11. Why is it important to consider your own motion when calculating relative velocity?
12. What units are used to measure velocity, and why are they important in calculating relative motion?
13. If you're on a boat traveling at 20 knots, and another boat is approaching you at 15 knots, what is their relative velocity?
14. How might understanding relative motion be useful in everyday activities, like driving or playing sports?

L4 Calculating resultant forces.

Forces are shown in diagrams called free-body diagrams. Forces are represented by **arrows** in diagrams. They are drawn showing the way in which they are acting. The longer the arrow, the larger the size of the force.

The motion of an object will depend on the **resultant force**. This is calculated by adding all the forces together, taking their direction into account. When more than one force acts on an object, the forces combine to form a 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**.

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.**

The resultant force was calculated by subtracting the smaller force from the larger force which is opposite. In the example above we subtracted 6000N from 10000N, giving us 4000N.

<u>Independent practice</u>

1. **Extended writing (paragraph required)**: Explain what a free body diagram shows.
2. How does the motion of an object depend on the resultant force, and how is the resultant force calculated?
3. What does it mean when the resultant force on an object is zero, and how does this affect the object's motion?
4. Can you provide an example of balanced forces mentioned in the text, and what is the implication of these balanced forces on the object?
5. In the given example, how was the resultant force of 4,000 N calculated, and what was the process of subtraction involved?
6. Two people are competing in a tug of war. Use the force diagram to the right to answer the questions:
   b) State whether the forces are balanced.
   c) Calculate the resultant force.

1. A lorry is travelling on the motorway. 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 lorry.

2. An aeroplane is on a flight. Use the force diagram to the right to answer the questions:
   a) State whether the forces are balanced.
   a) Calculate the resultant force.
   b) State what will happen to the aeroplane.

3. A force diagram for a boat is shown.
   a) Calculate the resultant force:
   b) State what will happen to the boat.

L5 Drag

Drag is a force that opposes the motion of an object moving through a fluid, such as air or water. In our context, we'll focus on air resistance, which is the drag force acting on objects moving through the air. Air resistance is a form of friction, but it works slightly differently from the friction you experience when, for example, rubbing your hands together.

Factors Affecting Air Resistance:

Several factors influence the strength of air resistance. It's essential to understand these factors to grasp the concept fully:

- Shape of the Object: The shape of an object greatly influences the amount of air resistance it experiences. Objects with streamlined, aerodynamic shapes encounter less air resistance compared to those with irregular or bulky shapes.
- Surface Area: A larger surface area exposed to the oncoming air will result in greater air resistance. Think of it as trying to move through the water – the more of your body is submerged, the harder it is to swim.
- Speed: As an object moves faster through the air, it encounters more air molecules per second, leading to an increase in air resistance. This is why a speeding car encounters more resistance than a slow-moving one.
- Density of the Fluid: The density of the fluid (in this case, air) also affects air resistance. Thicker, denser air creates more resistance than thinner air.
- Smoothness of Surface: A smooth, polished surface will experience less air resistance than a rough or textured one. Think of a polished car versus one with a bumpy, uneven surface.

Link to Resultant Forces and Resolving Forces:

Now, let's connect the concept of air resistance to resultant forces and resolving forces. Resultant forces are the combined effects of all the forces acting on an object. In the case of an object moving through the air, there are usually two main forces in play: the driving force (e.g., an engine's thrust) and the resisting force (air resistance). These forces combine to create the resultant force.

Resolving forces means breaking down these forces into their individual components. In the context of air resistance, this means understanding how it acts against the direction of motion of the object. When an object moves forward, air resistance acts backward, opposing the motion. This opposition results in the object slowing down. If air resistance is greater than the driving force, the object may come to a halt or even move in the opposite direction .

<u>Independent practice</u>

4. What is drag, and how does it affect the motion of objects through a fluid?
5. **Extended writing (paragraph required):** Describe the factors which affect air resistance and how you might use them to reduce it.
6. Why does the shape of an object matter in terms of air resistance?
7. How does the surface area of an object affect the amount of air resistance it experiences?
8. Why do objects move faster through the air encounter more air resistance?
9. How does the density of the fluid (in this case, air) impact air resistance?
10. What role does the smoothness of an object's surface play in air resistance?
11. Define resultant forces. How do they relate to the concept of air resistance?
12. How does resolving forces help us understand the effects of air resistance on an object's motion?
13. Explain the interaction between the driving force and air resistance in an object's motion.
14. When air resistance is greater than the driving force, what happens to the motion of an object?
15. Can you provide an example of an object that experiences minimal air resistance due to its shape?
16. Describe a situation where increasing the speed of an object would lead to a significant increase in air resistance.
17. How might air resistance affect the motion of a parachute falling through the sky?
18. Think of a scenario in which you could decrease air resistance on an object moving through the air. What changes would you make to achieve this?