General Kinematics 2ii

A Level

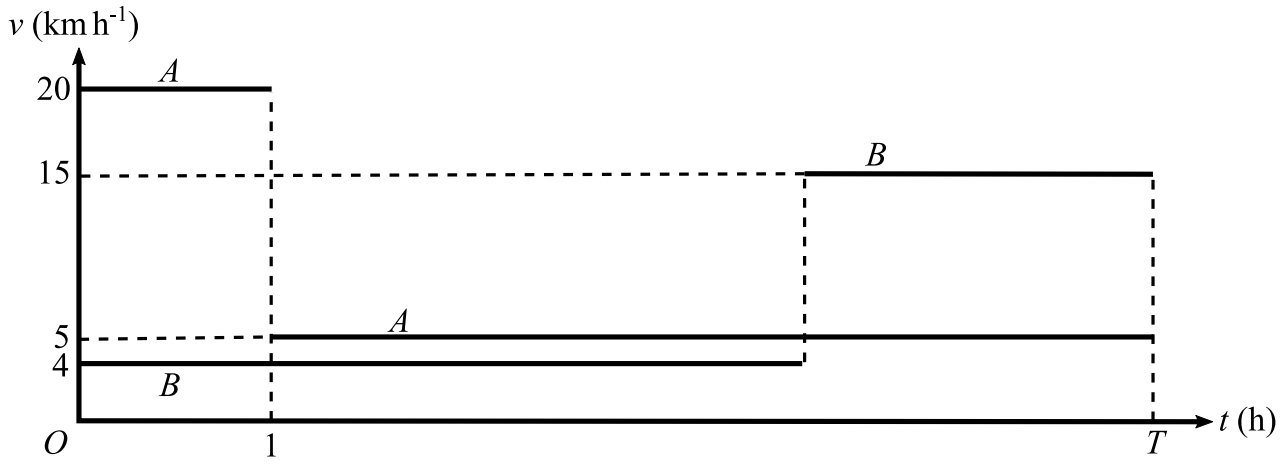

Figure 1: Velocity-time graph of two travellers A and B along a long straight road.

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 $20\,\mathrm{km\,h^{-1}}$ for 1 hour. A then leaves the bicycle at the side of the road, and completes the journey walking at $5\,\mathrm{km\,h^{-1}}$. B begins the journey walking at a steady $4\,\mathrm{km\,h^{-1}}$. When B finds the bicycle where A left it, B cycles at $15\,\mathrm{km\,h^{-1}}$ 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.

Used with permission from UCLES, A-level, June 2015, OCR M1, Question 3

General Kinematics 3ii

A Level

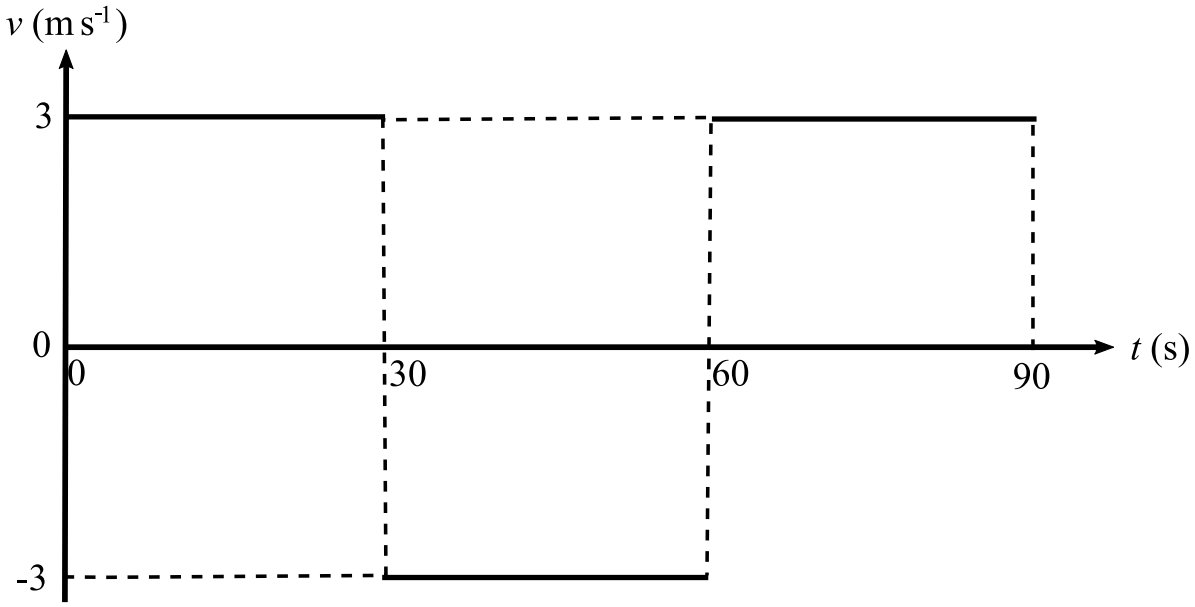

Figure 1: Velocity-time graph of a woman running between A and B.

A woman runs from A to B, then from B to A and then from A to B again, on a straight track, taking $90\,\text{s}$. 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

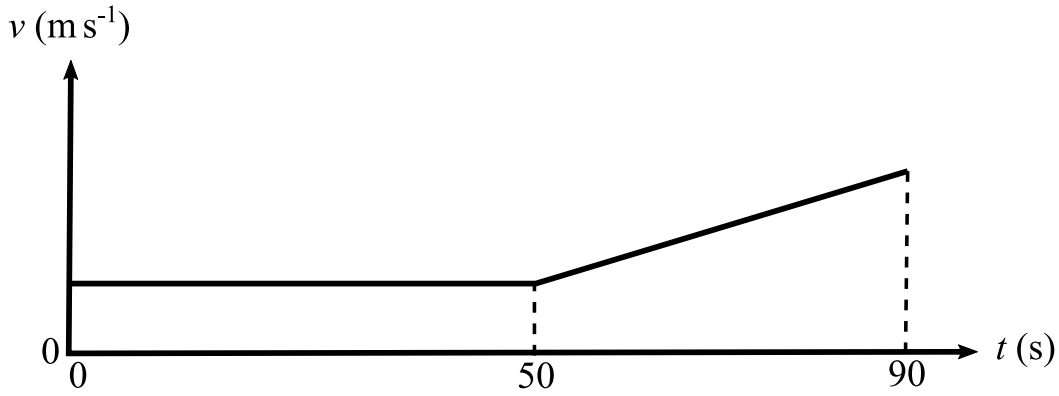

Figure 2: Velocity-time graph of a child moving from A along AB.

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

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 $50\,\text{s}$.

Part D Overtaking

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

Gameboard:
STEM SMART Double Maths 5 - Kinematics

General Kinematics 3i

A Level

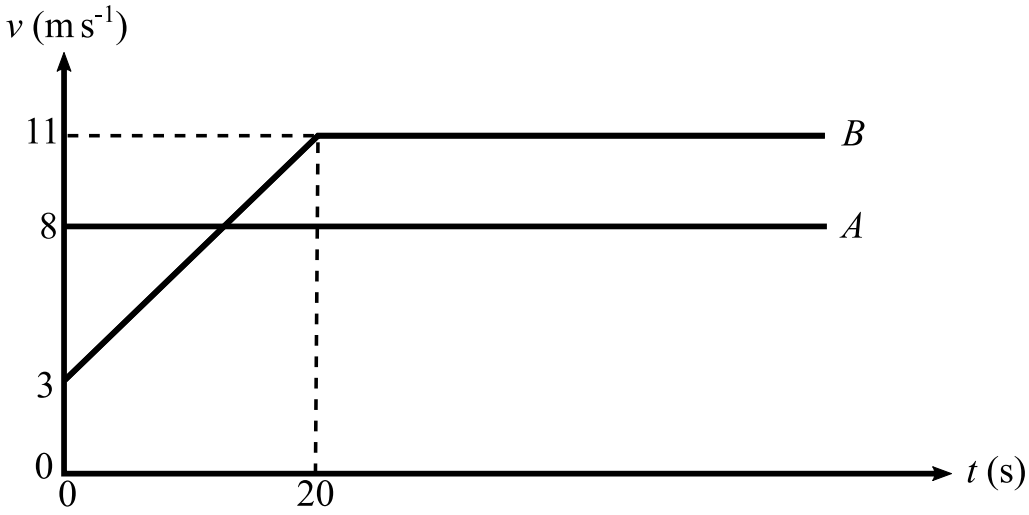

Figure 1: Velocity-time graph of the motion of two cyclists A and B racing.

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 $8\,\mathrm{m\,s^{-1}}$, overtakes B who has initial speed $3\,\mathrm{m\,s^{-1}}$. From time $t = 0$, B cycles with constant acceleration for $20\,\mathrm{s}$. When $t = 20$ her speed is $11\,\mathrm{m\,s^{-1}}$, 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 Distance 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.

Easier question?

Gameboard:
STEM SMART Double Maths 5 - Kinematics

Gravity & Projectiles (1D) 3i

A Level

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

Part A Maximum height

Find the maximum height reached by the particle.

Part B Speed at at $30\,\mathrm{m}$

Find the speed of the particle when it is $30\,\mathrm{m}$ above the ground.

Part C Time taken

Find the time taken for the particle to fall from its highest point to a height of $30\,\mathrm{m}$.

Part D Length of time

Find the length of time for which the particle is more than $30\,\mathrm{m}$ above the ground.

Gravity & Projectiles (1D) 2i

A Level

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

Part A Speed of object

Calculate the speed of the object when it is $6.1\,\mathrm{m}$ 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 $15.1\,\mathrm{m\,s^{-1}}$

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

Part D Height at $15.1\,\mathrm{m\,s^{-1}}$

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

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Gameboard:
STEM SMART Double Maths 5 - Kinematics

Gravity & Projectiles (1D) 1i

A Level

A particle P is projected vertically upwards, from horizontal ground, with speed $8.4\,\mathrm{m\,s^{-1}}$.

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 $2.0\,\mathrm{m}$ above the ground, with speed u. The greatest height **above the ground** reached by Q is $3.6\,\mathrm{m}$.

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.

Projectiles: Trajectories 1ii

A Level

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 $7\,\mathrm{m\,s^{-1}}$ and $21\,\mathrm{m\,s^{-1}}$ 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 $g \approx 9.8\,\mathrm{m\,s^{-2}}$.

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 $25\,\mathrm{m}$ 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.

Used with permission from UCLES, A Level, June 2007, OCR M2, Question 4

Gameboard:
STEM SMART Double Maths 5 - Kinematics

Projectiles: Trajectories 2ii

A Level

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

Part A Equations of motion

In this question, use g to represent the (positive) acceleration under gravity.

Express x in terms of u, t and θ.

The following symbols may be useful: `cos(), sin(), t, tan(), theta, u, x`

Express y in terms of u, t and θ.

The following symbols may be useful: `cos(), g, sin(), t, tan(), theta, u, x`

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

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

Part B Value of θ

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

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

Gameboard:
STEM SMART Double Maths 5 - Kinematics

Projectiles: Trajectories 3ii

A Level

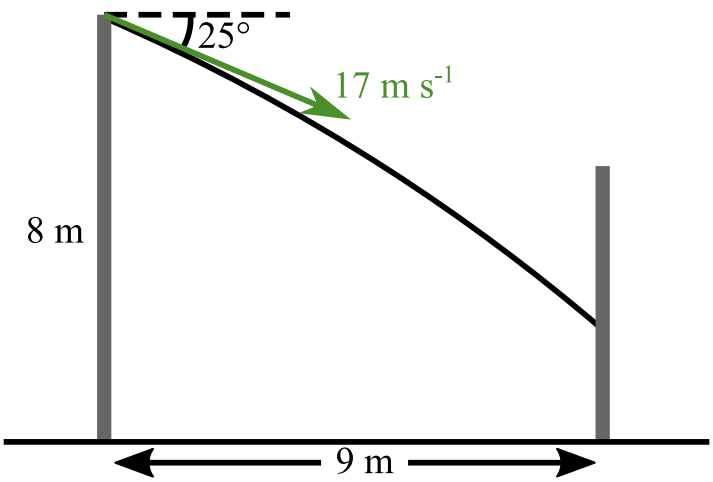

Figure 1: A ball projected from a horizontal point on the top of a vertical wall.

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

Gameboard:
STEM SMART Double Maths 5 - Kinematics

Shooting a Balloon

A Level

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 $\tan\theta$.

Part A Higher value

Give the higher of the two values of $\tan\theta$ (to 2 significant figures).

Part B Lower value

Give the lower of the two values of $\tan\theta$ (to 2 significant figures).

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