# Ferry and Current

A Level Further A

A ferry is to cross the Sound of Islay from Port Askaig on Islay to Feolin on Jura which is $0.950\,\mathrm{km}$ due east of Port Askaig. The tidal current in the Sound of Islay is strong and the water is flowing at $3.50\,\mathrm{m\,s^{-1}}$ in a northerly direction. The ferry travels at a speed of $5.00\,\mathrm{m\,s^{-1}}$ relative to the water.

## Part A Which direction?

In what direction should the ferry set out? Give your answer as a bearing.

## Part B How long to cross

How long, in seconds, will the ferry take to make the crossing?

# Forces in Equilibrium

A Level Further A

A body is acted on by three forces $\underline{\boldsymbol{T}}_1$, $\underline{\boldsymbol{T}}_2$ and $\underline{\boldsymbol{T}}_3$ in the $(x, y)$-plane as shown in the diagram. $\underline{\boldsymbol{T}}_3 = 20.0\underline{\hat{\boldsymbol{j}}}\,\mathrm{N}$, $\phi = 20.0^\circ$ and the body is in equilibrium.

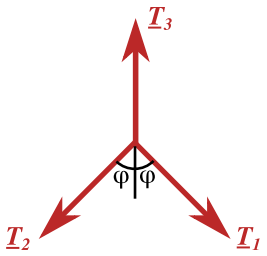


**Figure 1:** A vector diagram of the forces $\underline{\boldsymbol{T}}_1$, $\underline{\boldsymbol{T}}_2$ and $\underline{\boldsymbol{T}}_3$ acting on a body.

## Part A Magnitude of T1

Find the magnitude of $\underline{\boldsymbol{T}_1}$.

## Part B Horizontal Component of T2

Find the horizontal component of $T_2$, taking left-to-right to be the positive direction.

Created for isaacphysics.org by Julia Riley.

# Target Practice

A Level

When a rifle is fired horizontally at a target $P$ on a screen at a range of $25\,\mathrm{m}$ , the bullet strikes the screen at a point $5.0\,\mathrm{mm}$ below $P$ . The screen is now moved to a distance $50\,\mathrm{m}$ and the rifle again fired horizontally at $P$ in its new position.

Assuming that air resistance may be neglected, what is the new distance below $P$ at which the screen would now be struck?

- $10\,\mathrm{mm}$
- $5.0\,\mathrm{mm}$
- $5\sqrt{2}\,\mathrm{mm}$
- $40\,\mathrm{mm}$
- $20\,\mathrm{mm}$

Used with permission from UCLES, A Level Physics, November 1982, Paper 2, Question 2.

# The Harbour Entrance

A Level

The entrance to a harbour is a channel of length $a$ which runs between two sandbanks a distance $b$ apart. The banks and the channel can be assumed to be rectangular. On this particular day, there is a current of constant speed $v$ flowing from one sandbank to the other. A yacht travelling at a constant speed relative to the water of $u$ wants to enter the harbour.

Find the least value of $u$ needed for the yacht to safely enter the harbour.

The following symbols may be useful: `a, b, u, v`

Used with permission from UCLES, A Level Further Maths, Syllabus C, June 1989, Special Paper, Question 7.

# A Lifeboat

A Level

A lifeboat is drifting due South at a speed $u = 5.00\,\mathrm{km\,h^{-1}}$ when it is spotted by a sailboat at a distance $s = 300\,\mathrm{m}$ due East. The sailboat is sailing at a speed $3u$ on a bearing of $\theta = 240^\circ$ .

## Part A Range of rope

Given that the sailboat's longest rope is $L = 50\,\mathrm{m}$ and that both the boats maintain their course and speed, find the length of time the lifeboat is in range of the rope, if it is at all.

- $74.0\,\mathrm{s}$
- $12.3\,\mathrm{s}$
- The lifeboat will not come in range of the rope if both boats maintain their velocities.
- $18.0\,\mathrm{s}$
- $24.6\,\mathrm{s}$

## Part B New rope

What length of rope is required such that there will be a time when the lifeboat is instantaneously in range of the rope?

Adapted with permission from UCLES, A Level Further Maths, Syllabus C, June 1988, Paper II, Question 2

# Highway Pursuit

GCSE C C C A Level P P P

In a high speed highway pursuit, the police are chasing some gangsters. The police car is travelling at $45\,\mathrm{m\,s^{-1}}$ and the gangsters are travelling at $47\,\mathrm{m\,s^{-1}}$.

By considering the velocity of the gangsters relative to the police, what is the distance between the two cars after $90$ seconds? Assume they start at the same point (the crime scene).

- $2\,\mathrm{m}$
- $4050\,\mathrm{m}$
- $90\,\mathrm{m}$
- $4230\,\mathrm{m}$
- $180\,\mathrm{m}$

Created for isaacphysics.org by Jan Zamirski.

# Overtaking on the road

GCSE A Level

A driver on a single carriageway road (one where there is only one lane in each direction) needs to ensure that the way ahead is clear before they overtake. In this question, you will work out how far ahead the road needs to be clear of traffic coming the other way in order for overtaking to be safe.

## Part A Time to overtake

A car is travelling at the speed limit on a single carriageway road in England $\left(60\,\mathrm{mph} = 26.8\,\mathrm{m\,s^{-1}}\right)$. It comes up behind a lorry travelling at its speed limit $\left(50\,\mathrm{mph} = 22.3\,\mathrm{m\,s^{-1}}\right)$.

In order to honour the approved stopping distances, the car moves onto the other side of the road before getting closer than $73\,\mathrm{m}$ to the back of the lorry. The lorry is $15\,\mathrm{m}$ long, and the car does not pull back into the left hand lane until it is $53\,\mathrm{m}$ in front of the lorry. You may neglect the length of the car.

How much time will the car spend on the other side of the road?

## Part B Clear distance

Assume that all traffic travelling in the opposite direction does so at $60\,\mathrm{mph} = 26.8\,\mathrm{m\,s^{-1}}$. Calculate the distance ahead of the car which must be clear in the right hand lane at the point the car moves over into that lane in order to overtake the lorry as described in the last question.

# Love Bugs

A Level

A bug sits at each corner of a regular polygon with $N$ sides of length $l$. Each bug always walks directly towards the next bug around, counterclockwise.

How long does it take for all of the bugs to meet in the middle if they walk with a speed $v = 1.0\,\mathrm{cm\,s^{-1}}$, $l = 10\,\mathrm{cm}$ and $N = 4$?