

Revision Guide for Chapter 8

Contents

Student's Checklist

Revision Notes

Scalar quantities	<u>4</u>
Vectors.....	<u>4</u>
Vector components.....	<u>5</u>
Displacement.....	<u>5</u>
Velocity and speed	<u>6</u>
Vector addition.....	<u>7</u>
Distance–time graph.....	<u>7</u>
Speed–time graph	<u>9</u>

Summary Diagrams (OHTs)

Average and instantaneous speed	<u>11</u>
Components of a vector by projection	<u>12</u>
Components of a vector from angles.....	<u>13</u>

Student's Checklist

[Back to list of Contents](#)

I can show my understanding of effects, ideas and relationships by describing and explaining:

<p>that a vector has both size and direction, while a scalar just has size</p> <p>Revision Notes: Scalar quantities; Vectors; Vector components;</p>	
<p>how to use vectors to represent displacement and velocity</p> <p>Revision Notes: Displacement; Velocity and speed; Summary Diagrams: Average and instantaneous speed</p>	
<p>that vectors can be broken down into components acting in different directions, and that the effect of the original vector isn't changed by doing this</p> <p>Revision Notes: Vectors; Vector components; Summary Diagrams: Components of a vector by projection; Components of a vector from angles</p>	
<p>that vectors can be added to find a resultant vector</p> <p>Revision Notes: Vector addition;</p>	
<p>how graphs of speed–time and distance–time can describe the movement of an object</p> <p>Revision Notes: Distance-time graph; Speed-time graph</p>	
<p>that speed is distance / time: $v = \frac{s}{t}$ velocity is displacement / time: $\mathbf{v} = \frac{\mathbf{s}}{t}$ </p> <p>Revision Notes: Displacement; Velocity and speed; Summary Diagrams: Average and instantaneous speed</p>	
<p>the meaning of average and instantaneous speed</p> <p>Revision Notes: Velocity and speed; Summary Diagrams: Average and instantaneous speed</p>	
<p>the meaning of the area under a speed–time graph</p> <p>Revision Notes: Speed-time graph Summary Diagrams: Average and instantaneous speed</p>	

I can use the following words and phrases accurately when describing the motion of objects:

<p>vector, scalar displacement and velocity as vectors distance and speed as scalars component of a vector average speed, instantaneous speed</p> <p>Revision Notes: Scalar quantities; Vectors; Vector components; Displacement; Velocity and speed</p> <p>Summary Diagrams: Components of a vector by projection; Components of a vector from angles; Average and instantaneous speed</p>	
<p>gradient, slope, tangent (with respect to graphs)</p> <p>Revision Notes: Distance-time graph; Speed-time graph</p>	

I can interpret:

<p>vector diagrams showing components and the addition of vectors</p> <p>Revision notes: Vector addition;</p>	
<p>graphs of speed–time and distance–time for the movement of an object</p> <p>Revision Notes: Distance-time graph; Speed-time graph</p>	

I can calculate:

<p>the components of a vector acting at right angles to each other by (i) making scale drawings and (ii) using geometry or trigonometry</p> <p>Revision Notes: Vector components;</p> <p>Summary Diagrams: Components of a vector by projection; Components of a vector from angles</p>	
<p>the resultant vector produced by adding two vectors the resultant vector produced by subtracting one vector from another</p> <p>Revision notes: Vector addition</p>	
<p>the unknown quantity given any two in the equation</p> $v = \frac{s}{t}$ <p>Revision Notes: Displacement; Velocity and speed</p>	
<p>speed from the gradient (slope) of a distance–time graph distance from the area under a speed–time graph</p> <p>Revision Notes: Distance-time graph; Speed-time graph</p>	

Revision Notes

[Back to list of Contents](#)

Scalar quantities

A scalar quantity is any physical quantity that can be represented by a single numerical value.

Vector quantities have components, which specify their direction as well as their magnitude.

Examples of scalar quantities include distance, speed, mass, energy, work, power, temperature, charge and potential. A scalar quantity is completely specified by its magnitude at a given position or time.

The magnitude of a vector is a scalar quantity.

Many scalar quantities are the product or the quotient of two other scalar quantities. For example, power = energy transferred divided by time taken, which is a quotient of two scalar quantities.

A vector multiplied or divided by a scalar quantity is a vector. Example: $\mathbf{v} = \mathbf{s} / t$

Some scalar quantities are the product of two vector quantities. For example, the work W done by a force of magnitude F which moves its point of application through a distance s is given by the equation $W = F s \cos \theta$, where θ is the angle between the force vector and the displacement vector.

[Back to Student's Checklist](#)

Vectors

Vector quantities are used to represent physical quantities that have both magnitude and direction. Displacements, velocities, accelerations and forces are examples of vector quantities.

Vectors are often represented by the length and direction of an arrow. The length of the arrow is proportional to the magnitude of the vector. For example, the displacement from the Channel Tunnel exit to Paris is 230 km nearly due South. It can be represented on a map by an arrow 230 mm long pointing (say) downwards.

Notice that the magnitude of a vector is unchanged by rotating the frame of reference (the distance to Paris stays the same if you turn the map around).

A vector quantity is a package of similar quantities bundled together. It is made of components. The components of the sum of two vectors are equal to the sums of the components of the vectors. A two-dimensional vector has two components. A vector in three dimensions needs three components.

A bold type symbol e.g. \mathbf{s} is used to refer to the whole vector quantity.

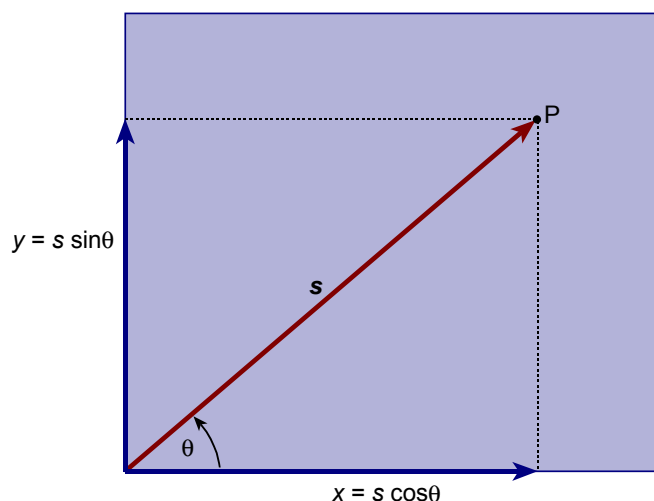
[Back to Student's Checklist](#)

Vector components

The components of a vector are projections of the vector on to any two perpendicular axes.

The process of expressing a vector of known magnitude and direction as perpendicular components is called **resolving** the vector.

Vector components



Components x and y of the vector \mathbf{s} are $x = s \cos \theta$ and $y = s \sin \theta$, where θ is the angle between the vector \mathbf{s} and the x-axis. By Pythagoras' theorem the magnitude s of the vector \mathbf{s} is given by

$$s = \sqrt{x^2 + y^2}.$$

[Back to Student's Checklist](#)

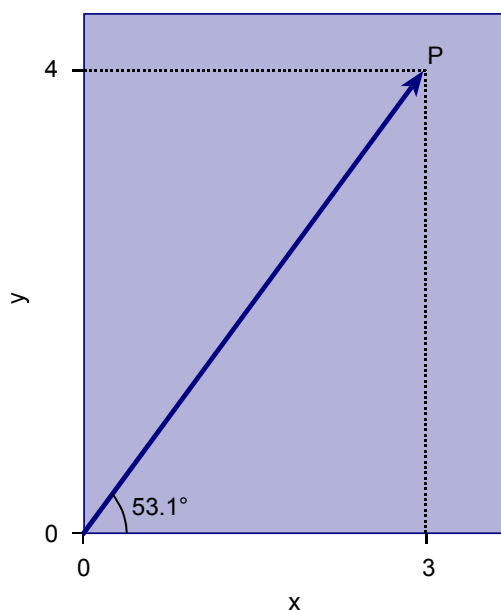
Displacement

Displacement is distance moved in a given direction. Displacement is a **vector quantity**.

The displacement of an object moved from one point to another can be represented as a vector arrow pointing from the starting point to the finishing point. Displacement can be expressed as components in two perpendicular directions.

Distance is a scalar quantity, indicating the length along a path, without regard to the shape or direction of the path. Thus an object going once around a complete circle radius r travels a distance $2\pi r$, but has zero net displacement.

Displacement



For example, using x and y coordinates, a displacement (3 m, 4 m) from the origin O of the coordinates would be represented by a vector arrow from the origin to point P which has coordinates $x = 3$ m, $y = 4$ m.

1. The distance from O to $P = \sqrt{3^2 + 4^2} = 5$ m.
2. The direction from O to P is 53.1° above the x -axis, the angle whose tangent is $4/3$.

[Back to Student's Checklist](#)

Velocity and speed

The velocity of an object is its rate of change of displacement. The unit of velocity is the metre per second (m s^{-1}). Velocity is a **vector quantity**.

Thus the vector velocity $\mathbf{v} = \mathbf{s} / t$, where \mathbf{s} is the vector displacement and t is the time taken. The direction of the velocity is the direction of the displacement.

The **speed** of an object is the distance it travels per unit time. Speed, like distance, is a scalar quantity. The speed of an object is the magnitude of its velocity.

If an object travels in a straight line, its velocity changes only if its speed changes. But an object travelling along a curved path changes its velocity because the direction of motion changes.

The **average speed** of an object over a distance s , $v_{av} = s / t$, where t is the time taken.

The **instantaneous speed** of an object is the rate of change of distance moved at a given instant. This is usually written as $v = ds / dt$.

[Back to Student's Checklist](#)

Vector addition

Vector addition is the addition of two vectors. It can be done simply by adding the components of the two vectors to obtain the components of the resultant vector. It can be achieved without breaking the vectors into components by adding the two vectors 'tip-to-tail' using a scale drawing.

Two vectors in the **same** direction add to give a resultant vector in the same direction and of magnitude equal to the sum of the individual magnitudes.

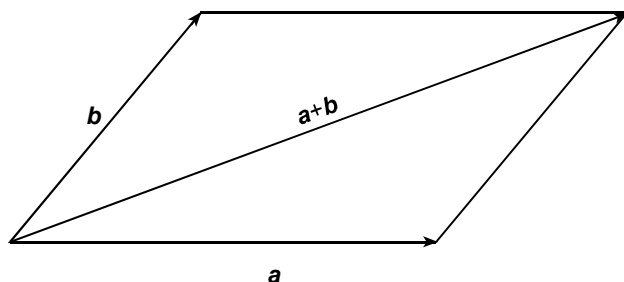
Two vectors in **opposite** directions add to give a resultant vector in the direction of the larger vector and of magnitude equal to the difference of the individual magnitudes.

Adding vectors in different directions

The **parallelogram rule** for adding two vectors is an accurate geometrical method of finding the resultant of two vectors. The two vectors are drawn so they form adjacent sides of a parallelogram. The resultant is the diagonal of the parallelogram from the start of one vector to the end of the other vector.

Vectors add 'tip-to-tail' so the resultant vector is from the start of one vector to the end of the other vector.

The parallelogram rule



Adding components

Two vectors may be added by adding their components. For example, if the components of **A** and **B** with respect to the x -, y -axes are:

$$\mathbf{A} = (A_x, A_y)$$

$$\mathbf{B} = (B_x, B_y)$$

then

$$\mathbf{A} + \mathbf{B} = (A_x + B_x, A_y + B_y).$$

The components of the vector sum are the sums of the components of the added vectors.

[Back to Student's Checklist](#)

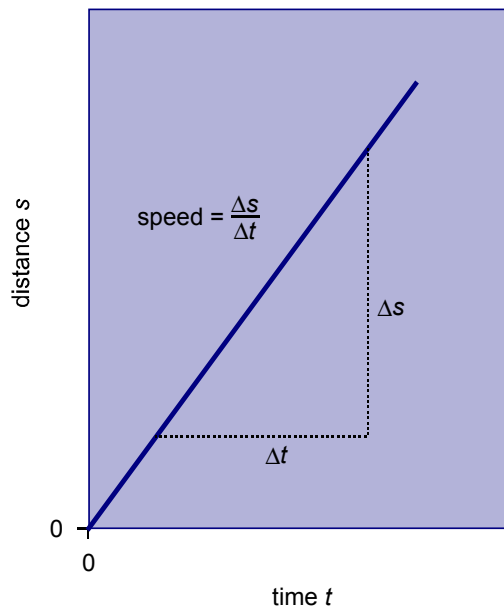
Distance–time graph

A distance–time graph is a graph of distance on the y -axis against time on the x -axis. The progress of an object from a fixed point O can be shown as a graph of distance from O on the y -axis against time on the x -axis.

The gradient at any point of a distance–time graph is equal to the speed at that point.

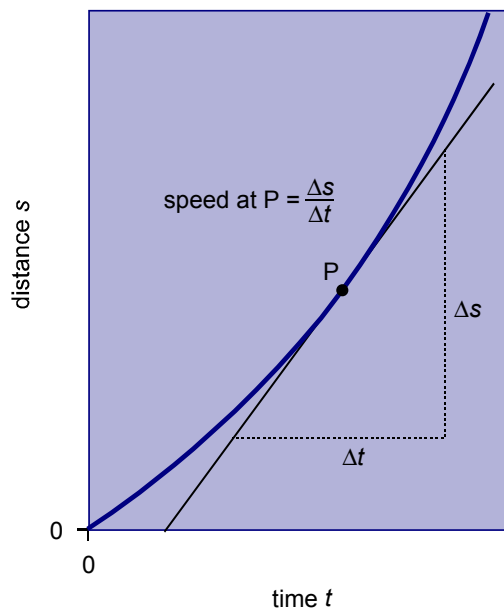
The speed of the object is the rate of change of distance with time. If the line on the graph representing the progress of the object is straight and not flat, the object must be moving at constant speed. The gradient of the line represents the speed.

Distance-time graphs



constant speed

To find the speed at a point on a distance–time graph where the line is curved, the tangent to the curve is drawn at the relevant point. The gradient of the tangent is equal to the gradient of the curve at that point.



increasing speed

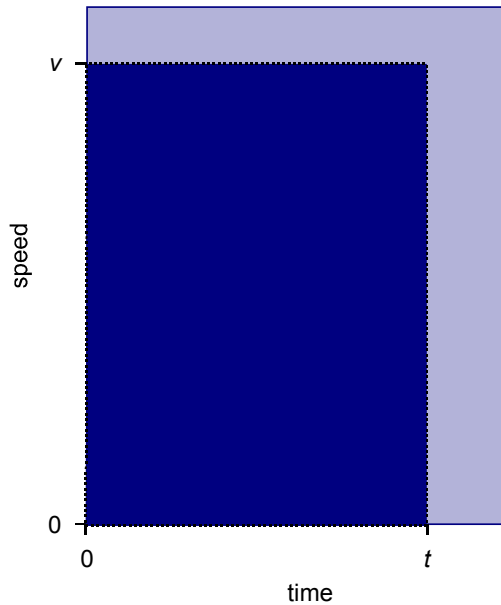
[Back to Student's Checklist](#)

Speed–time graph

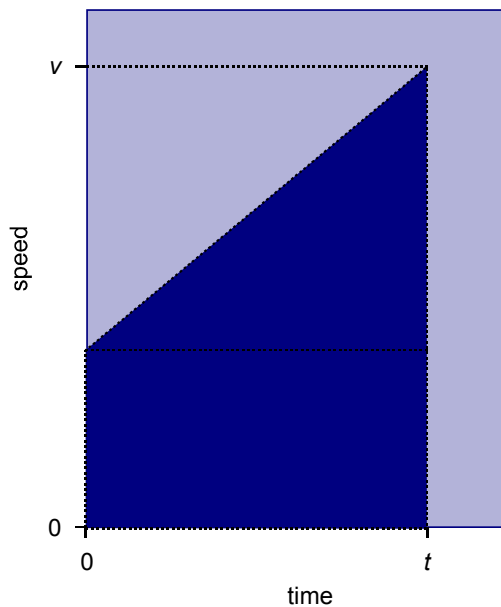
A speed–time graph is a graph of speed on the y-axis against time on the x-axis.

A speed–time graph is a useful way of showing how the motion of an object changes. In addition, the acceleration and distance travelled can be worked out from the graph.

Speed-time graphs



area in dark blue represents distance $s = vt$



area in dark blue represents distance $s = \frac{1}{2}(u+v)t$

The gradient of the graph is equal to the acceleration. A negative gradient corresponds to a deceleration.

The area between the line and the x -axis represents the distance travelled.

In general, at any given time, the acceleration of an object $a = dv / dt$ where v is its speed at that time. The gradient of a speed–time graph at any given point is equal to the acceleration at that point. The gradient can be determined by measuring the gradient of the tangent to the curve at that point.

The area between the graph and the x -axis between any two points in time gives the distance travelled in that time interval.

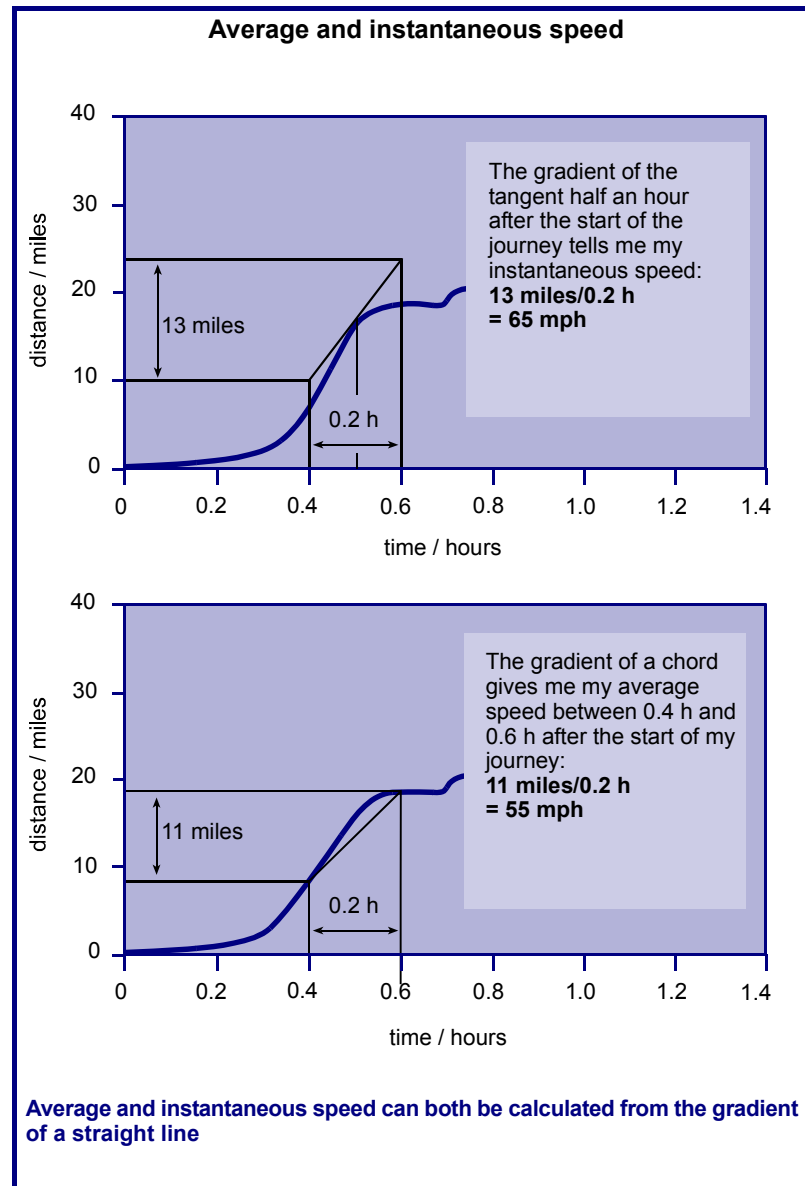
For constant speed v , the distance moved in time t , $s = vt$ which is represented on the graph by a rectangular area vt .

[Back to Student's Checklist](#)

Summary Diagrams (OHTs)

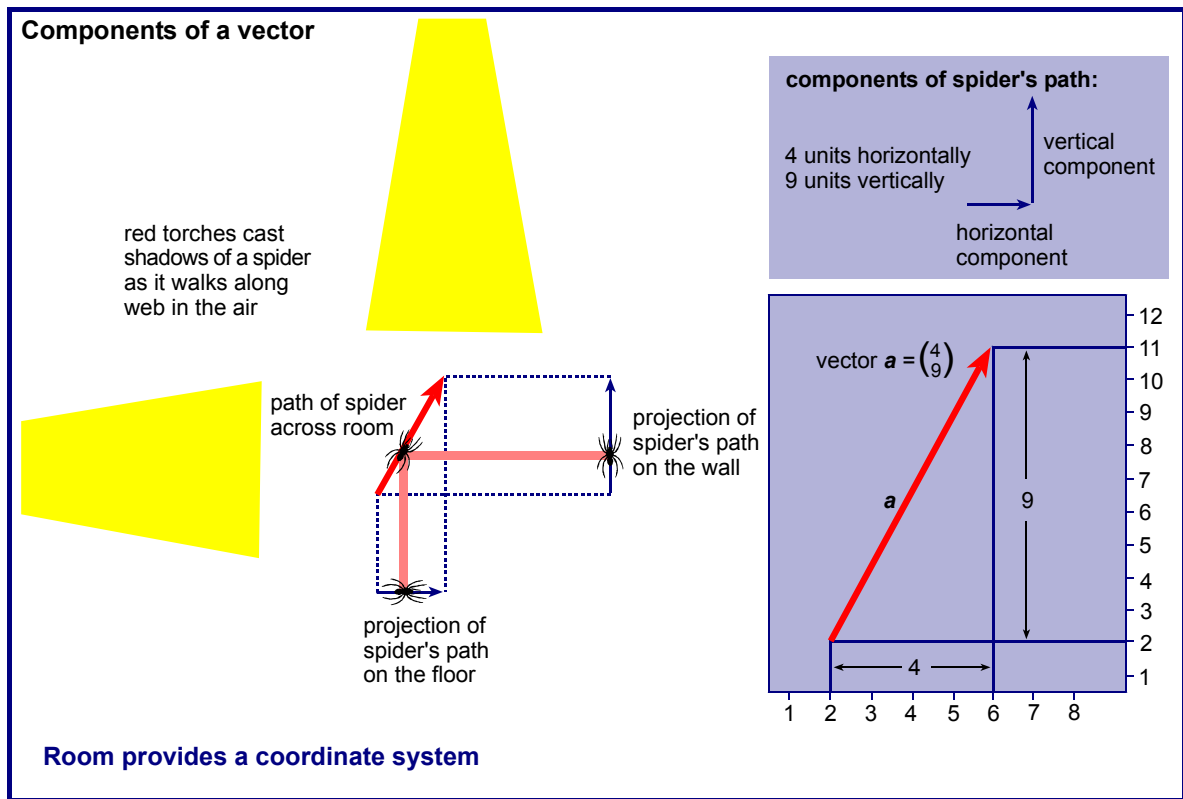
[Back to list of Contents](#)

Average and instantaneous speed



[Back to Student's Checklist](#)

Components of a vector by projection

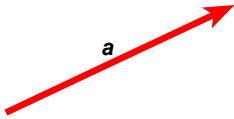


[Back to Student's Checklist](#)

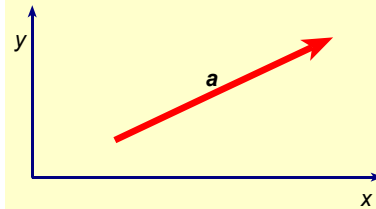
Components of a vector from angles

Components of a vector from angles

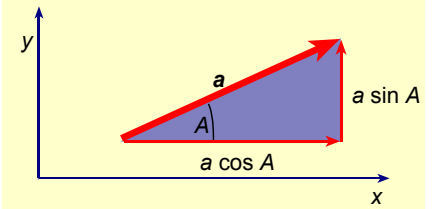
1 take a vector



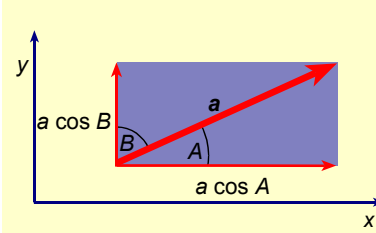
2 choose coordinate axes



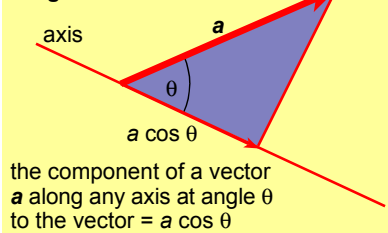
3 take components like this



or like this



in general...



the component of a vector a along any axis at angle θ to the vector = $a \cos \theta$

The components of a vector depend on the choice of coordinates
The vector itself does not

[Back to Student's Checklist](#)