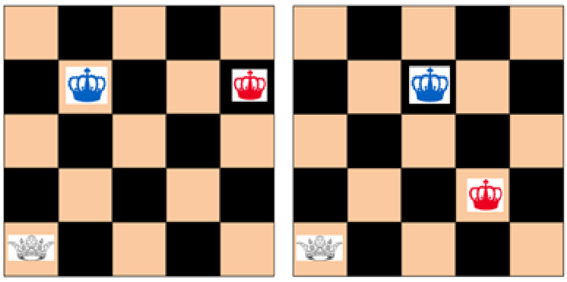
(INCORPORATING THE LIVERPOOL BRANCH OF THE MA AND THE ATM)

OPEN CHALLENGE '15

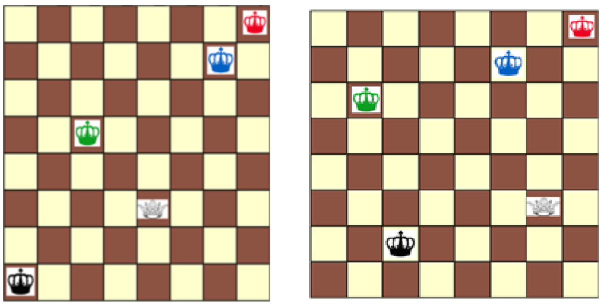
SOLUTIONS

1. GAME OF QUEENS

These are the only three fundamentally different solutions for a four by four chessboard.



There are many solutions for three queens on a five by five chessboard.
The first one here shows two queens under attack and the second one shows all three queens "safe".



There are many solutions for five queens on an eight by eight chessboard.
The first one here shows all five queens under attack and the second one shows all five queens "safe".

2. THE QUEEN'S CHALLENGE

....						
21	....					
11	20	....				
10	12	19	....			
4	9	13	18	....		
3	5	8	14	17	....	
1	2	6	7	15	16	....

The highlighted numbers form part of the triangular number sequence 1, 3, 6, 10, 15,...., x,....
The formula for generating triangular numbers is $x_n = n(n+1)/2$.
For odd n, the triangular numbers sit horizontally.
Solving $2015 = n(n+1)/2$ gives a positive root of 62.98.
If n=63 we have the triangular number 2016.
As 63 is an odd number, 2016 will be on the bottom row at (63,01).
Hence 2015 will be one place to the left and one place up.
Thus flamingo 2015 will be at (62,02).

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3. ROUND AND ROUND WE GO

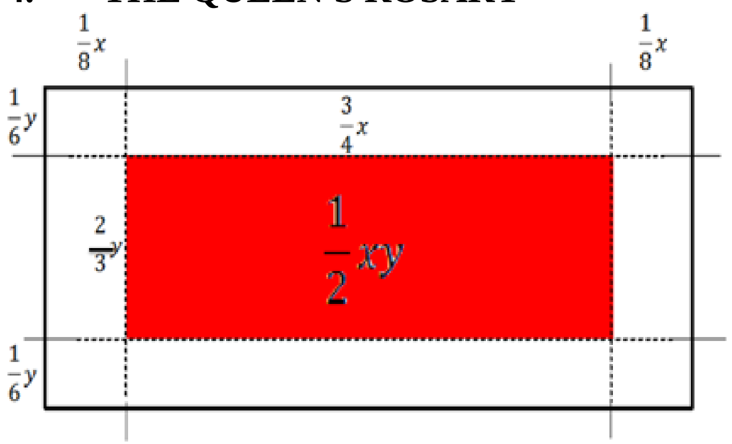
The smallest possible sum is 17 and the largest possible is 23.
The two cards in the middle of any side can be interchanged.

```
      1
    9   6
  4       8
3   7   5   2
```

```
      7
    4   2
  3       6
9   5   1   8
```

Thus there are eight ways (2^3) of presenting every fundamental arrangement.
The number of fundamentals is 18 as follows:
two summing to 17, four summing to 19, six summing to 20, four summing to 21 & two summing to 23.
These 18 fundamentals multiplied by 8 give a total of 144 ways.

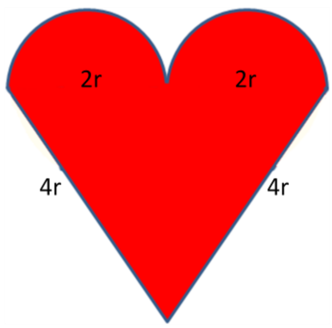
4. THE QUEEN'S ROSARY



One solution is to find two fractions which when multiplied give a value of one half (e.g. three quarters times two thirds).
If the length is x then Alice measures this with the tape and then folds this in half and half again and half for a third time and she marks this length from the two top corners and the two bottom corners.
If the width is y then Alice measures this and folds the tape into 3 equal pieces and halves this and marks this distance from the side corners.
The central rectangle will now have an area equal to half the original one.

Another solution can be found in which the border is always the same width.

5. WHO'S BEEN AFTER THE TARTS?



Perimeter of the tart is 2πr+8r, where r is the radius of the semicircle.
Area of the top of the tart is

$$\pi r^2 + \frac{1}{2} \times 4r \times 4r \times \sin 60$$

$$\pi r^2 + \frac{1}{2} \times 4r \times 4r \times \sin 60 = 2\pi r + 8r$$

$$\text{As} \quad r \neq 0 \qquad r(\pi + 4\sqrt{3}) = 2\pi + 8$$

$$r = \frac{2\pi + 8}{(\pi + 4\sqrt{3})} = 1.42\ cm\ (to\ 3s.f.)$$

Hence the radius of the semicircles is 1.42cm.

BONUS

Alice, The White Rabbit, The Cheshire Cat, The Knave of Hearts, The Playing Cards, The Queen of Hearts (by implication), Flamingos & The Hatter (not The **Mad** Hatter).