Secondary Magazine 133

National Centre for Excellence in the Teaching of Mathematics

Welcome to Issue 133 of the Secondary and FE Magazine

This is may be our busiest time of year in school, but why not take a break from the exam prep, put the kettle on and settle down with some of these articles?

You might notice a few tweaks and changes to the magazine over the next few issues. In this issue we're launching a new Classroom View feature - and be sure to click on the Qualifications and Curriculum link for an opportunity to pose questions to the exam boards.

Feel free to let us know what you think about these changes, by email to info@ncetm.org.uk or on Twitter @NCETMsecondary.

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Heads Up

In April the Education Endowment Foundation released A Marked Improvement, a review on the evidence of written marking.

This is likely to be worth a read if you're reviewing your department marking policy this summer (and even if you're not!). Also watch out for the NCETM's own guidance document on marking in Secondary Maths coming soon.

Also in April the DfE published a second consultation on proposals for grade standards for GCSEs being awarded from 2018, and grades 8 and 9 in maths, English language and English literature from 2017. This consultation includes a change to the previous decisions for mathematics, about how grades 8 and 9 are set. You can contribute to the consultation before 17 June.

A set of pages elsewhere on the NCETM website brings together for the first time the extensive range of maths resources and workshop information available to all teachers of maths up to GCSE, and trainers in vocational areas, across the FE and Skills sector. And, in case you missed it, we recently published a new set of online resources to support the professional development of Key Stage 3 teachers in the area of teaching multiplicative reasoning.

Heard about Core Maths? It's been around for a couple of years and this summer a few thousand Year 13s are taking the first exams in the new subject. What's more in the latest edition of Bespoke, the Maths Hubs programme magazine, there's a feature on how Core Maths is becoming part of the post-GCSE maths scene in Yorkshire.

Secondary schools in five areas of England are being sought to take part in a trial of mathematical reasoning materials for Key Stage 3 pupils.

The trial, funded by the Educational Endowment Foundation (EEF), is of materials developed by the ICCAMS (Increasing Competence and Confidence in Algebra and Multiplicative Structures) project, which investigates ways of raising students' attainment and engagement by using formative assessment to inform teaching and learning of mathematics in secondary school.

Read more and find out how to take part

Given that you're reading the NCETM Secondary Magazine we can assume that you have an interest in mathematics! If you also have a passion for craft and are in London on 25 June, then the FMSP Maths Arts and Crafts Teachers Day is for you! Explore the link between maths and arts in hands-on workshops run by expert mathematicians and artists.

The penultimate Tuesday of every month is MathsJam, a monthly opportunity for like-minded self-confessed maths enthusiasts to get together in a pub and share stuff they like. Puzzles, games, problems, or just anything they think is cool or interesting. Events happen simultaneously around the UK (and the world!): why not head along to the meeting on 21st June? Details are on the MathsJam website.

Image credit

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Classroom View
Making use of talk

In this, the first article in our new Classroom View *section, we hear the views of Dan Polak, a primary school teacher from Devon, who moved to the primary phase a few years back having been a secondary school English teacher. Here he offers, with due humility, some views to his former colleagues, in secondary school maths departments.*

It can be easy to take certain things for granted in a primary classroom.

When I moved from secondary teaching to primary, I calculated how much contact time I had previously with my tutor group, who I left at the end of Year 10 having been their tutor for four years. Fifteen minutes' contact time at registration in the morning, a 50-minute PSHE session each week. Over four school years this equates to a maximum of 19 500 minutes. A total of 325 hours of contact time with the group of students I felt I was most able to influence.

When I started thinking about this, I had taught my new primary class for five hours a day in a 14-week term. This works out at 350 hours. In a single term, I could have more conversations about learning than in four years as a secondary tutor. If you want to affect a child's perspective on what makes good learning, it's easier to do in a primary setting.

As the children in my class gather whiteboards, sit in a circle and begin to discuss the calculation on the board, the ease and routine of it isn't lost on me. The calculation (34 x 59) is set out formally in the column method and the question 'what mistakes might people make using this method?' is displayed.

> "I hate this method."
>
> "Grid's much easier."
>
> "I struggle with my nines, so I'd change the second number and get it right, I think,"

I sit listening to the children talk in threes, jotting down their observations so I can intervene and direct their learning later in the lesson. They then explain their conversations as a class, with little input from me.

> "People always forget place value holders with this method."

A great observation, I think. Someone who looks secure with this method.

> "I'd only use this method. I wouldn't use grid," another child comments.
>
> "Can I just clarify," starts one girl "would you only use this method because it's more efficient? Or do you only use this method because you find grid method difficult?"

I share a look with my TA. It's a question many of us as teachers may not routinely consider, yet a child is really putting pressure on another to consider their process.

> "I don't know which is more efficient," the child answers.
>
> "Have you thought about it?" Another pipes up.

This quality of talk has taken time. We started at the beginning of Year 5 with simple stock phrases which encouraged children to agree or disagree with a previous statement. Now in Year 6, this has developed into a daily dialogue that I don't need to influence greatly. The children themselves make sure that any answer without an explanation is interrogated and thought through carefully. They have been 'coached to consider'.

When these children arrive in a secondary setting, depending on the classroom they find themselves in, these skills may be utilised or neglected. For secondary teachers, the time allotted for mathematics each day is so precious and scarce. And with constant moving between classrooms, by the time bags are unpacked and coats are off, it's easy to bend to the rush of the curriculum, and cut conversations short in order to 'get it done'.

The discussions in my classroom may have taken time to develop, but many primary schools are building the foundations for this excellent dialogic learning which might inform secondary teachers' judgements in a better way than a round of assessment at the beginning of the year. I remember, when I was a secondary teacher, noticing children from one of our feeder primaries stood out, because the quality of their explanation was so high. In that situation, the hours had already been spent in getting children to really master skills and become efficient in their application. Setting up discussion opportunities showed their understanding quickly and negated the need for a more formal assessment.

Secondary teachers are always rushing against the clock, so the idea of developing a mastery approach to the curriculum can feel overwhelming in the face of a tidal wave of objectives- but some of the work may have already been done. If teachers are brave enough to plan for discussions similar to those happening in many primary schools, they will see that children are far more able to explain their thinking than ever before. They are developing their mastery of skills. Given the right opportunity, they'll show you everything they know.

If you'd like to offer a Key Stage 3 maths teacher's reply to this view from a primary school, we'd love to hear it. And we'll offer a £20 voucher to anything published. Email us at info@ncetm.org.uk with **Secondary Magazine Classroom View submission** in the subject line.

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Sixteen Plus
A Different Angle?

GCSE resit students in the Post-16 sector know that the PASS is all important, and that a C on their results slip will mean that more, and more rewarding, doors are open to them. But they have many barriers to learning that they have built around them over the previous eleven (at least) years of studying maths and, as they see it, failing it again and again. GCSE resit tutors in Post-16 colleges have the task of building confidence as well as teaching maths, of breaking down those barriers and showing their students that it's not that they have failed in the past, it's that they just haven't passed YET.

There are many topics within the Maths GCSE where it is quite easy for students to see the relevance to their "real lives": Statistical skills to be able to interpret the deluge of infographics or best-buy skills whilst out shopping. However, there are some which cause tutors to flounder when asked that ubiquitous question, "WHEN WILL I EVER NEED THIS?"

GCSE resit students are in your lesson for one thing and one thing only – to move on. Truth be told, they probably will never need circle theorems or Pythagoras in their lives post-GCSE.

It's difficult to enthuse students when studying the topic of angles in parallel lines, but it's an ideal place for students to gain marks – an ideal place for them to show off what they know.

Lessons can start with students' blank faces, and cries of "I've never been good at angle questions". Careful teasing out of the angle facts that they have absorbed through osmosis throughout their previous learning can produce surprising results. They know that angles on a straight line add up to 180 degrees. They know that alternate and corresponding angles are equal. They know that angles in a quadrilateral total 360 degrees. What is lacking is their ability to use these facts to answer questions, and more importantly, their ability to explain the use of such facts.

Here are some effective approaches to help your resit students get the most out of angles in parallel lines, and the like:

- engage students in the problem solving aspects of the questions – entice them into channelling the strategies of Sherlock Holmes, finding the truth through a process of deductions based on facts
- encourage students to annotate the questions, marking on angles they know and can work out, BEFORE they move on to answering the actual question. This gives them the freedom to demonstrate their knowledge before narrowing down to their solution
- model the way your students should approach the question
- demonstrate your thought processes, and your solution, broken down into systematic stages. Seeing a teacher tackle a tricky question with no preparation can be quite enlightening for students. Risky, but certainly worth it!
- make use of tracing paper. If students are having difficulty identifying the equal angles, they can mark on the known angles and slide the paper to discover which angles match up
- when explaining their choices, students need to ensure they give full reasons. Writing "corresponding angles" and leaving it at that, is an extremely frustrating way for them to drop marks
- remind students that mark schemes are applied POSITIVELY. You can never lose marks by giving a question a go…

The Cockcroft Report (1982) tells us that success in mathematics amounts to:

> *"Confidence to make effective use of whatever mathematic skills and understanding is possessed."* [Para 34]

We can apply this, word for word, to our resit students. It's not the knowledge they lack, it's the confidence to use it, and we need to do everything in our power to give students that confidence.

What have you done to overcome your students' uncertainty with, perhaps even anxiety about, angle facts? What activities, challenges and games have you found to be effective? Let us know, by email to info@ncetm.org.uk, or tweet us @NCETMsecondary.

From the Library

Working with fractions is an area that many students find challenging.

This issue's From the Library features an article from the January 2016 Mathematical Association journal, *Mathematics in School*, in which tasks and ideas to represent fractions using GeoGebra software are described and explored. The article also includes links to four prepared GeoGebra resources.

- Read Making Sense of Fractions with GeoGebra: Representing Fractions Using Area and Length, by Hea-Jin Lee and Irina Boyadzhiev

Geogebra is available to use in your web browser direct from the Geogebra website, so no software needs to be installed on school computers.

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It Stands to Reason

Graphs provide one of the most powerful and revealing ways of representing the relationships between quantities that are the essence of many mathematical and 'real' situations. Pupils need to acquire a deep understanding of the qualitative meanings of graphical features, such as maxima, minima, gradients, discontinuities, and so on, over and above the technical skills of choosing scales, plotting points, drawing curves … . They can then use that understanding to reason about particular related quantities; they can solve problems by reasoning qualitatively about the features of appropriate graphs.

What kinds of task will help pupils develop this mastery of the qualitative aspects of graphs? Research (Shell Centre for Mathematical Education, 1985) has shown that the best challenges include those in which pupils:

- try to pair-up given sketch-graphs with given written or pictorial descriptions of how particular quantities are related
- try to sketch graphs to represent given relationships (described in writing or using pictures)
- are given sketch-graphs and try to describe, in words or pictures, the relationships that they show.

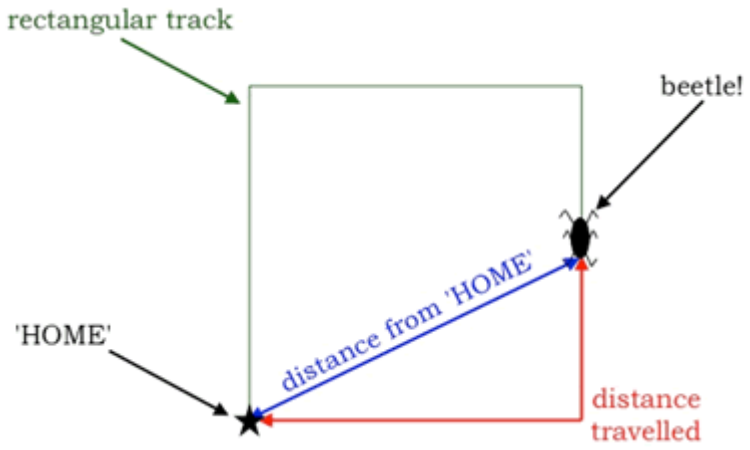
Here we look at just one (quite hard) context, before we provide the link to an excellent free source of detailed advice about ways of working with these ideas, and that includes a great variety of interesting and relevant tasks.

Example

Suppose that a small 'thing', such as a beetle, moves along a track that is a closed loop. The two related quantities that we are interested in are:

- the distance that the beetle has travelled along the track,
- the distance between the beetle and a fixed point, which might be a 'home' point on the track, and the point from which it started.

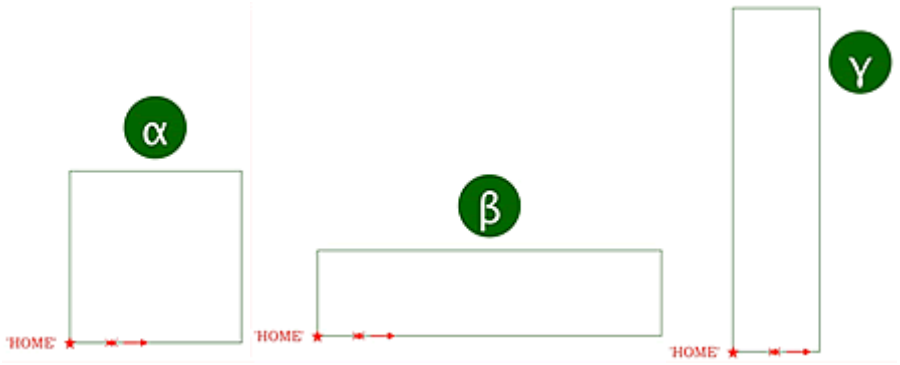
The track may be any shape; for example, it might be rectangular …



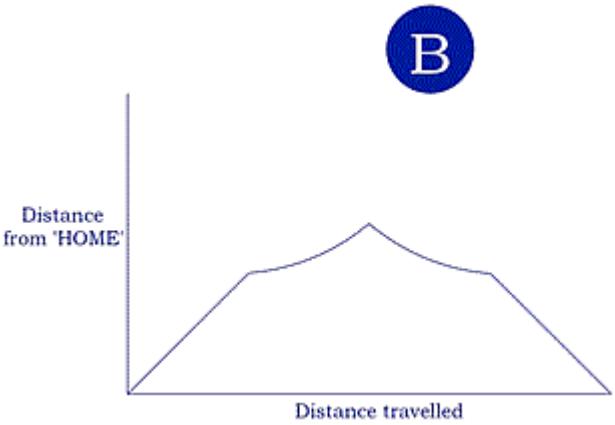
Part 1

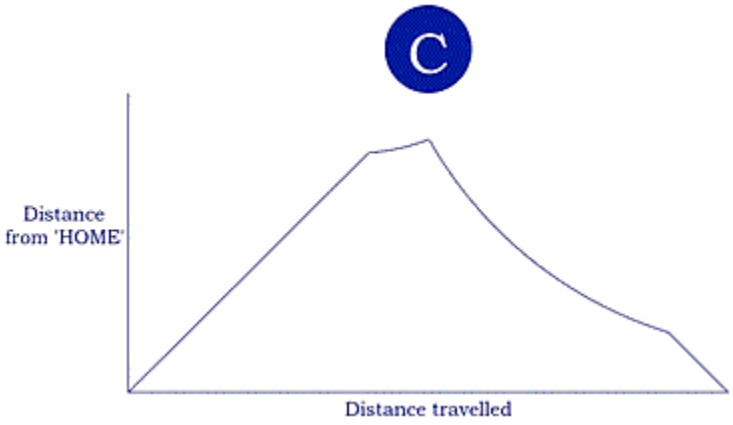
Each of the pictures, α, β and γ, shows a track of a different shape. In each case the beetle starts from a

'Home' point at the bottom-left corner of the track, and does one circuit of the track in an anti-clockwise direction.



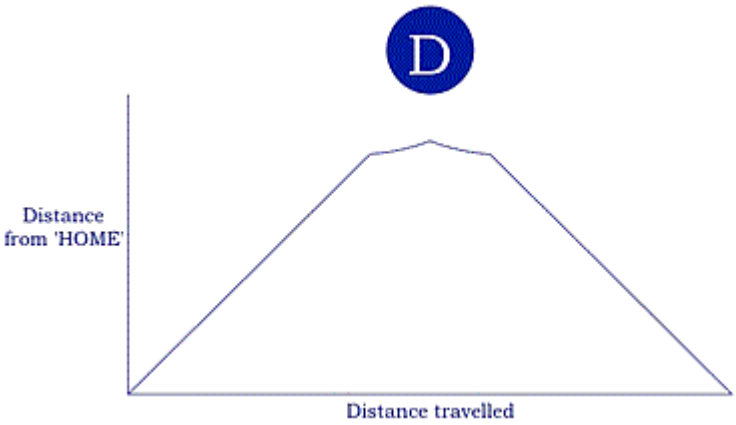
Each one of the following sketch-graphs, A, B and C, shows the relationship between 'distance-travelled' and 'distance-from-'home'' for one of the diagrams above. The pupils' task is to pair-up the diagrams and sketch-graphs, and to ***explain why*** their pairing is correct.



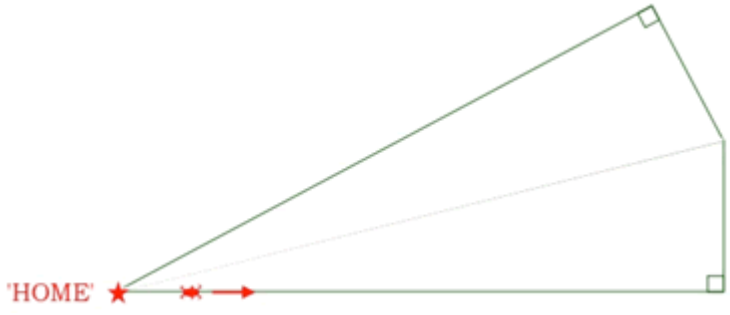


Part 2

Using your thinking about Example 1, draw a track that would produce sketch-graph D:

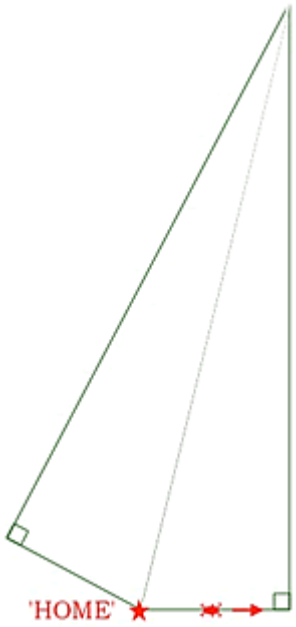


The following track would fit sketch-graph D:



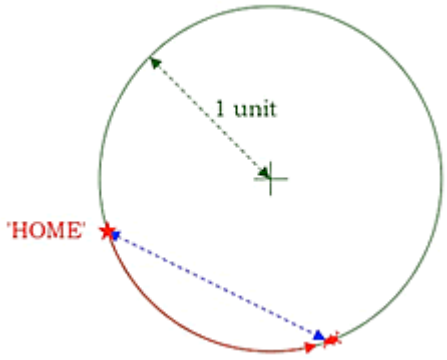
Part 3

Again using your previous observations, sketch a graph to show the relationship between 'distance from 'home'' and 'distance travelled' when the beetle does one circuit of this track:



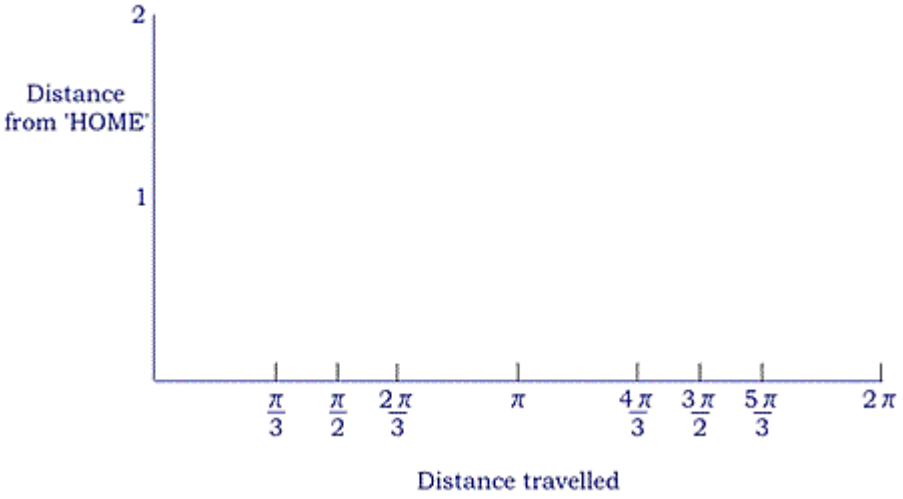
Part 4

The track is a circle of radius 1 unit. The beetle starts from 'home', which is a point on the circular track, as shown …

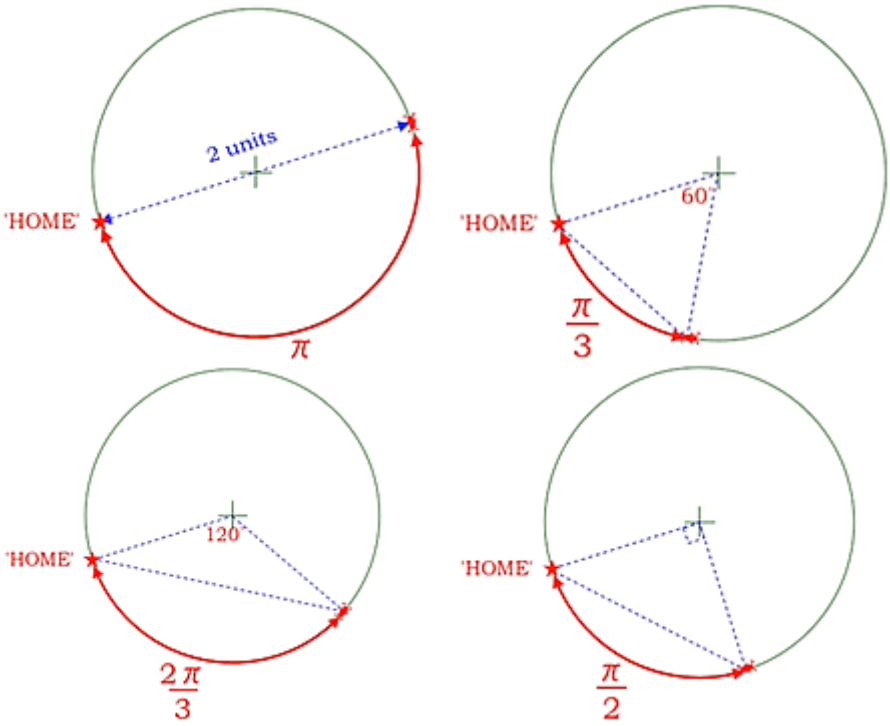


Sketch a graph to show the relationship between 'distance from 'home'' and 'distance travelled' when the beetle does one circuit of this track.

Pupils might find this template useful …

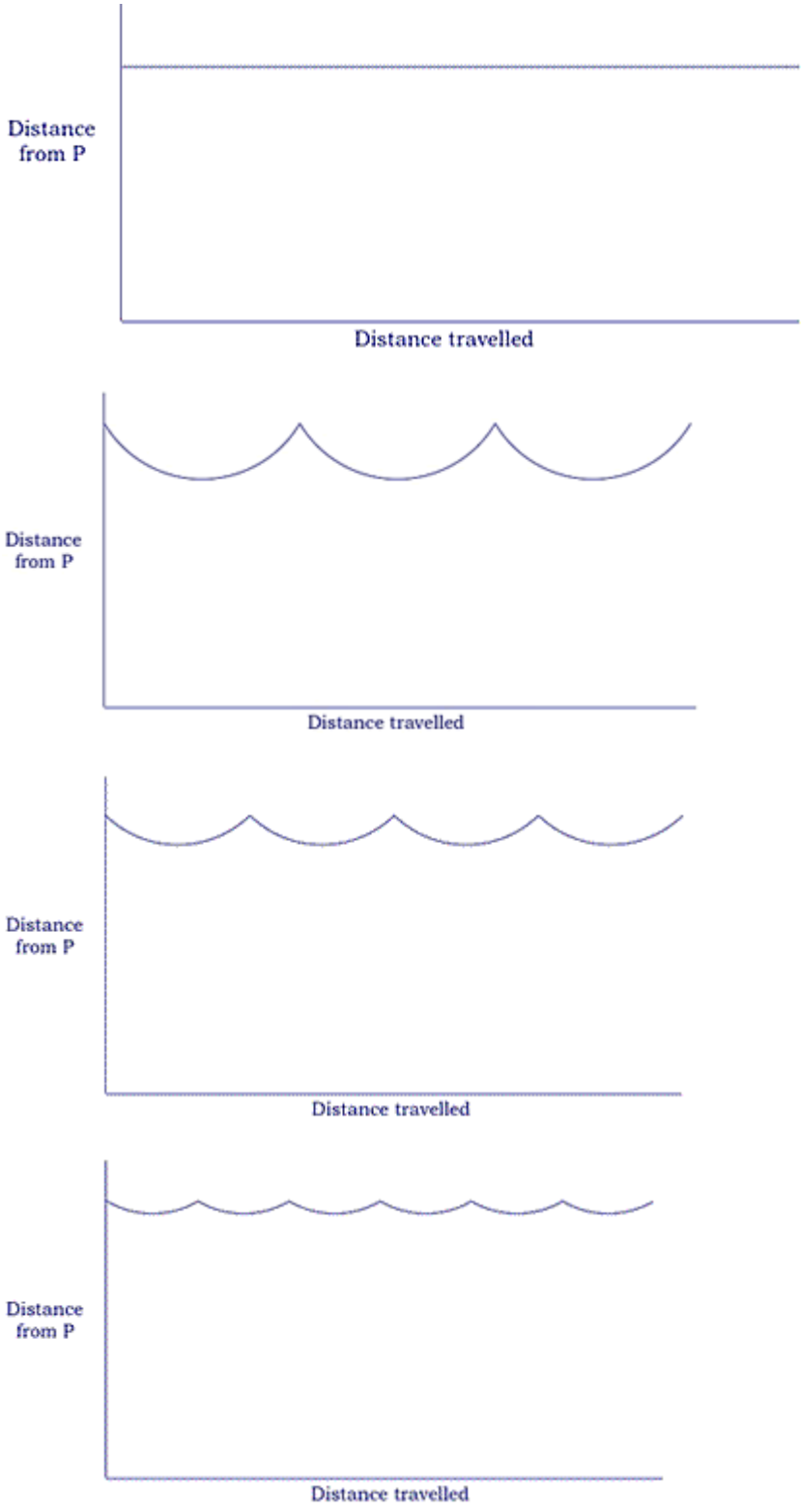


An idea of the shape of the graph can be deduced from reasoning about images such as these …



Part 5

For each of the following sketch-graphs, draw a diagram showing the shape of the track and the position of P that would produce a graph with the given features:



Ways of working

Allow pupils time to attempt these tasks in small groups. The atmosphere should be one of conjecture and discussion so that pupils have plenty of opportunities to explain their thinking, perhaps at first tentatively, and obtain feedback from each other.

For each task-part described above, each group should be encouraged to discuss the ideas of everyone in the group (which might at first be conflicting) until they reach a conclusion with which they all agree. Then invite a representative of each group to explain their conclusions, and how they arrived at them.

Avoid voicing immediate judgements because this may prevent other groups from contributing slightly different or even conflicting explanations.

Further material

This article is about just a few of the many ideas, advice and classroom materials that are beautifully presented in the free-to-download resource The Language of Functions and Graphs, available at the Shell Centre for Mathematical Education Publications Ltd.

You can find previous *It Stands to Reason* features here

Qualifications and Curriculum

Welcome to another new section of the Secondary Magazine.

The aim here, month by month, will be to bring you news, information and views linked to curriculum and qualifications change across the 11-18 maths landscape.

We'll hope to reflect messages and views from the following areas:

- Exam boards
- Ofqual
- DfE
- Subject Associations and other mathematical bodies
    - and of course, most importantly, teachers: teachers who blog
    - teachers who share
    - teachers who discuss.

We hope that means, you!

As a starter, we're offering a few pointers that might be of help to those of you looking ahead to next year's GCSE exams, which, we don't need to tell you, will be the first year of the new version of GCSE Maths.

Before that, though, some news.

Next month, two Maths Hub Leads, Matthew Linney and Dean Rowley (from the North Mids and Peaks and Norfolk and Suffolk Maths Hubs respectively) are sitting down with the three main exam boards to ask questions and seek assurances regarding the new GCSE specification. What they learn will be reflected in this section before the end of term.

But, Matt and Dean want to go armed with as many questions from current classrooms and staffrooms as possible.

So, if you have any thoughts, queries or concerns relating to the new GCSE, which you would like Matt and Dean to raise with the exam boards, please drop us an e-mail.

But, between now and next month, let is us point you to some information and discussion already out there:

- earlier this month, the NCETM's regular, Twitter-based #mathscpdchat concentrated on this very area. Here is an account of the discussion, with embedded links
- Mel Muldowney, of Just Maths fame, has written a blog with details of the known knowns and the known unknowns
- the NCETM's #mathscpdchat isn't the only Twitter chat about maths teaching! @Bettermaths hosts a regular #mathschat too, and this recently focussed on making predictions for the current Year 10
- and we can't possibly leave out the section dedicated to the new GCSE on Jo Morgan (@mathsjem)'s Resourceaholic site.