General Kinematics 3ii

A Level

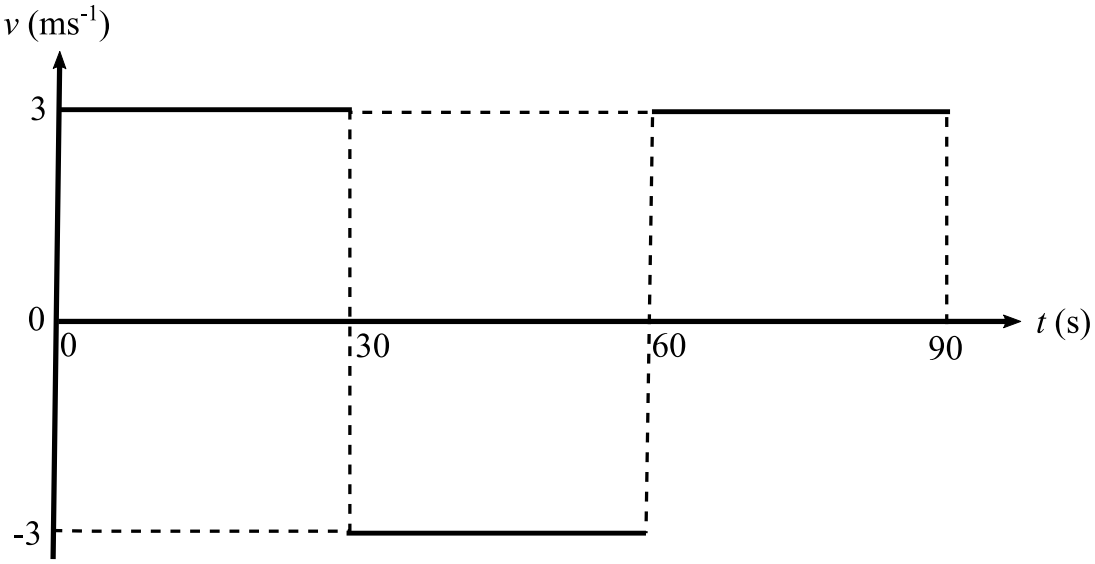

Figure 1: Velocity-time graph of a woman running between A and B.

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

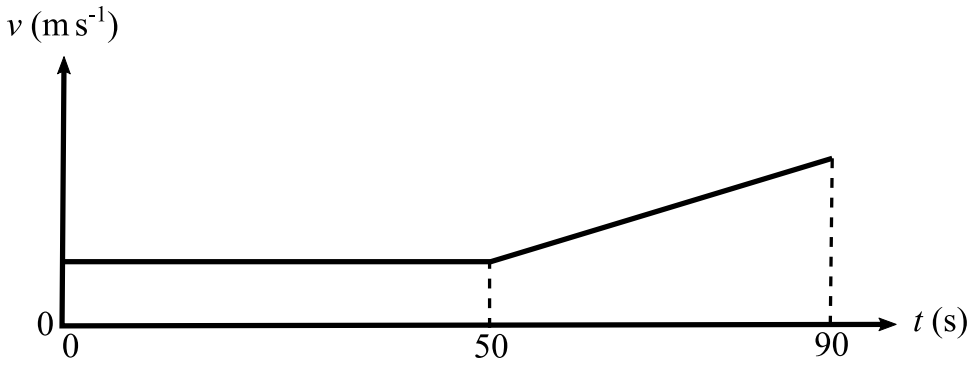

Figure 2: Velocity-time graph of a child moving from A along AB.

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.

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.

General Kinematics 2ii

A Level

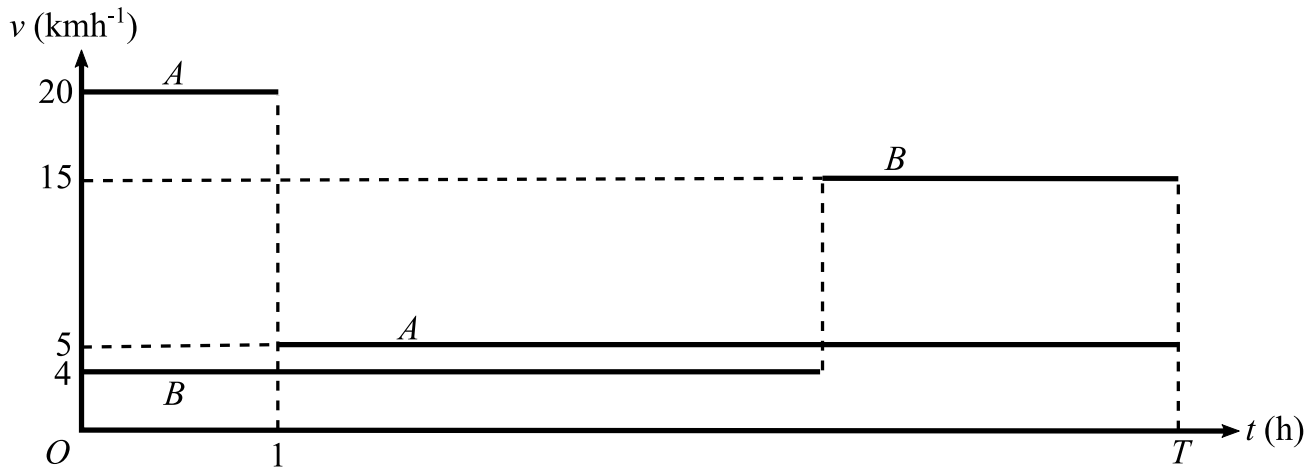

Figure 1: Velocity-time graph of two travellers A and B along a long straight road.

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.

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.

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 t and θ.

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

Express y in terms of 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 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.

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.

Created for isaacphysics.org by Sally Waugh

Projectiles: Trajectories 3ii

A Level

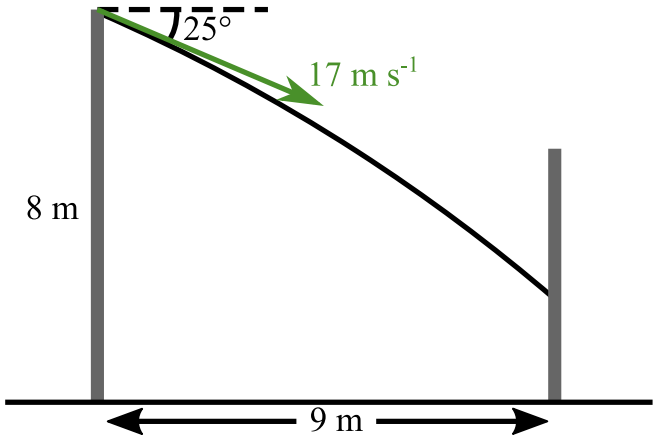

Figure 1: A ball projected from a horizontal point on the top of a vertical wall.

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.

Used with permission from UCLES, A Level, OCR M2, June 2009, Question 7

General Kinematics 3i

A Level

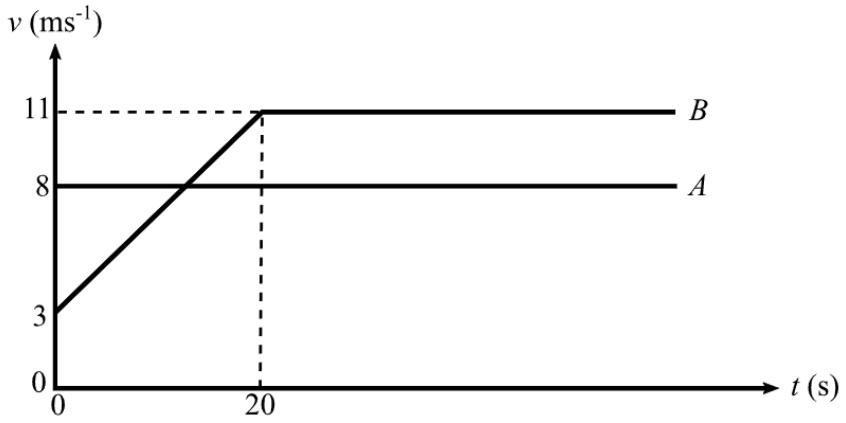

Figure 1: Velocity-time graph of the motion of two cyclists A and B racing.

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?