OCR
RECOGNISING ACHIEVEMENT

# Support for problem solving in GCSE Mathematics A J562 and Mathematics B J567

## Taster pack

**L1059**

February 2010


The School Mathematics Project

www.ocr.org.uk/2010

# Support for problem solving in GCSE Mathematics A J562 and Mathematics B J567

## Taster pack

The GCSE Mathematics A and Mathematics B specifications for first teaching from September 2010 require candidates to apply the subject in a range of contexts ('functional mathematics'*) and to interpret, analyse and solve problems.

In response to requests from centres OCR is making available, in spring 2010, a downloadable resource to help teachers prepare for these new elements. Supplied in PDF format, it will consist of a number of tasks on sheets that can be printed off and projected.

The tasks, which are being carefully developed and trialled by The School Mathematics Project in partnership with OCR, are intended to be embedded into a scheme of work over a significant period of time. They are not designed as practice exam questions but are intended to help learners develop the mental flexibility that they will need for the new elements in the exam.

Each task is preceded by teaching notes highlighting common difficulties and suggesting ways the teacher can develop the work.

This taster pack gives centres an early idea of what will be available in the full resource and allows teachers to try some tasks out.

The tasks cover a wide range of difficulty (see the suggested GCSE tier designations below) and vary in the amount of time they take, some requiring only a few minutes, others needing a lesson or more. While they all involve the ability to analyse and solve problems ('thinking skills'), they vary in style: the functional tasks involve making sense of a significant amount of realistic data; some tasks require the learner to make sense of a spatial situation; others are essentially 'pure' investigations.

* Two resource packs to support Functional Skills Mathematics Levels 1 and 2, have already been developed by the SMP and are downloadable free from the OCR website. The Level 2 pack is particularly valuable as a source of additional support for the functional element in GCSE Mathematics: go to www.ocr.org.uk/functionalskills and follow the links.

## Contents of this taster pack




**Acknowledgments**

Photographs on pages 4 and 5 by Dave Ellis
Photographs and entry price details on pages 7 and 8 by courtesy of Thorpe Park

Foundation

# 1 Photo layout

## Notes

### Resources required

calculators

### Optional resources

photos (or scissors and old magazines from which photos can be cut)
suitably sized rectangles of card
rulers
adhesive

### Examples of related questions you could ask

My car is 1.80 m wide. My garage door is 2.10 m wide. How much clearance will I have on each side if I keep the car centred-up as I drive in?

Design a layout for an A4 newsletter that will have three columns of text going across. (Learners will have to decide on the margins at the edges of the page and the gap between the text columns, then calculate carefully the width of the columns.)

### Points to note

■ Trialling showed that many learners have difficulty with tasks that involve positioning shapes evenly: although the maths for a task like part (a) is simple (find the difference in height or width and divide by 2) many avoided it when dealing with the real situation, attempting instead to place the picture centrally by eye.

■ In parts (a) and (b) we have structured the problem slightly by starting with diagrams that highlight the equal border widths that need to be found. The important thing is for learners to reason logically from those diagrams to the mathematical steps they will use.

■ The piece of card in parts (a) and (b) is A4 size.

■ Either before doing part (a) or straight after it we recommend you give each learner a suitable card rectangle and photo, and ask them to calculate where to place the photo centrally on the card.

■ Some learners may feel more confident working in millimetres.

■ Some may use alternative approaches, for example calculating and marking the centre point of each edge and then aligning the centre points: such an approach is mathematically valid and should be given full credit. However it will not work with the trickier calculation of the vertical distances in part (b).

■ Another way to think about each problem is to turn the horizontal or vertical lengths into a simple equation and solve it. For example, the horizontal dimensions for Sue's picture give the equation

$$b + 17.8 + b = 29.6$$

or

$$2b + 17.8 = 29.6$$

where $b$ is the width of the left and right borders.

Foundation

# 1 Photo layout



Sue wants to display a photo of herself and her friend on the piece of card.

She wants these borders to be the same … … and she wants these borders to be the same.

Here are the dimensions of the photo and the piece of card.

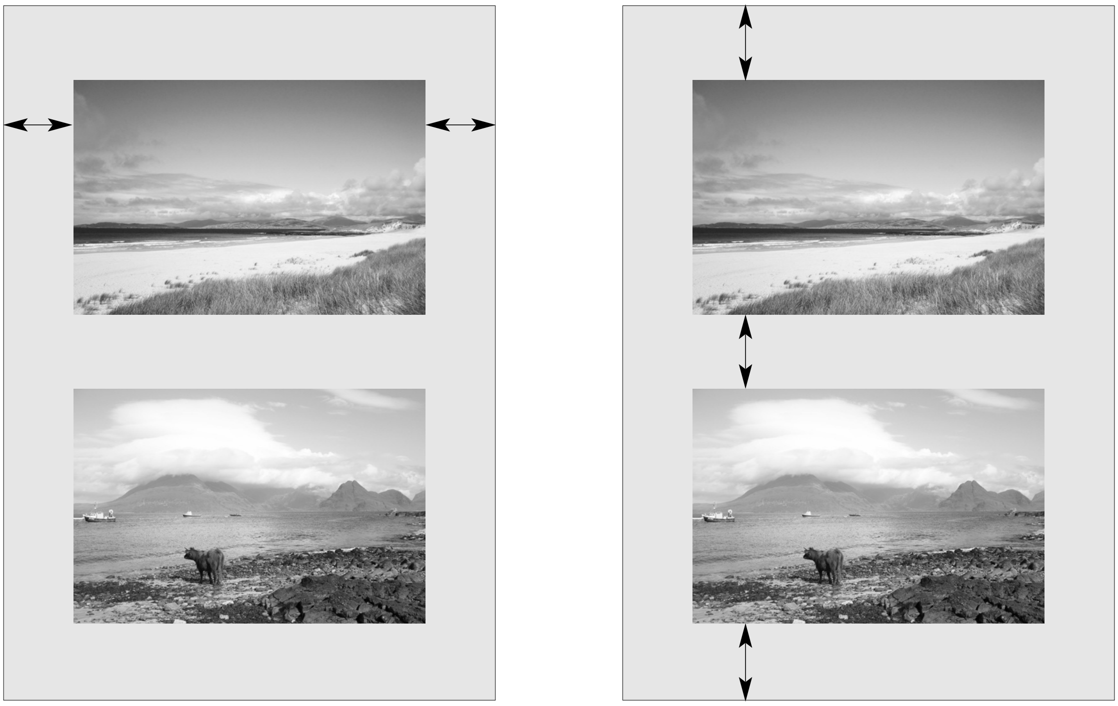


**(a)** Use the dimensions given to show where she should put the photo.
Sketch a plan of the card, marking in enough measurements to show where the photo should go.

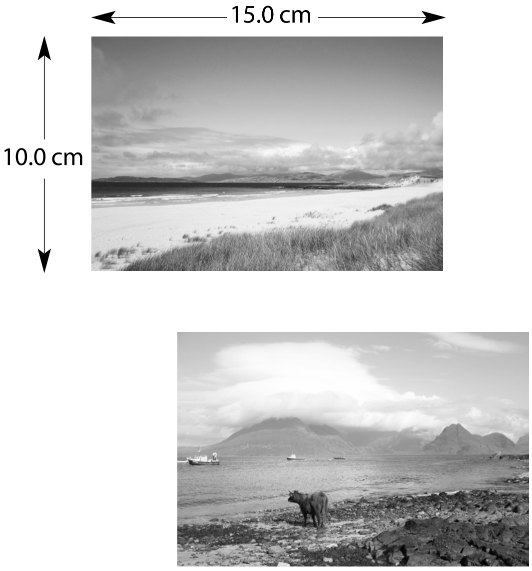
  

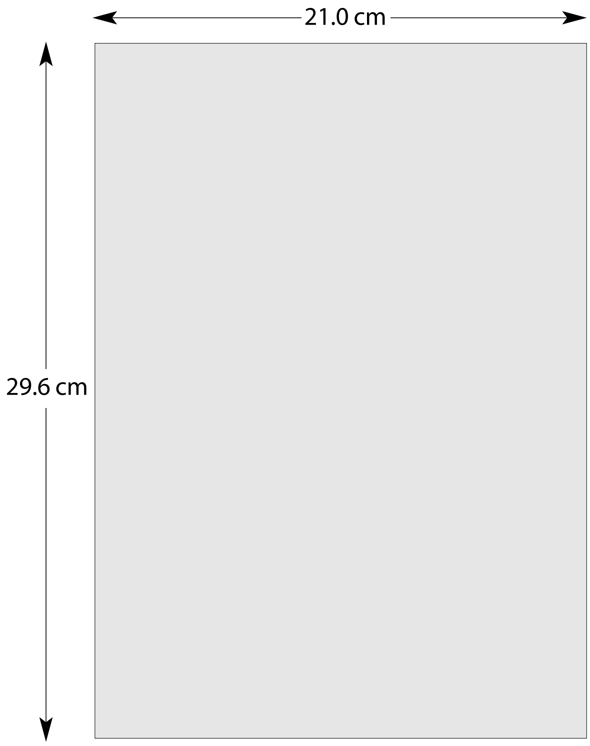
Billy wants to display two photos on a piece of card.

He wants these borders to be the same … … and he wants these three gaps to be the same.



Here are the dimensions of the piece of card and the photos (which are both the same size).




**(b)** Sketch a plan of the card, marking in enough measurements to show where the photos should go.

Foundation

# 2 Thorpe Park

## Notes

**Resources required**

calculators

**Optional resources**

metre stick

**Points to note**

■ To start with you could just give out the first sheet and pose the following questions in class discussion to help learners become familiar with the price list and the definitions of adult, child and the two sizes of family. Then give out the second sheet for them to do the written questions.

- Jane is 15 years old.
  Does she count as an adult or a child?
- Jenny is two years old.
  Do you think she would get into Thorpe Park free?
- How much does it cost for an adult ticket bought on the day?
- How much does it cost to buy a Family of 5 ticket on-line?
- Jane and Mark have two children aged 14 and 5.
  Can they all get into Thorpe Park on a Family of 4 ticket?
- Ken has four children aged 11, 11, 8 and 6.
  Can they all get into Thorpe Park on a Family of 5 ticket?
- Paul is 61. Do you think he counts as a senior?

■ Learners may be unfamiliar with the height of a typical child at different ages. A metre stick should help them appreciate that a child who is less than a metre in height is likely to be quite young, certainly younger than 7 (the youngest child referred to here).

■ Learners will probably assume the parents of young children are not seniors. However someone might raise the point.

■ Learners could compare prices with another well-known adventure park such as Alton Towers or a more local venue.

# 2 Thorpe Park



Thorpe Park is an adventure park near London with lots of exciting rides.


Colossus

Samurai

You can book on-line in advance or pay on the day.
Here are the prices for the main season 2009.

| | **On-line** | **On the day** |
|---|---|---|
| Adult * | £28.00 | £35.00 |
| Child ** | £18.00 | £21.00 |
| Family of 4 *** | £82.00 | £92.00 |
| Family of 5 **** | £97.00 | £115.00 |
| Senior | £22.00 | £24.00 |
| Disabled/helper | £18.00 | £20.00 |
| Child under 1 metre | FREE | FREE |

Slammer

* Aged 12 or over

** Aged under 12 years

*** 2 adults (12 or over) and 2 children (under 12) or 1 adult (12 or over) and 3 children (under 12)

**** 2 adults (12 or over) and 3 children (under 12) or 1 adult (12 or over) and 4 children (under 12)

**Tickets booked in advance must be bought at least 24 hours before the date of visit.**

**(a)** Joe and his daughter Ellie go to Thorpe Park and buy tickets on the day.
Ellie is 8.
How much do their tickets cost in total?

**(b)** Barry, Eva and and their son Donal plan to go to Thorpe Park and buy tickets on-line.
Donal is 14.
How much do their tickets cost in total?

**(c)** Helen and her sister Hazel decide to visit Thorpe Park with Hazel's two children Sasha and Roxy.
Sasha is 13 and Roxy is 10.

**(i)** Can they buy a 'Family of 4' ticket? Give a reason.

**(ii)** How much will they pay to buy their tickets on-line?

**(d)** Lorraine, Nick and their children Billy and Paula plan to go to Thorpe Park.
Billy is 8 and Paula is 10.
What is the cheapest way for them to buy their tickets?
Show how you decided.

**(e)** Babs has four children.
They are aged 15, 12, 10 and 7.
They wake up on a lovely day and all want to go to Thorpe Park.

They have £120 to spend.
Can Babs and her children afford to go to Thorpe Park?
Show clearly how you decided.


Vortex

# 3 Socks

## Notes

**Optional resources**

coloured counters, cubes or socks in a bag or box

**Points to note**

■ During trialling, some teachers described this task as a 'long starter'.

■ If learners can't get started with the task it can be tricky to give help without giving the game away. One approach is to try a related activity with coloured counters (or you could use cubes or cut-out pictures of coloured socks – or you could use real socks!). Fill a bag with blue, red and yellow counters (or whatever you've chosen). Now pick one out at a time, until a pair is found. You could record how often a pair is found after 2 counters, 3 counters and so on. Then you could discuss why a pair is found after 2, 3 or 4 counters and why you never need to pick a fifth counter. Now ask the class to try and apply this to the first socks question.

■ Part (e) has a Higher tier level of difficulty.

■ During trialling some learners extended the task to a third colour. You could, for example, add 8 yellow socks to the drawer and then consider *p* red socks, *q* blue socks and *r* yellow socks. You could also consider the case of a three-footed space creature who needs three matching socks!

# 3 Socks



In my sock drawer I have 6 identical loose red socks and 10 identical loose blue socks.

I share a room with my little sister.
I get up early and don't want to put the light on and disturb her.
I reach into the drawer without being able to see the socks.

**(a)** How many socks must I take out of the drawer to be sure of getting a matching pair?

**(b)** How many socks must I take to be sure of a blue pair?

**(c)** How many socks must I take to be sure of a red pair?

**(d)** What if I have 4 red socks and 3 blue socks?

**(e)** What if I have $p$ red socks and $q$ blue socks?

Foundation/Higher

# 4 Moving house

## Notes

**Optional resources**

scissors

**Points to note**

- During trialling, learners worked on part (a) with the minimum of explanation from the teacher. Typically, discussion centred around how much time, if any, they should allow for lunch.
- A branch of applied mathematics called operational research treats problems like these in a more formal way. Within it, a planning problem like part (b) would be dealt with by a technique called critical path analysis, which helps managers schedule the stages of a project at times that will result in the quickest completion of the whole project. Critical path analysis may reveal ways in which a whole project can be speeded up by applying more resources just to certain stages (as with the question whether and when Linda should help).
- For part (b) learners could cut out and label rectangles (using a standard size for a person's work for a day) and move them around until they form a plan that meets all the conditions.
- There could be discussion about those jobs that could be speeded up when done by more than one person and other jobs that could not because of the need for drying time.

# 4 Moving house



Josh and Katy are moving house.
Their friend Linda has promised to help them.

They have to pack all their things into boxes and clean each room in the house.

Katy estimates how long it will take one person to pack up the things in each room and then clean it.

| **Room** | **Approximate time** |
|---|---|
| Kitchen | 4 hours |
| Dining room | 2 hours |
| Lounge | 3 hours |
| Main bedroom | 3 hours |
| Spare bedroom | 2 hours |
| Study | 3 hours |
| Bathroom | 2 hours |
| Shower room | 1 hour |
| Shed | 5 hours |
| Garage | 3 hours |

They want to do all the packing and cleaning in one day, starting at 8:30 a.m.

**(a)** Make a list of jobs for each person, showing roughly when they should aim to start and finish in a room.

Before they move into their new house, Josh and Katy want to do some decorating.

The table shows the decorating jobs they need to do and the time it will take for **one person** to complete each job.

The 'time needed' includes time for any paint, wallpaper or plaster to dry.

| Job | Time needed | What needs to be finished before this job is started |
|---|---|---|
| **Painting woodwork** | | |
| Sand and prime | 1 day | Wallpaper stripped |
| Undercoat | 1 day | Woodwork sanded and primed |
| Top coat | 1 day | Undercoat on woodwork |
| **Papering walls** | | |
| Strip off wallpaper | 1 day | |
| Repair wall plaster | 1 day | Wallpaper stripped |
| Paper walls | 2 days | Top coat of paint on woodwork<br>**and** wall plaster repaired<br>**and** second coat of paint on ceilings |
| **Painting ceilings** | | |
| Repair ceilings | 1 day | |
| First coat | 1 day | Ceilings repaired |
| Second coat | 1 day | First coat of paint on ceilings |

Josh and Katy start the decorating on a Monday.

**(b)** **(i)** Plan the jobs that need to be done day by day.

**(ii)** They plan to move in when the decorating is finished.
When can they move in?

**(iii)** Could the job be speeded up if Linda helped on some days?
Show how on a revised plan.

# 5 Queen power

## Notes

**Resources required**

squared paper

**Optional resources**

scissors

**Points to note**

■ This is a rich task that can be approached in a variety of ways. Encourage learners to try to explain the statements they make and to prove any generalisations.

■ If they find it difficult move forward at any point you could pose relevant questions along the lines of the following.

- Do you have to think about every square on the board? How does the symmetry of the board help you?
- In how many directions can the queen move from a corner? How many squares can she move on to in each of these directions?
- What happens if you move the queen from one edge square to another? Do you add to or subtract from her power? What happens to the horizontal power and vertical power? What happens to the diagonal power? Can you explain this?
- What happens if you move the queen towards the centre of the board? Do you add to or subtract from her power? How much do you add or subtract? Can you explain this?
- Are there any areas of the board where the power of the queen remains the same? Can you explain this?
- Where on an *n* by *n* board does the queen have the most power? What happens when *n* is even, and when *n* is odd?

■ Later in their investigation, some learners may want to draw a queen with her power radiating out in eight directions, which they view though square 'windows' of different sizes and in different positions. You could have scissors and paper ready for this.

# 5 Queen power

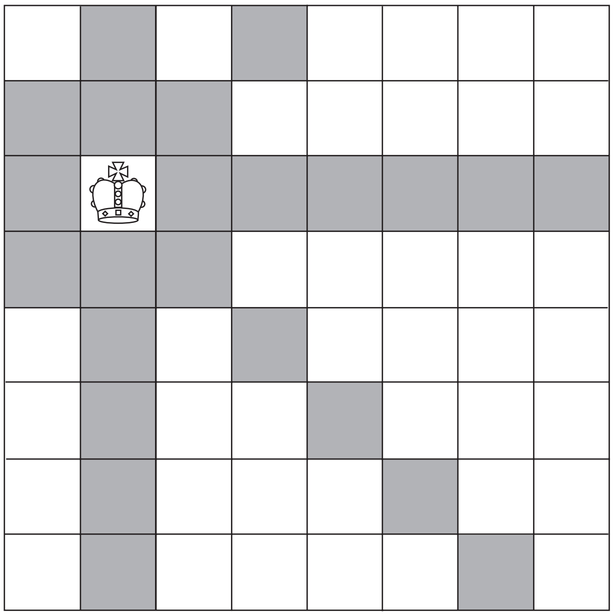
Sheet 1 of 1

Chess is a game where pieces move on an 8 by 8 board of squares.
The pieces move in different ways.

The queen is a very powerful piece.
She can move any number of squares in any direction – up or down, left or right, or diagonally.

From this position on the board, the queen can move to 23 different squares.
These squares are coloured grey.

We can measure the 'power' of a queen on a particular square as the number of squares she can move to.
So the queen here has a power of 23.



**(a)** Investigate the power of the queen on different squares on the 8 by 8 board.
Where does she have the most power?
Where does she have the least power?

**(b)** Investigate the power of the queen on smaller and larger square boards.
Where does the queen have the most power on each board?
Where does she have the least power?

**(c)** What is the greatest and least power of a queen on an *n* by *n* board?