



General Kinematics 2ii

Subject & topics: Maths **Stage & difficulty:** A Level P1

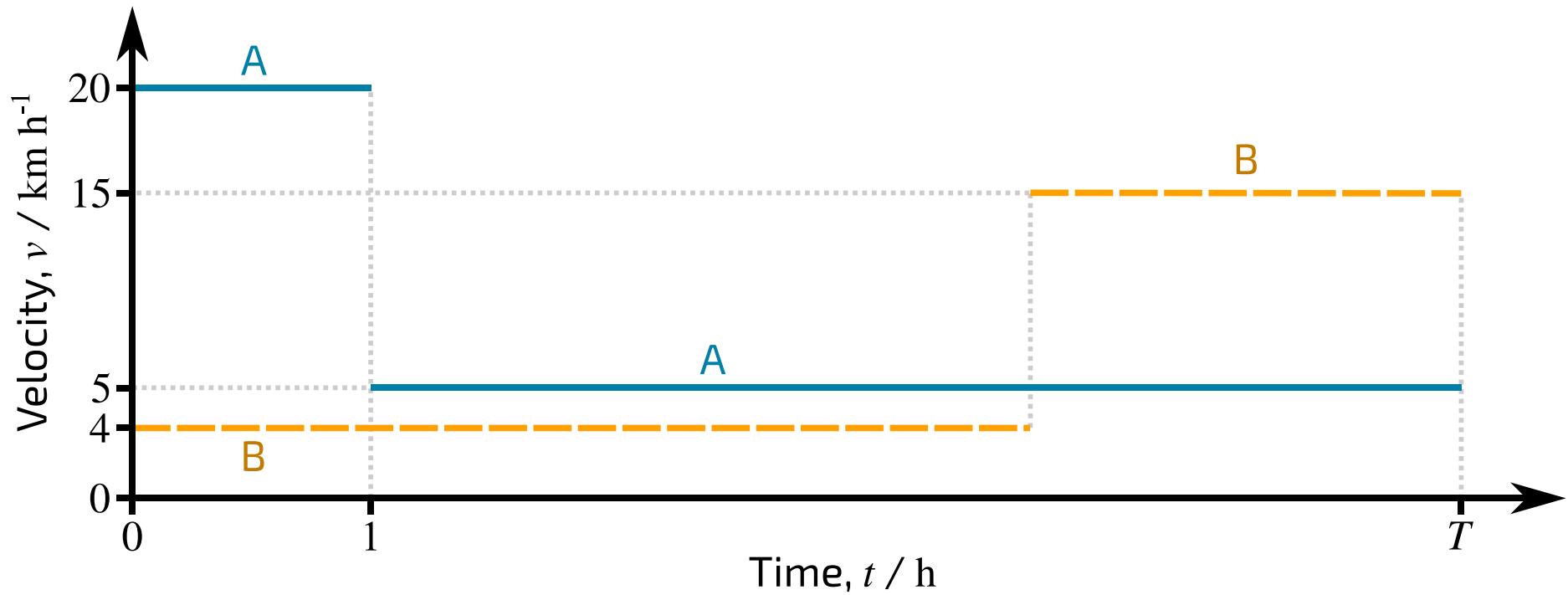


Figure 1: Velocity-time graph of two travellers A and B along a long straight road.

Two travellers A and B make the same journey on a long straight road. Each traveller walks for part of the journey and rides a bicycle for part of the journey. They start their journeys at the same instant, and they end their journeys simultaneously after travelling for T hours. A starts the journey cycling at a steady 20 km h^{-1} for 1 hour. A then leaves the bicycle at the side of the road, and completes the journey walking at 5 km h^{-1} . B begins the journey walking at a steady 4 km h^{-1} . When B finds the bicycle where A left it, B cycles at 15 km h^{-1} to complete the journey.

Part A

Distance cycled and time

Calculate the distance A cycles.

Hence, find the period of time, in hours, for which B walks before finding the bicycle.

Part B
Completion time

Find T in hours.

Part C
Total distance

Calculate the distance A and B each travel.

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General Kinematics 3ii

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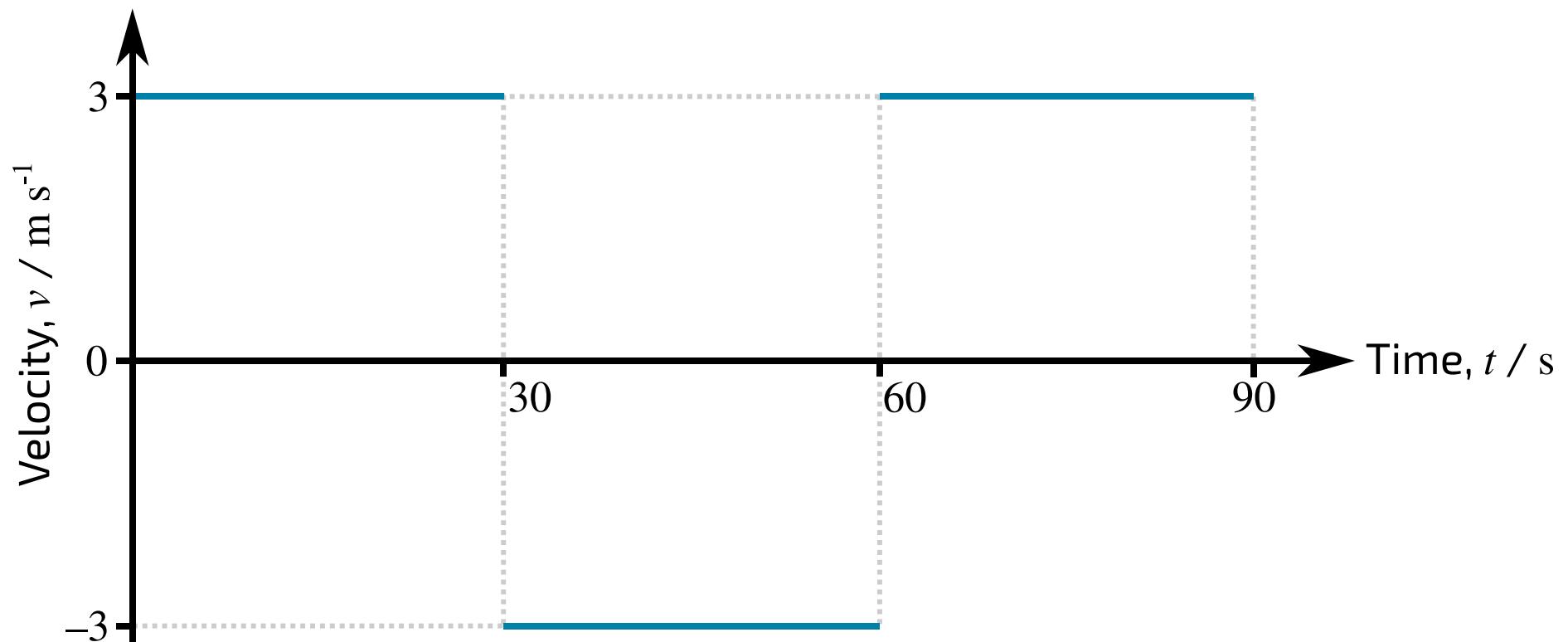


Figure 1: Velocity-time graph of a woman running between A and B.

A woman runs from A to B, then from B to A and then from A to B again, on a straight track, taking 90 s. The woman runs at a constant speed throughout.

Part A

Total distance

Find the total distance run by the woman.

Part B Distances

Find the distance of the woman from A when

$t = 50$:

$t = 80$:

Part C Child's speed

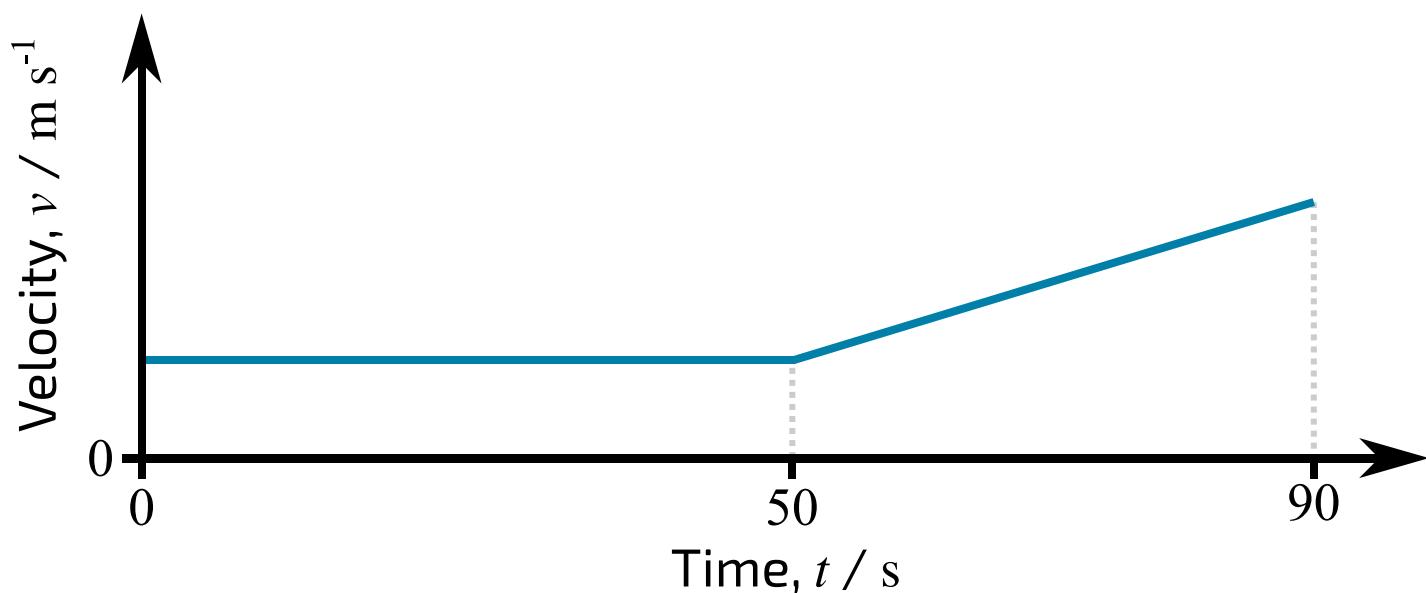


Figure 2: Velocity-time graph of a child moving from A along AB.

At time $t = 0$, a child also starts to move, from A, along AB. The child walks at a constant speed for the first 50 s and then at an increasing speed for the next 40 s.

At time $t = 50$, the woman and the child pass each other, moving in opposite directions. Find the speed of the child during the first 50 s.

Part D

Overtaking

At time $t = 80$, the woman overtakes the child. Find the speed of the child at this instant.

Used with permission from UCLES, A-level, Specimen, OCR M1

Question deck:

[STEM SMART Double Maths 5 - Kinematics](#)



General Kinematics 3i

Subject & topics: Maths **Stage & difficulty:** A Level P1

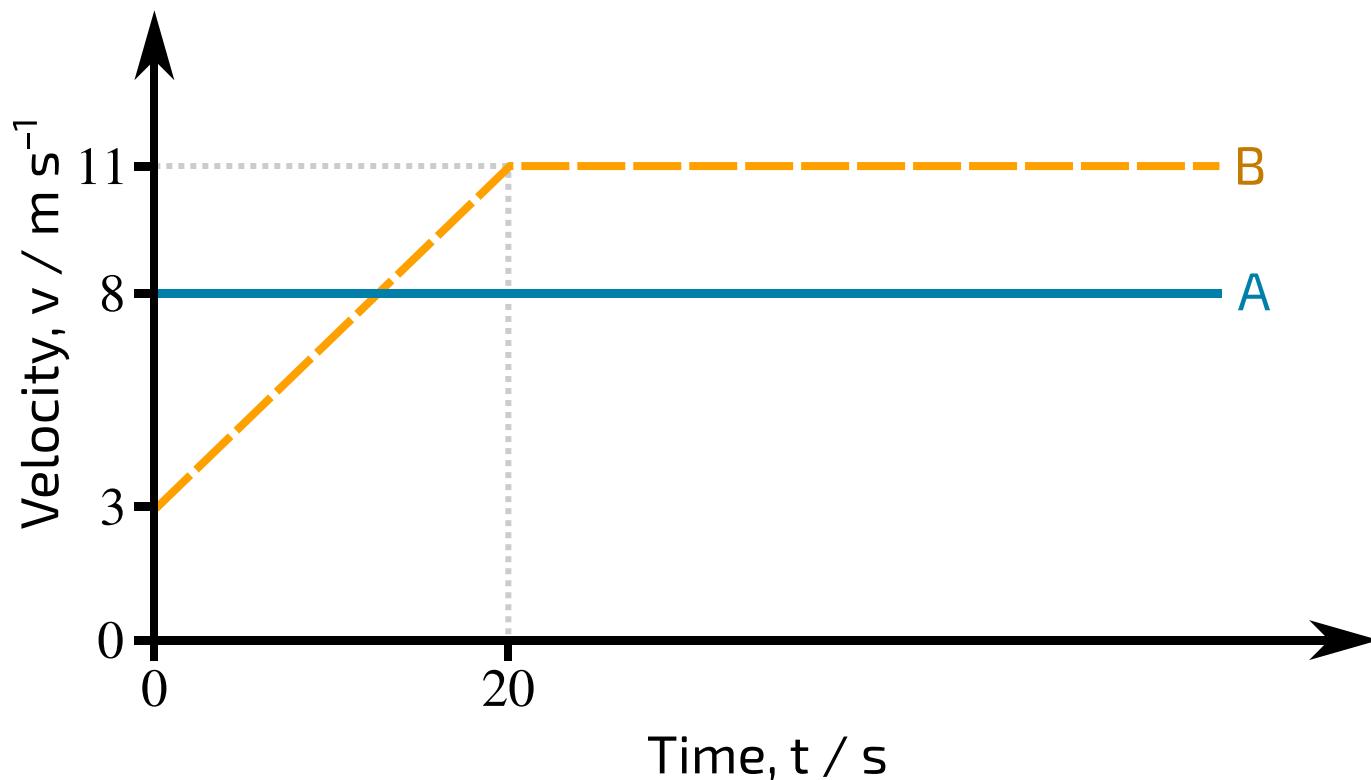


Figure 1: Velocity-time graph of the motion of two cyclists A and B racing.

Figure 1 shows the motion of two cyclists A and B who are travelling along a horizontal straight road. At time $t = 0$, A, who cycles with constant speed 8 m s^{-1} , overtakes B who has initial speed 3 m s^{-1} . From time $t = 0$, B cycles with constant acceleration for 20 s . When $t = 20$ her speed is 11 m s^{-1} , which she subsequently maintains.

Part A

Same speed

Find the value of t when A and B have the same speed. Give your answer to 2 significant figures.

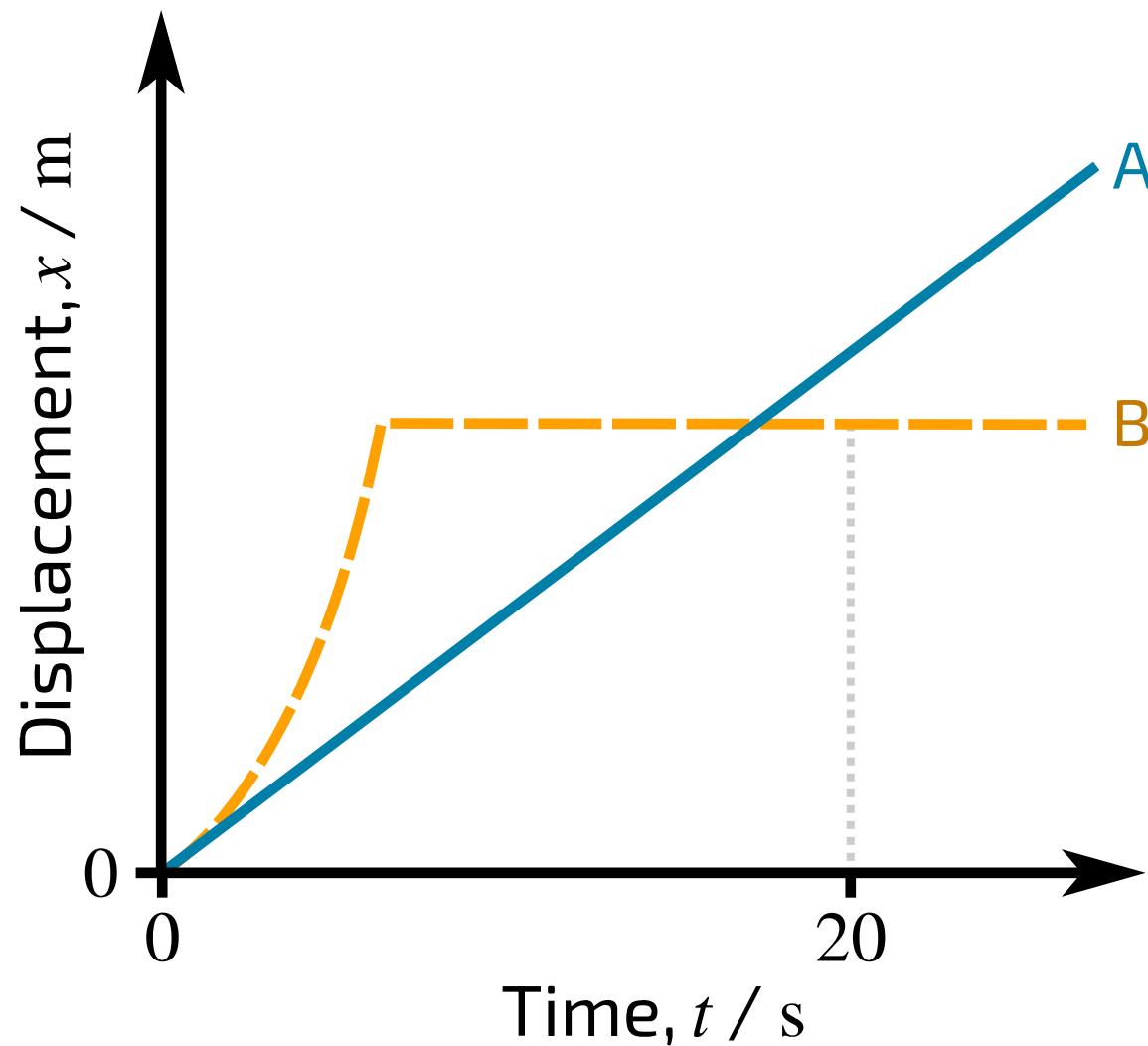
Part B**Time of overtaking**

Calculate the value of t when B overtakes A. Give your answer to 2 significant figures.

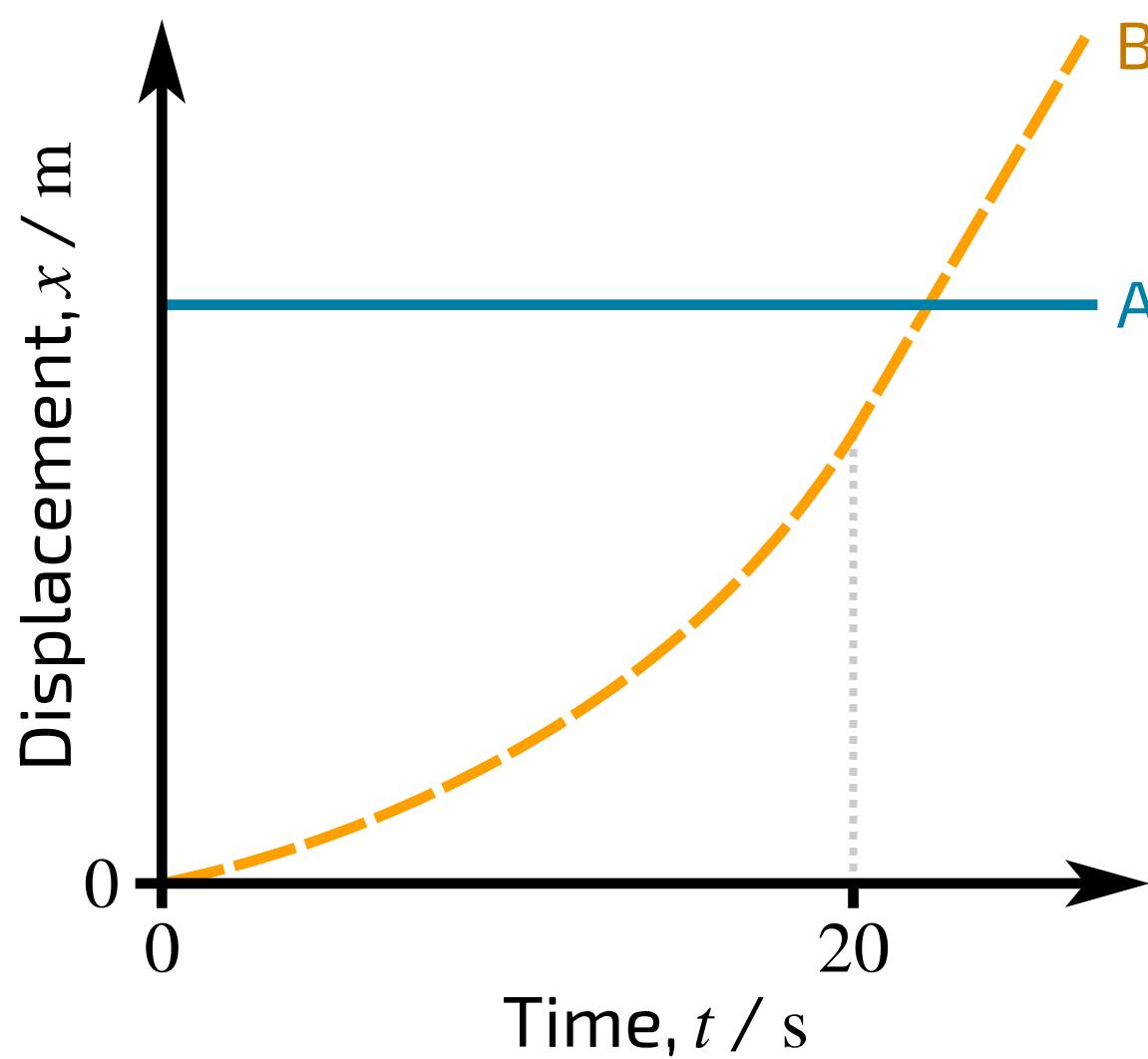
Part C**Displacement-time graph**

On a single diagram, sketch the (t, x) graphs for the two cyclists for the time from $t = 0$ until after B has overtaken A.

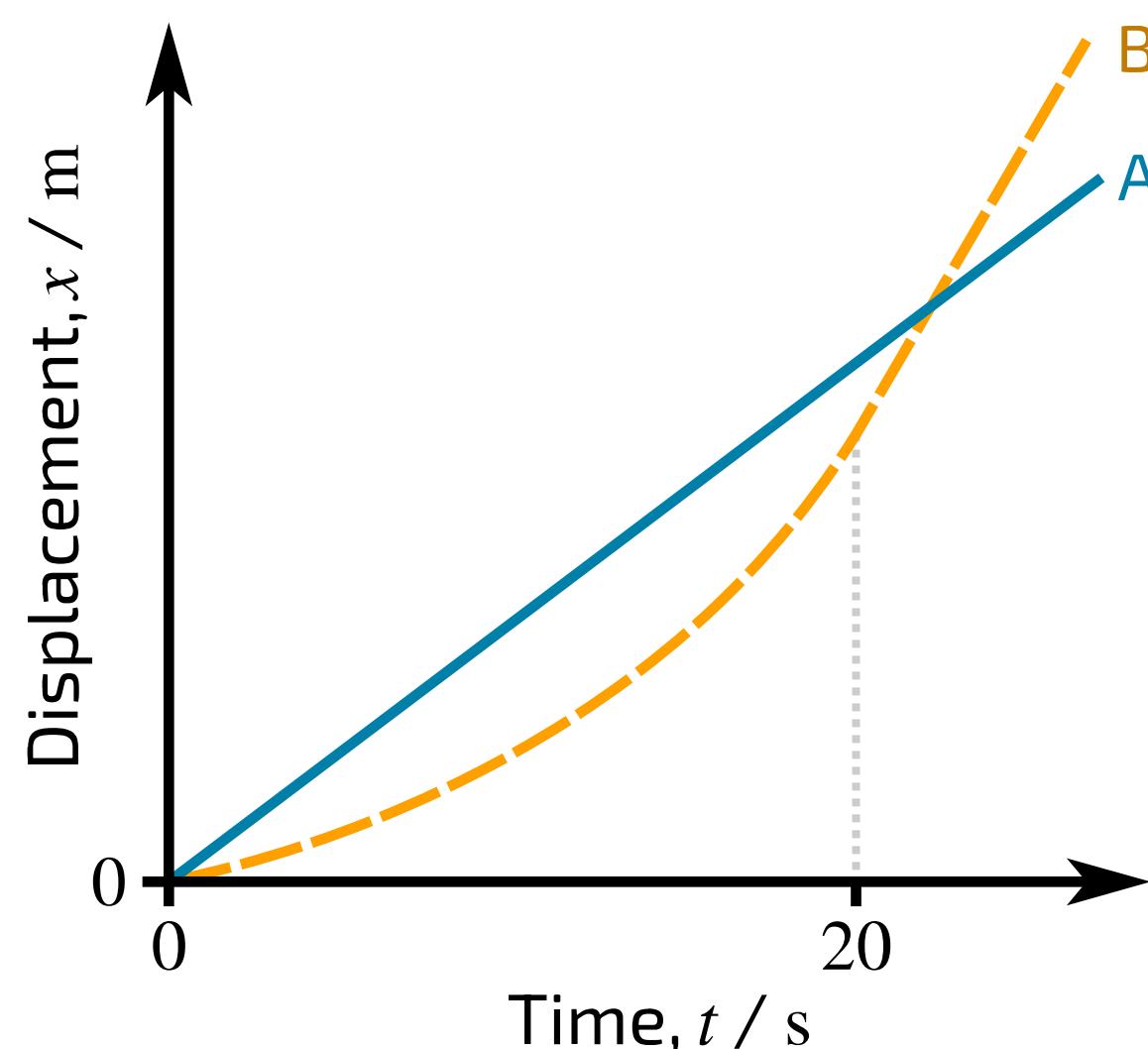
Choose the correct option from the sketches below.



Option 1



Option 1



Option 2

- Option 1
- Option 2
- Option 3

Option 3

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Gravity & Projectiles (1D) 3i

Subject & topics: Maths **Stage & difficulty:** A Level P2

A particle is projected vertically upwards, from the ground, with a speed of 28 m s^{-1} . Ignore air resistance throughout this question.

Part A

Maximum height

Find the maximum height reached by the particle.

Part B

Speed at 30 m

Find the speed of the particle when it is 30 m above the ground.

Part C

Time taken

Find the time taken for the particle to fall from its highest point to a height of 30 m.

Part D**Length of time**

Find the length of time for which the particle is more than 30 m above the ground.

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Gravity & Projectiles (1D) 2i

Subject & topics: Maths **Stage & difficulty:** A Level P2

An object is projected vertically upwards, from a position 1.5 m above horizontal ground, with speed 17.5 m s^{-1} .

Part A

Speed of object

Calculate the speed of the object when it is 6.1 m above the point of projection. Give your answer to 3 significant figures.

Part B

Greatest height

Calculate the greatest height above the point of projection reached by the object. Give your answer to 3 significant figures.

Part C

Time at 15.1 m s^{-1}

Calculate the time after projection when the object is travelling downwards with speed 15.1 m s^{-1} . Give your answer to 3 significant figures.

Part D**Height at 15.1 m s^{-1}**

Calculate the height above ground level of the object when it is moving downwards at 15.1 m s^{-1} . Give your answer to 3 significant figures.

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Gravity & Projectiles (1D) 1i

Subject & topics: Maths **Stage & difficulty:** A Level P2

A particle P is projected vertically upwards, from horizontal ground, with speed 8.4 m s^{-1} . Throughout this question use $g = 9.8 \text{ m s}^{-2}$.

Part A

The greatest height

Find the greatest height above the ground reached by P. Give your answer to 2 significant figures.

Part B

A second particle

A particle Q is projected vertically upwards, from a point 2.0 m above the ground, with speed u . The greatest height **above the ground** reached by Q is 3.6 m.

Find the value of u . Give your answer to 2 significant figures.

Part C**Same height, same speed**

It is given that P and Q are projected simultaneously.

Show that, at the instant when P and Q are at the same height, the particles have the same speed and are moving in opposite directions. Find this speed. Give your answer to 2 significant figures.

Used with permission from UCLES, A Level Maths, June 2007, OCR M1, Question 5

Question deck:

STEM SMART Double Maths 5 - Kinematics



Projectiles: Trajectories 1ii

Subject & topics: Maths **Stage & difficulty:** A Level P2

A ball is projected from a point O on the edge of a vertical cliff. The horizontal and vertically upward components of the initial velocity are 7 m s^{-1} and 21 m s^{-1} respectively. At time t seconds after projection the ball is at the point (x, y) referred to horizontal and vertically upward axes through O. Air resistance may be neglected.

Part A

Equations of motion

Express x and y in terms of t . For this question you can use $g \approx 9.8 \text{ m s}^{-2}$.

Express x in terms of t .

The following symbols may be useful: t , x

Express y in terms of t .

The following symbols may be useful: t , y

Hence, find an expression for y in terms of x .

The following symbols may be useful: x , y

Part B**Horizontal distance travelled**

The ball hits the sea at a point which is 25 m below the level of O.

Find the horizontal distance between the cliff and the point where the ball hits the sea. Give your answer to 3 significant figures.

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Question deck:

STEM SMART Double Maths 5 - Kinematics



Projectiles: Trajectories 2ii

Subject & topics: Maths **Stage & difficulty:** A Level P2

A particle is projected with speed $u \text{ m s}^{-1}$ at an angle of θ above the horizontal from a point O. At time $t \text{ s}$ after projection, the horizontal and vertically upwards displacements of the particle from O are $x \text{ m}$ and $y \text{ m}$ respectively.

Part A

Equations of motion

In this question, use g to represent the magnitude of the acceleration under gravity.

Express x in terms of u , t and θ .

The following symbols may be useful: $\cos()$, $\sin()$, t , $\tan()$, θ , u , x

Express y in terms of u , t and θ .

The following symbols may be useful: $\cos()$, g , $\sin()$, t , $\tan()$, θ , u , x

Hence find an equation for y in terms of u , x and θ .

The following symbols may be useful: $\cos()$, $\cosec()$, $\cot()$, g , $\sec()$, $\sin()$, $\tan()$, θ , u , x , y

Part B**Value of θ**

In this part, use $g = 9.8 \text{ m s}^{-2}$.

In a shot put competition, a shot is thrown from a height of 2.1 m above horizontal ground. It has initial velocity of 14 m s^{-1} at an angle of θ above the horizontal. The shot travels a horizontal distance of 22 m before hitting the ground.

Find the value of θ correct to 3 significant figures.

Part C**Time of flight**

Find the time of flight of the shot correct to 3 significant figures.

Used with permission from UCLES, A Level, January 2013, OCR M2, Question 7

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Projectiles: Trajectories 3ii

Subject & topics: Maths

Stage & difficulty: A Level P2

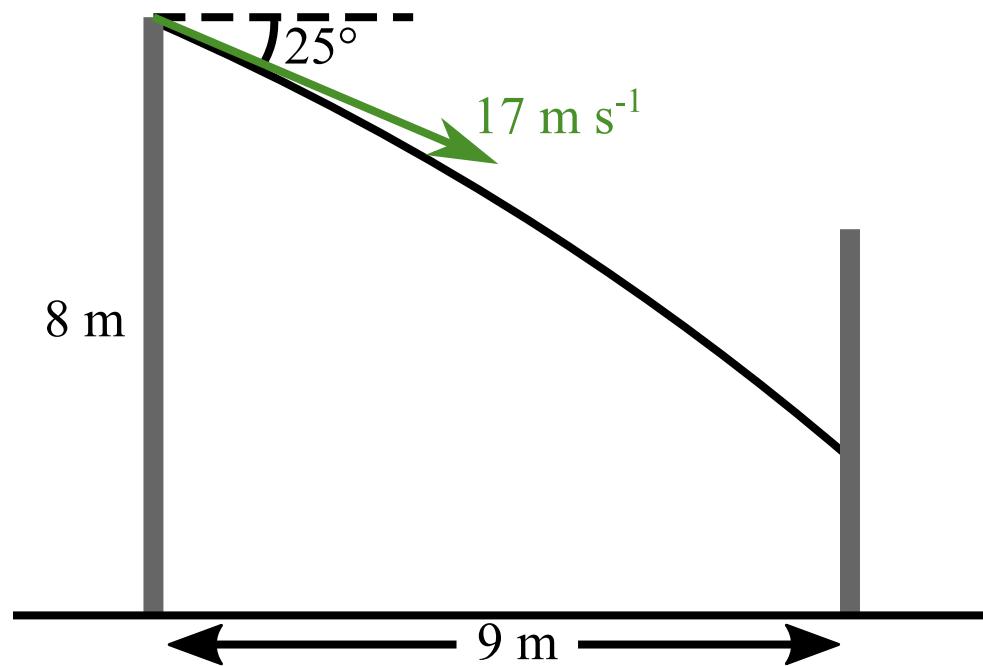


Figure 1: A ball projected from a horizontal point on the top of a vertical wall.

A ball is projected with an initial speed of 17 m s^{-1} at an angle of 25° below the horizontal from a point on the top of a vertical wall. The point of projection is 8 m above horizontal ground. The ball hits a vertical fence which is at a horizontal distance of 9 m from the wall.

Part A

Height above ground

Calculate the height above the ground of the point where the ball hits the fence. Give your answer to 3 significant figures.

Part B**Direction of motion**

Calculate the direction of motion of the ball immediately before it hits the fence. Give your answer as an angle below the horizontal.

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STEM SMART Double Maths 5 - Kinematics



Shooting a Balloon

Subject & topics: Physics | Mechanics | Kinematics **Stage & difficulty:** A Level C2

The points A and B are a distance a apart and AB is horizontal. A shot is fired from A with velocity $\sqrt{\lambda ag}$ at an angle θ to the horizontal. At the same instant a balloon is released from rest at B and rises vertically with constant acceleration $(\mu - 1)g$, where $1 < \mu < \lambda$. The shot hits the balloon.

For $\lambda = 10$ and $\mu = 5.0$ find the possible values of θ .

Enter the two values of θ (to 2 significant figures).

(lower value)

(higher value)

Used with permission from UCLES, A Level, Further Maths, Syllabus A, June 1987, Special Paper, Question 7
