

Choose your lottery numbers

On your bit of paper write the 6 numbers you would choose if you were playing the lottery...

The rules:

- There are **59 numbers (integers from 1 to 59)** to choose from.
- You **choose 6** with the aim of matching the 6 numbers that are drawn in the lottery, to win the jackpot.

Royal Institution Primary Maths Masterclasses

Off the shelf Masterclass: **Get Lucky!** **Probability and the Lottery.**



rigb.org
@Ri_Science

Image credits: Pixabay

Ri The Royal Institution
Science Lives Here

Masterclass network

The Royal Institution

Our vision is:
A world where everyone is
inspired to think more
deeply about science and
its place in our lives.



Image credits: Tim Mitchell

Royal Institution activities

- Online videos & activity resources
- National education programmes
- Membership
- London-based:
 - Talks and shows
 - Holiday workshops
 - Family fun days
 - Faraday Museum



The CHRISTMAS LECTURES

The CHRISTMAS LECTURES are the Ri's most famous activity and are televised on the BBC. The first maths lectures by Prof. Sir Christopher Zeeman in 1978 started off the Masterclass programme!

Christmas Lecturers include Michael Faraday, David Attenborough, Carl Sagan, Richard Dawkins, Alison Woollard, Saiful Islam & Alice Roberts



Image credits: Tim Mitchell, Paul Wilkinson

Royal Institution videos

- CHRISTMAS LECTURES – on the Ri website

The screenshot shows the Royal Institution website's interface for Christmas Lectures. At the top left is the 'Ri' logo with the tagline 'The Royal Institution Science Lives Here'. To the right are navigation buttons for 'Menu', 'Blog', and 'Video'. Below this is a breadcrumb trail 'Christmas Lectures → Watch →'. The main banner features a video player with the text 'Watch past CHRISTMAS LECTURES' and 'Catch up with past CHRISTMAS LECTURES in full and for free on our ever expanding online archive.' Below the banner is a search bar labeled 'Search Lectures' and a filter section with dropdown menus for 'Topics', 'Lecturer', and 'Year', along with a 'View all' button. A YouTube logo is also present. Under the filters, the 'Active filters' section shows 'series x'. Two video thumbnails are displayed: 'The language of life' by Sophie Scott and 'Supercharged: fuelling the future' by Saiful Islam.

Ri The Royal Institution
Science Lives Here

Menu Blog Video

Christmas Lectures → Watch →

Watch past CHRISTMAS LECTURES
Catch up with past CHRISTMAS LECTURES in full and for free on our ever expanding online archive.

Search Lectures

Topics Lecturer Year View all

YouTube

Active filters **series x**

The language of life
Sophie Scott takes us on a journey through one of the fundamentals of human and animal life - the unstoppable urge to communicate, in the 2017 CHRISTMAS LECTURES.

Supercharged: fuelling the future
Saiful Islam leads an incredible journey through the invisible presence that

Royal Institution videos

- CHRISTMAS LECTURES – on the Ri website
- Ri on YouTube – experiments, videos & talks for all ages

The image shows a composite of two screenshots. The top screenshot is from the Royal Institution website, featuring the logo 'Ri The Royal Institution Science Lives Here' and navigation buttons for 'Menu', 'Blog', and 'Video'. A banner for 'Watch past CHRISTMAS LECTURES' is visible, along with a search bar and filter options. The bottom screenshot is from the Royal Institution's YouTube channel, showing the channel name, subscriber count (378,807), and a grid of video thumbnails including 'Levitating Superconductor', 'Purple Doesn't Exist', 'Nitrogen Triiodide', 'Burning a Diamond', and 'Fluorine and Caesium'.

Ri The Royal Institution Science Lives Here

Menu Blog Video

Christmas Lectures → Watch →

Watch past CHRISTMAS LECTURES
Catch up with past CHRISTMAS LECTURES in full and for free on our ever expanding online archive.

Search Lectures

Topics [dropdown] Lectures [dropdown]

Active filters series x

(Ri) The Royal Institution 378,807 subscribers

HOME VIDEOS PLAYLISTS COMMUNITY CHANNELS ABOUT

Popular Experiments PLAY ALL

Watch and learn the science behind some of the most popular demonstrations we have done here at the Ri.

Levitating Superconductor 7:30
Levitating Superconductor on a Möbius strip
The Royal Institution

Purple Doesn't Exist 5:14
Colour Mixing: The Mystery of Magenta
The Royal Institution

Nitrogen Triiodide 4:56
Slow Motion Contact Explosive - Nitrogen Triiodide
The Royal Institution

Burning a Diamond 4:41
2012 Christmas Lectures - Burning a Diamond
The Royal Institution

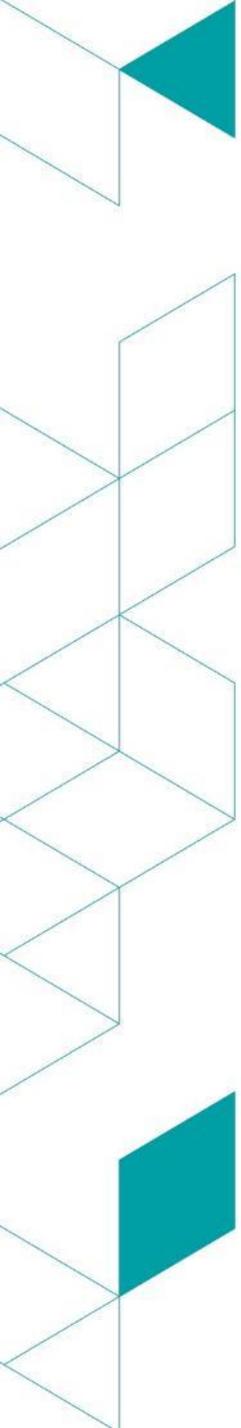
Fluorine and Caesium 4:37
Reacting Fluorine with Caesium - First Time on
The Royal Institution

Royal Institution videos

- CHRISTMAS LECTURES – on the Ri website
- Ri on YouTube – experiments, videos & talks for all ages
- ExpeRimental – science experiments at home

The screenshot shows the top navigation bar of the Royal Institution website. The logo 'Ri The Royal Institution Science Lives Here' is on the left. To the right are three hexagonal menu items: 'Menu' (yellow), 'Blog' (grey), and 'Video' (black). Below the navigation is a dark grey bar with the text 'Christmas Lectures → Watch →'. The main content area features a large banner with the text 'Watch past CHRISTMAS LECTURES' and 'Catch up with past CHRISTMAS LECTURES in full and for free on our ever expanding online archive.' The background of the banner shows a lecture hall with pink seats.

This screenshot shows the YouTube channel page for The Royal Institution. The channel name 'The Royal Institution' is displayed with a subscriber count of 378,807. The navigation tabs 'HOME', 'VIDEOS', and 'PLAYLISTS' are visible. The 'VIDEOS' tab is active, showing a list of videos. The first video is 'The language of Sophie Scott', featuring a woman speaking into a megaphone. Below it is 'Supercharged' by Saiful Islam. The 'Popular Experiments' section includes 'Levitating Superconductor on a Möbius strip' (7:30) and 'Purple Doesn't Exist' (Colour Mixing: The Myth of Magenta). The channel description reads: 'About ExpeRimental All about ExpeRimental, our series of videos that help you bring science home.' At the bottom, there is a blue banner with the text 'Make your home a science lab with our fun experiments to do with children' and a row of small icons representing various experiments.



Get Lucky!

Probability and the Lottery

One Coin Flip

H

T

$$\frac{1}{2}$$

Two Coin Flips

You could have...

TT

What other combinations could you have?

Two Coin Flips

T T T H

H T H H

Three Coin Flips

TTT

TTH

THT

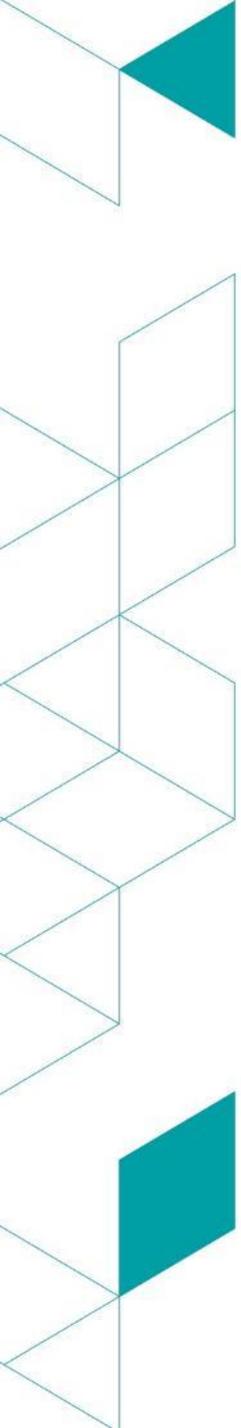
HTT

TNN

HTH

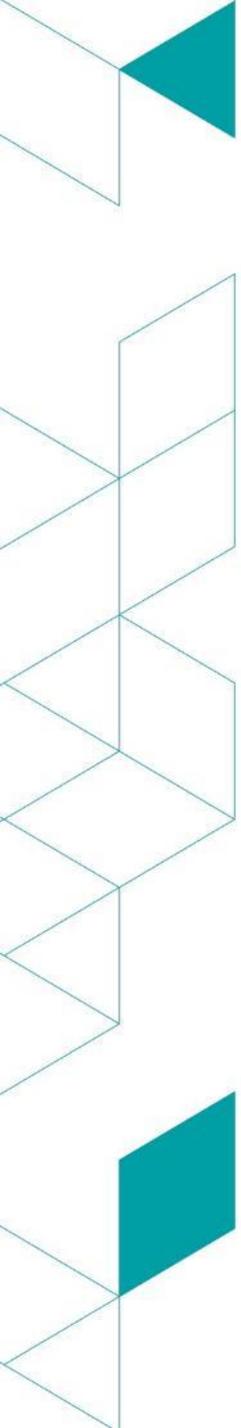
HNT

HHH



Is it worth playing the lottery?

What do we need to find out?



Combinations

Mini Lottery

Players choose two numbers from 1,2,3,4,5

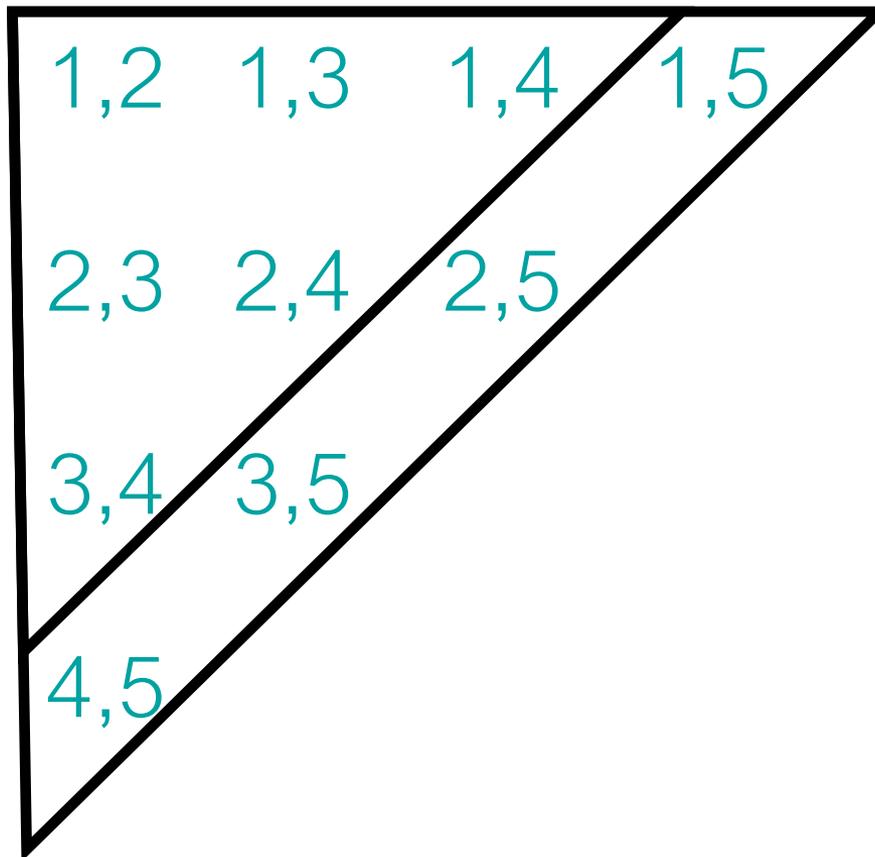
If you choose the two numbers that are chosen from the machine, then you win the jackpot!

- a) Write out ALL the possible pairs of numbers you can choose. Order doesn't matter in the lottery!

- b) Finished? Write out ALL the possible groups of three numbers you can choose from the five.

Mini Lottery

Write out ALL the possible pairs of numbers you can choose!



$${}^5C_2 = 10$$

$${}^4C_2 = 6$$

Mini Lottery

Three numbers chosen from 1,2,3,4,5

Write out ALL the possible groups of three numbers you can choose from the five

3,4,5 2,4,5 2,3,5 2,3,4

1,4,5 1,3,5 1,3,4

1,2,5 1,2,4

1,2,3

$${}_5C_3 = 10$$

How many lottery numbers you choose.

CHOOSE

How many numbers to choose from.

FROM

0

1

2

3

4

5

0

1

2

3

4

5

6

10

10

How many lottery numbers you choose.

CHOOSE

How many numbers to choose from.

FROM

0

1

2

3

4

5

0

1

2

3

4

5

6

10

10

How many lottery numbers you choose.

CHOOSE

How many numbers to choose from.

FROM

0

1

2

3

4

5

0

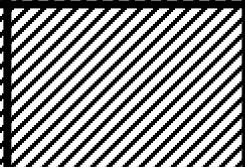
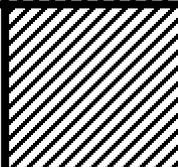
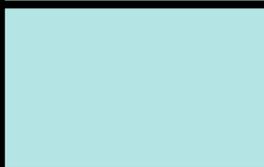
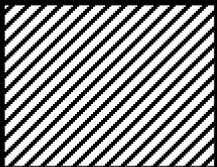
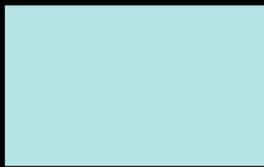
1

2

3

4

5



6



10

10



How many lottery numbers you choose.

CHOOSE

How many numbers to choose from.

FROM

0

1

2

3

4

5

0

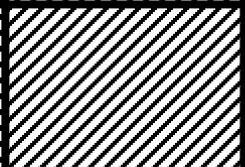
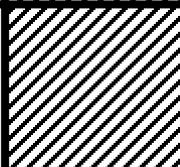
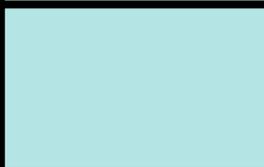
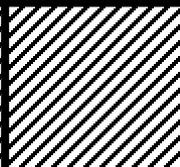
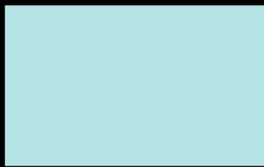
1

2

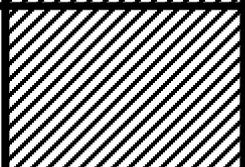
3

4

5

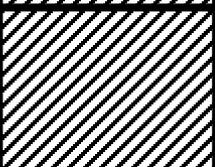


3



6

4



10

10

5



How many lottery numbers you choose.

CHOOSE

How many numbers to choose from.

FROM

0

1

2

3

4

5

0

1

2

3

4

5

1

2

3

4

5

3

6

10

4

10

5

How many lottery numbers you choose.

CHOOSE

How many numbers to choose from.

FROM

	0	1	2	3	4	5
0						
1		1				
2		2	1			
3		3	3	1		
4		4	6	4	1	
5		5	10	10	5	1

How many lottery numbers you choose.

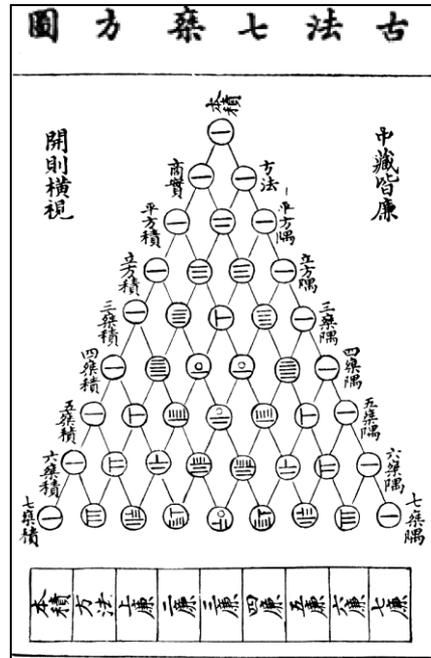
CHOOSE

How many numbers to choose from.

FROM

		0	1	2	3	4	5
0	1	1					
1	1	1	1				
2	1	1	2	1			
3	1	1	3	3	1		
4	1	1	4	6	4	1	
5	1	1	5	10	10	5	1

Pascal's Triangle



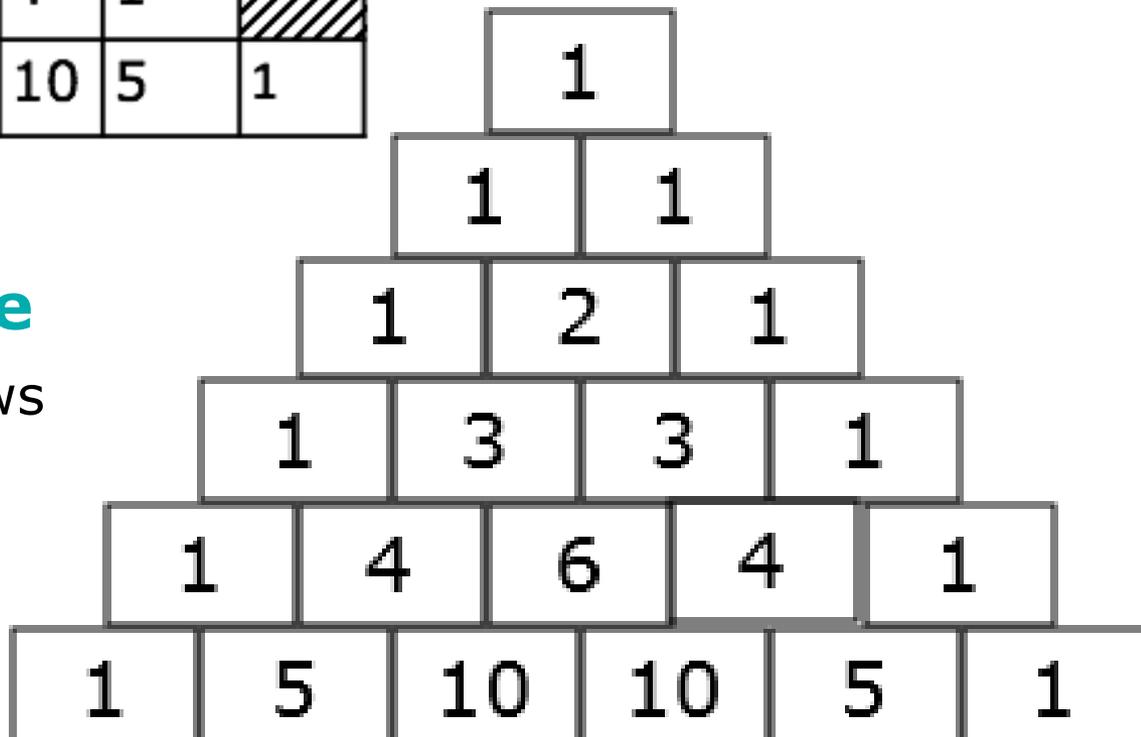
Also known as

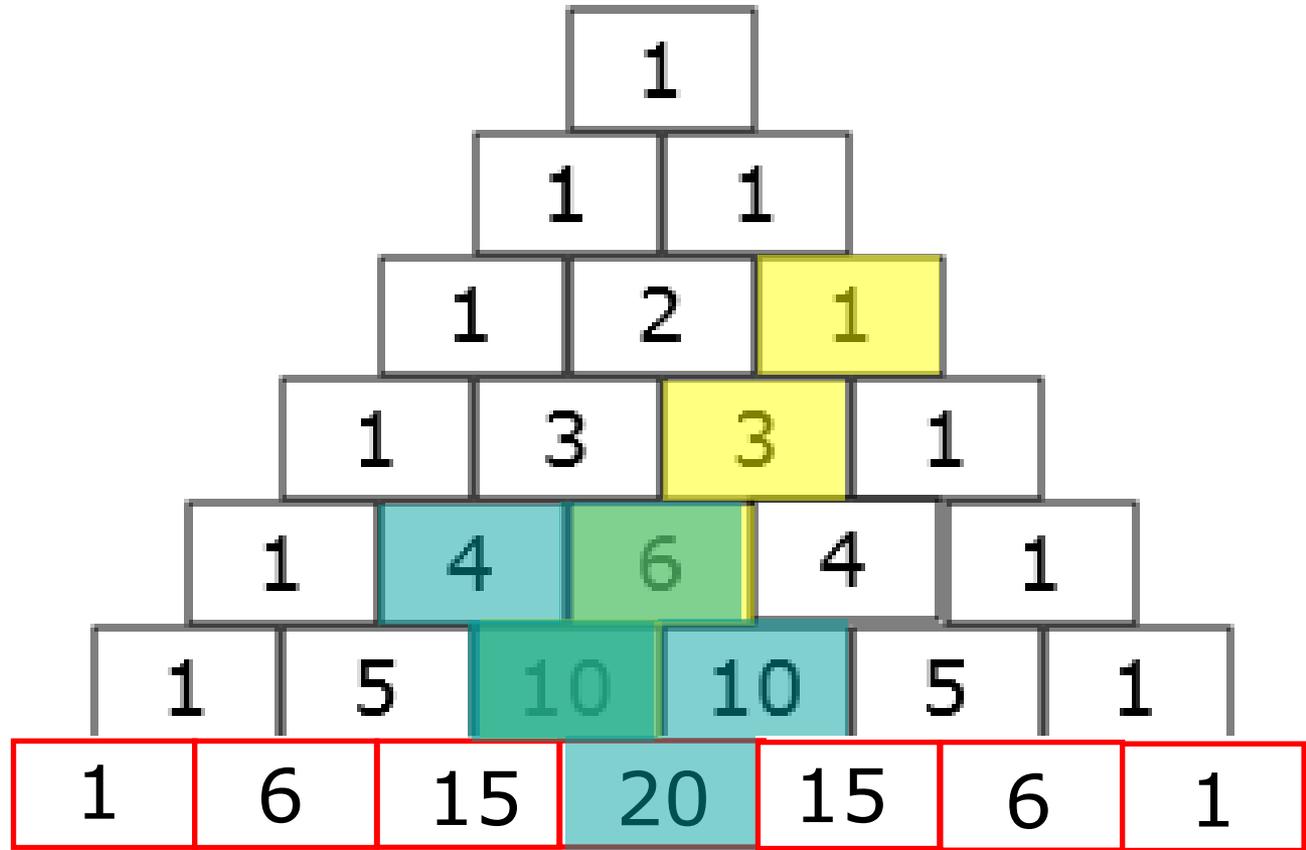
Yanghui Triangle

		How many lottery numbers you choose. CHOOSE					
		0	1	2	3	4	5
How many numbers to choose from. FROM	0	1					
	1	1	1				
	2	1	2	1			
	3	1	3	3	1		
	4	1	4	6	4	1	
	5	1	5	10	10	5	1

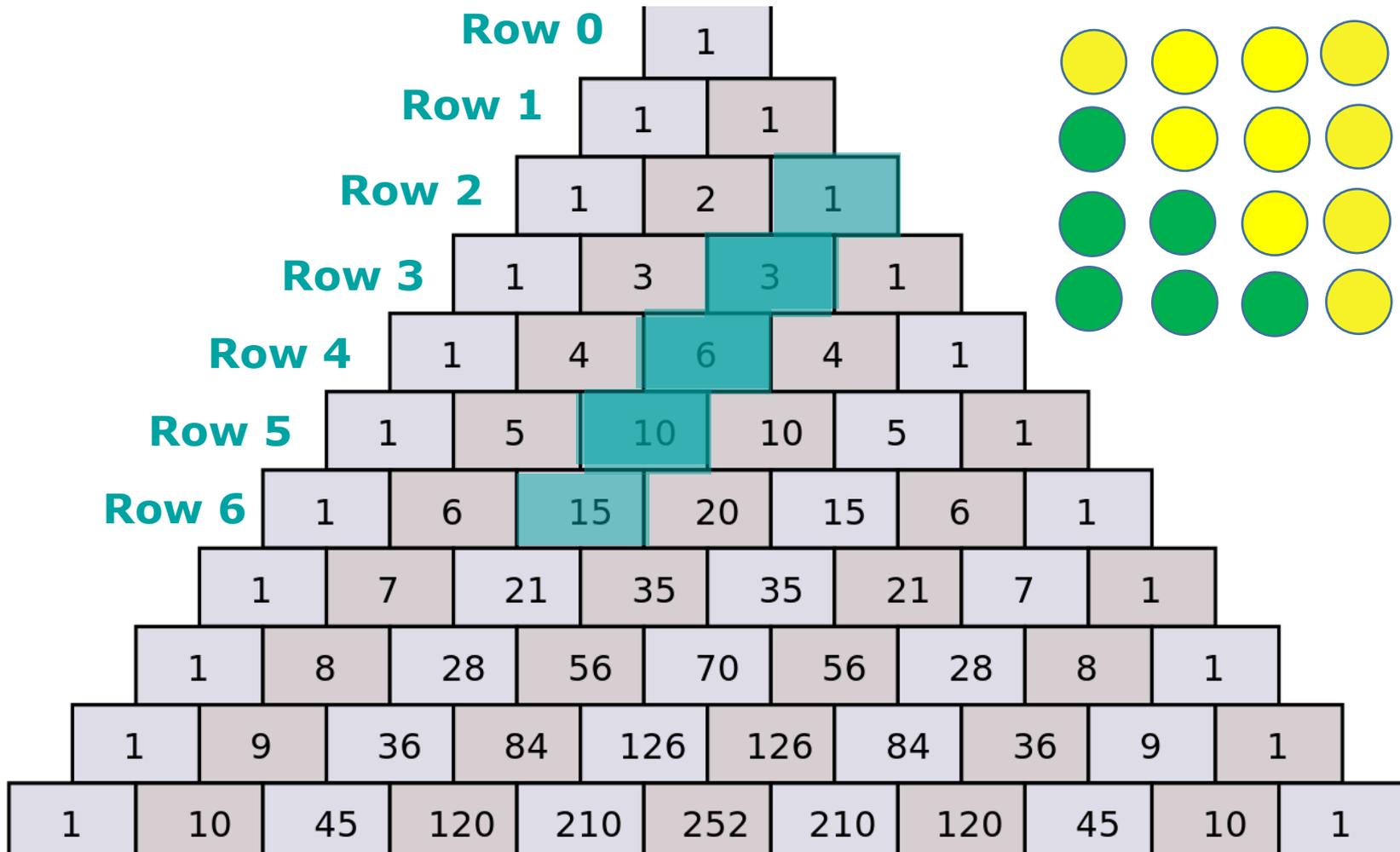
Pascal's Triangle

Can you fill in the rows below?

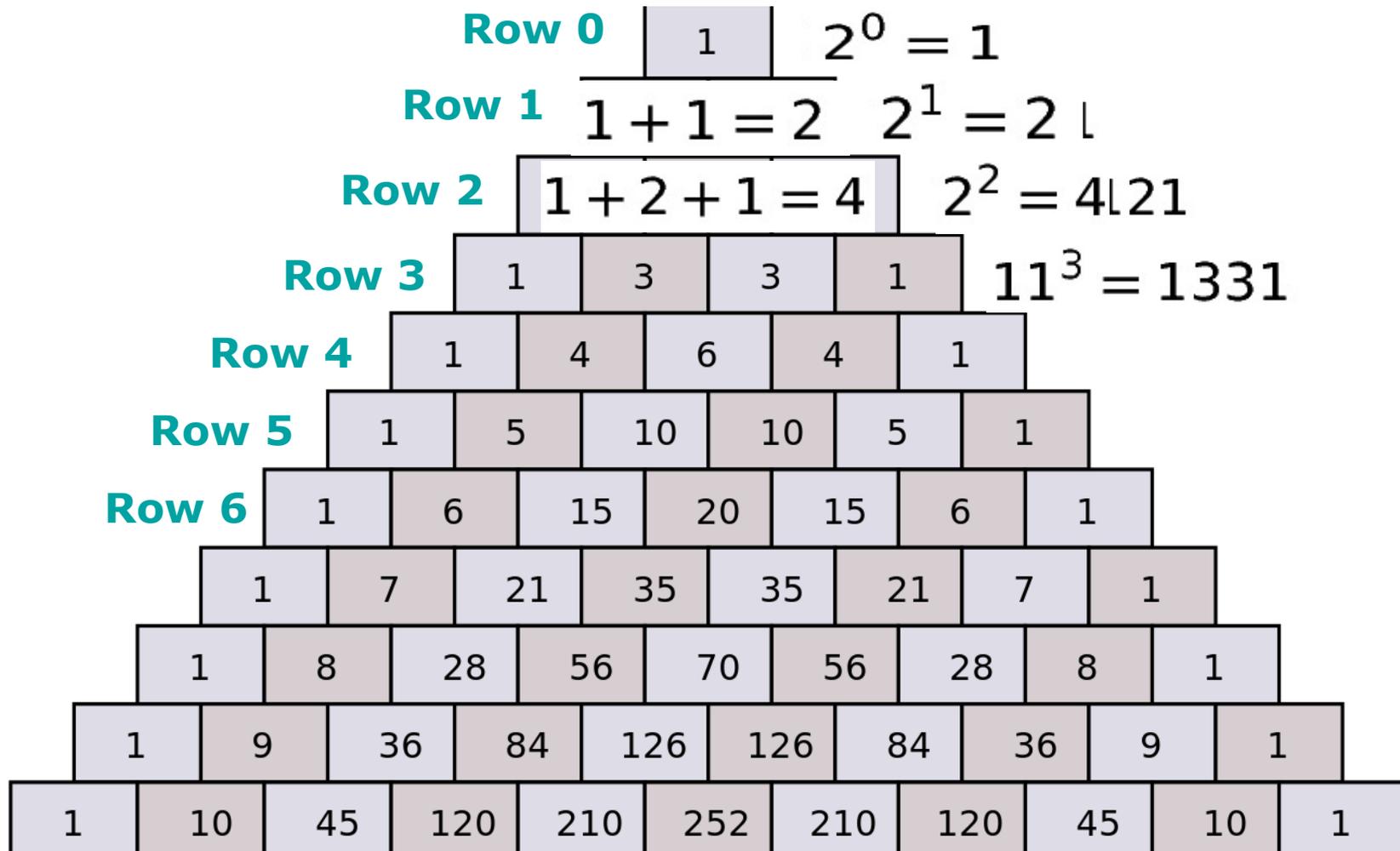




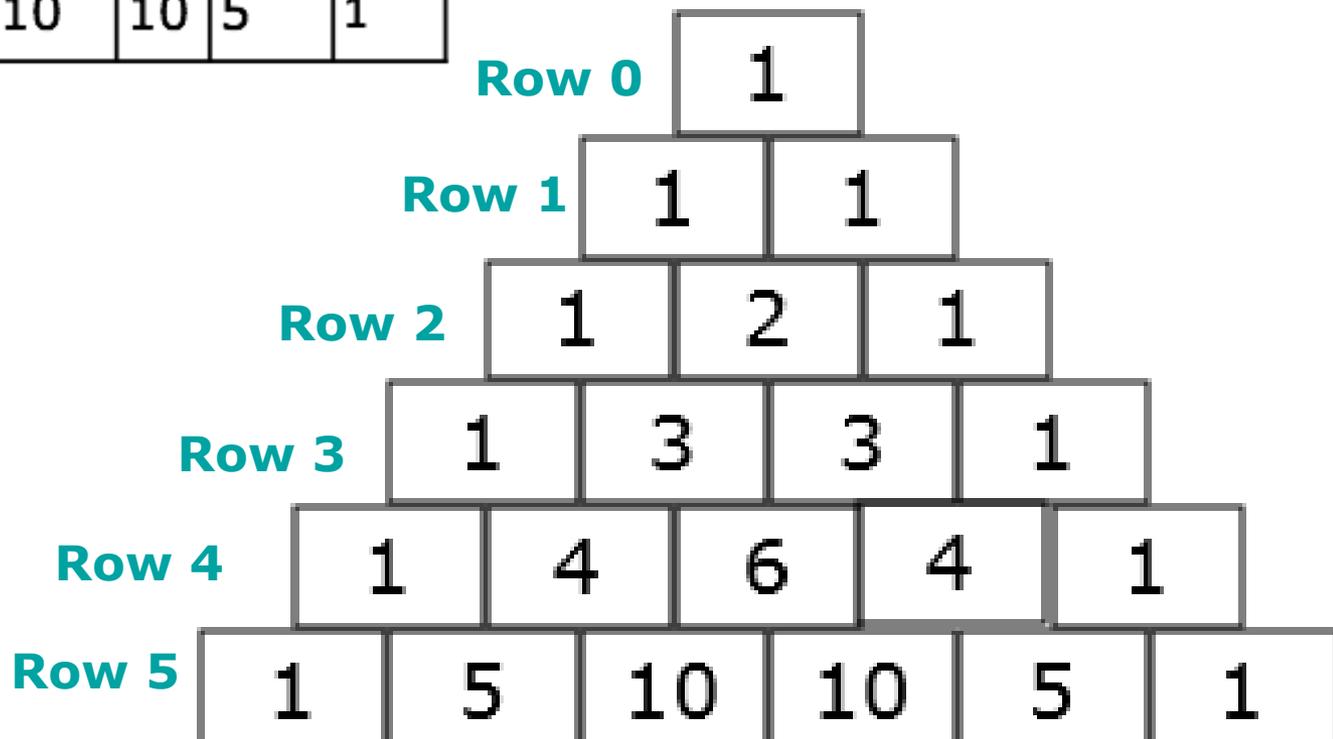
Pascal's Triangle



Pascal's Triangle



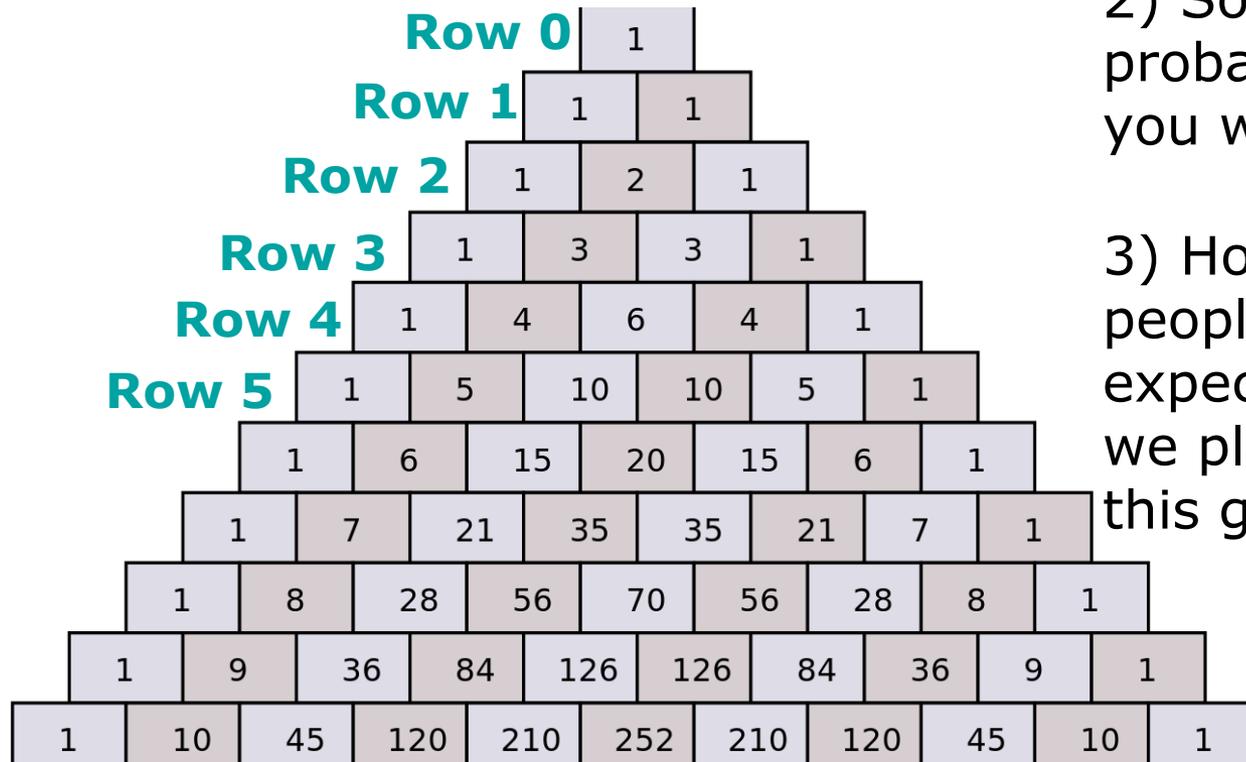
		How many lottery numbers you choose. CHOOSE					
		0	1	2	3	4	5
How many numbers to choose from. FROM	0	1					
	1	1	1				
	2	1	2	1			
	3	1	3	3	1		
	4	1	4	6	4	1	
	5	1	5	10	10	5	1



Mini Lottery

Players choose two numbers from 1,2,3,4,5,6,7

1) How many different groups of numbers are there that you could choose?



2) So what is the probability that you will win?

3) How many people would we expect to win if we played with this group?

Lottery - how many ways?

Interactive Pascal's Triangle

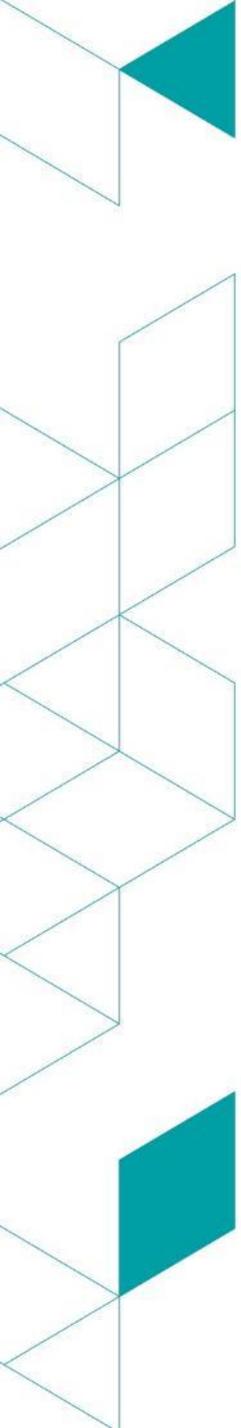
Lottery - how many ways?

Two cells above 59 C 6 in Pascal's triangle...

4582116

40475358

45057474



So is it worth it?

Lottery - how many ways?

$$= 45,057,474$$

$$= 1 \text{ in } 45,057,474$$

$$= \frac{1}{45,057,474}$$

$$= 0.00000002219$$

What does that mean...?

You need to play **45,057,474** times to expect to win once

1. How many years does it take to play that many times, if you buy a ticket a week?
2. How many lifetimes is that?
3. If £2,000,000 is the average jackpot winnings per person, how much money do you expect to lose in total (if you could play for that many lifetimes)?

Finished?

Can you think of another way of calculating the probability of winning the jackpot?

What does that mean...?

1. How many years does it take to play that many times, if you buy a ticket a week?

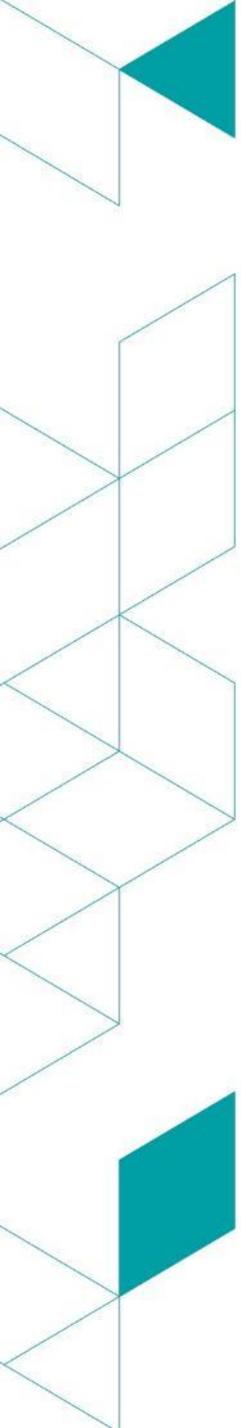
$$45,057,474 / 52 = 866,489.88$$

2. How many lifetimes is that?

$$866,489.88 / 74 = 11709.32$$

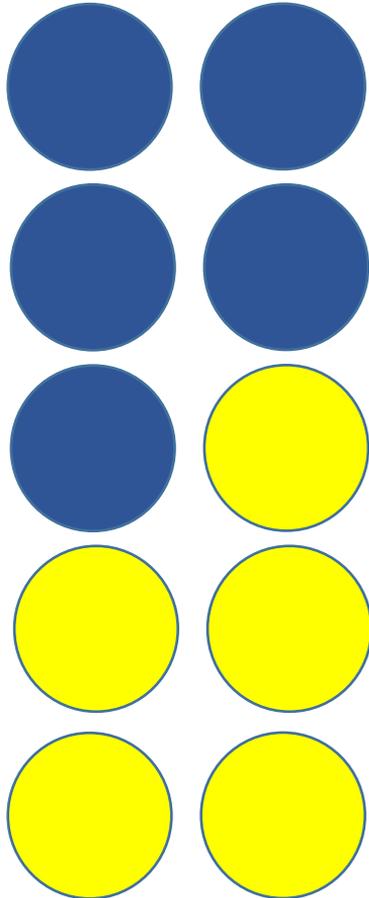
3. If £2,000,000 is the average jackpot winnings per person, how much money do you expect to lose in total (if you could play for that many lifetimes)?

$$45,057,474 \times 2 - 2,000,000 = 88,114,948$$



Extension Material: Expected value of a lottery ticket.

Extension activity: Is it worth it?



Game 1

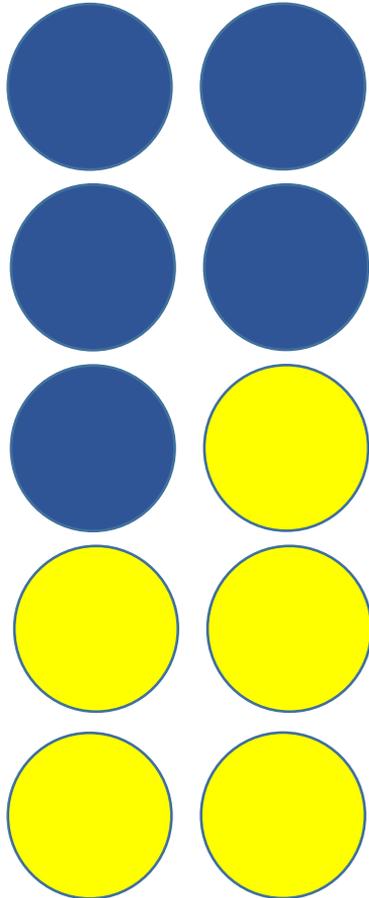
Cost 3 sweets to play

Win 10 sweets if you draw blue.

Win nothing if you draw yellow

Is it worth playing?

Is it worth it?



Game 2

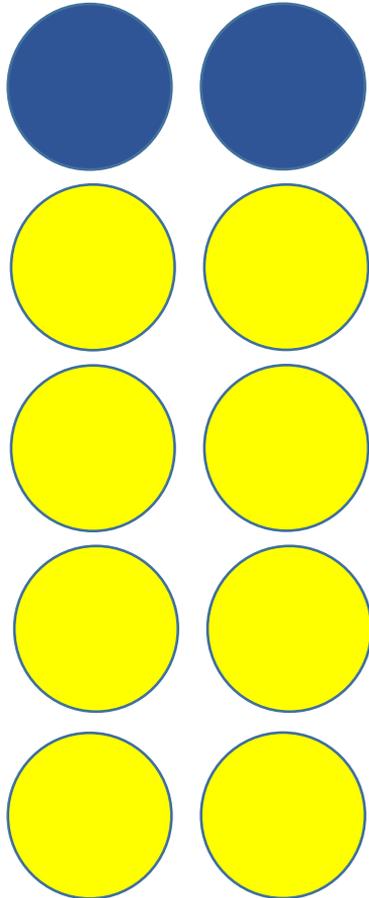
Cost 3 sweets to play

Win 5 sweets if you draw blue.

Win nothing if you draw yellow

Is it worth playing?

Is it worth it?



Game 3

Cost 3 sweets to play

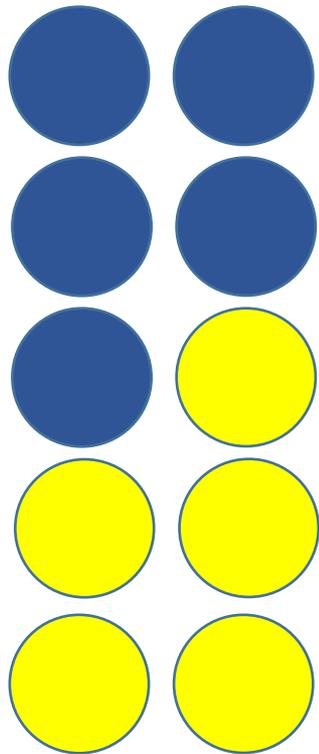
Win 10 sweets if you draw blue.

Win nothing if you draw yellow

Is it worth playing?

Expected value

Expected value = probability win x prize if you win
= 0.5×10
= 5



Game 1

Cost 3 sweets to play

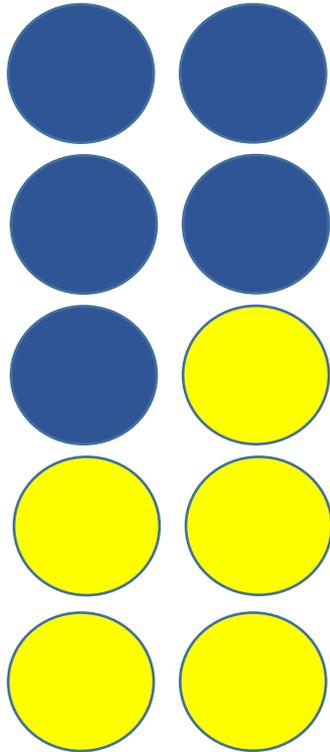
Win 10 sweets if you draw blue.

Win nothing if you draw yellow

Is it worth playing?

Expected value

Expected value = probability win x prize if you win
= 0.5×5
= 2.5



Game 2

Cost 3 sweets to play

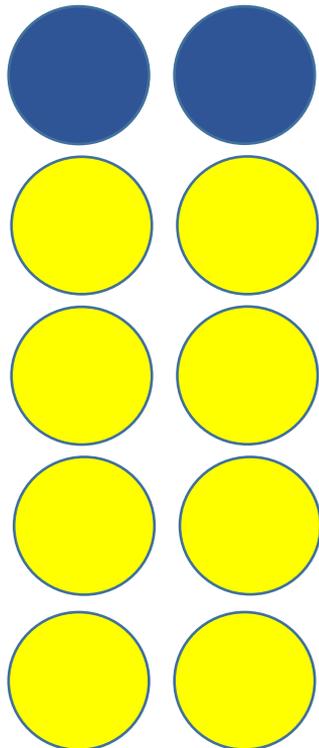
Win 5 sweets if you draw blue.

Win nothing if you draw yellow

Is it worth playing?

Expected value

Expected value = probability win x prize if you win
= 0.2×10
= 2



Game 3

Cost 3 sweets to play

Win 10 sweets if you draw blue.

Win nothing if you draw yellow

Is it worth playing?

Expected value

Expected value =

probability you win \times prize if you win

+

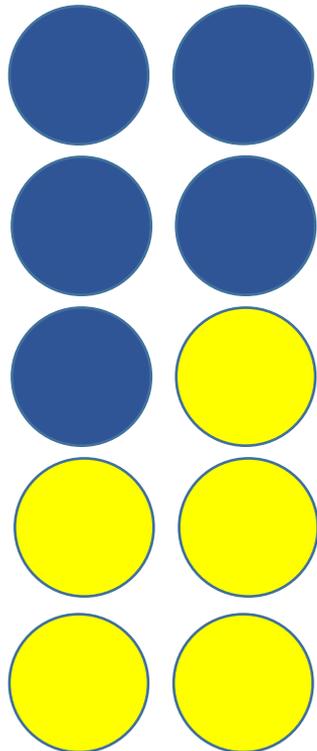
probability that you lose \times prize if you lose

$$E(x) = P_w \times X_w + P_L \times X_L$$

Expected value

$$E(x) = P_w \times X_w + P_L \times X_L$$

$$E(x) = 0.5 \times 10 + 0.5 \times 0 = 5$$



Game 1

Cost 3 sweets to play

Win 10 sweets if you draw blue.

Win nothing if you draw yellow

Is it worth playing?

Expected value of a lottery ticket

$$E(x) = P_1X_1 + P_2X_2 + P_2X_3 + \dots P_nX_n$$

Number of numbers matched	Outcomes (X) (Average prize money per person)	Probability (p)	Prize multiplied by probability
6	£2,000,000		
5 and bonus	£50,000		
5	£1000		
4	£100		
3	£25		
	TOTAL:		

Expected value of a lottery ticket

$$E(x) = P_1X_1 + P_2X_2 + P_2X_3 + \dots P_nX_n$$

Number of numbers matched	Outcomes (X) (Average prize money per person)	Probability (p)	Prize multiplied by probability
6	£2,000,000	0.00000002219	
5 and bonus	£50,000		
5	£1000		
4	£100		
3	£25		
	TOTAL:		

Expected value of a lottery ticket

$$E(x) = P_1X_1 + P_2X_2 + P_2X_3 + \dots P_nX_n$$

Number of numbers matched	Outcomes (X) (Average prize money per person)	Probability (p)	Prize multiplied by probability
6	£2,000,000	0.00000002219	
5 and bonus	£50,000	0.00000013316	
5	£1000	0.0000069244	
4	£100	0.00045874742	
3	£25	0.01039827488	
	TOTAL:		

Expected value of a lottery ticket

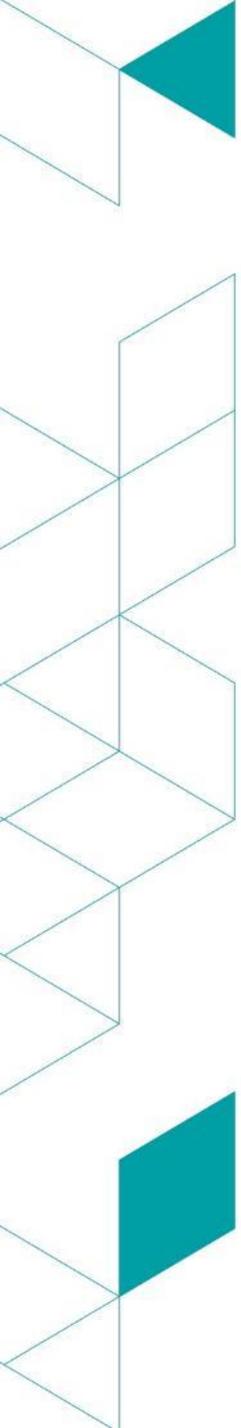
$$E(x) = P_1X_1 + P_2X_2 + P_2X_3 + \dots P_nX_n$$

Number of numbers matched	Outcomes (X) (Average prize money per person)	Probability (p)	Prize multiplied by probability
6	£2,000,000	0.00000002219	£0.044
5 and bonus	£50,000	0.00000013316	£0.007
5	£1000	0.00000069244	£0.007
4	£100	0.00045874742	£0.046
3	£25	0.01039827488	£0.260
	TOTAL:		

Expected value of a lottery ticket

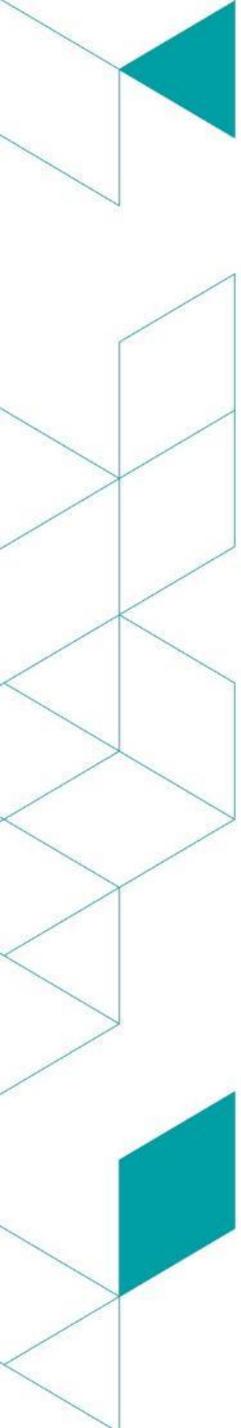
$$E(x) = P_1X_1 + P_2X_2 + P_2X_3 + \dots P_nX_n$$

Number of numbers matched	Outcomes (X) (Average prize money per person)	Probability (p)	Prize multiplied by probability
6	£2,000,000	0.00000002219	£0.044
5 and bonus	£50,000	0.00000013316	£0.007
5	£1000	0.00000069244	£0.007
4	£100	0.00045874742	£0.046
3	£25	0.01039827488	£0.260
	TOTAL:		£0.36



On average, for every £2 spent
on a ticket –
maths says you should expect to
get 36p back.

So is it worth it?



Expected value of a lottery ticket

There's never been a better day to play the lottery, mathematically speaking

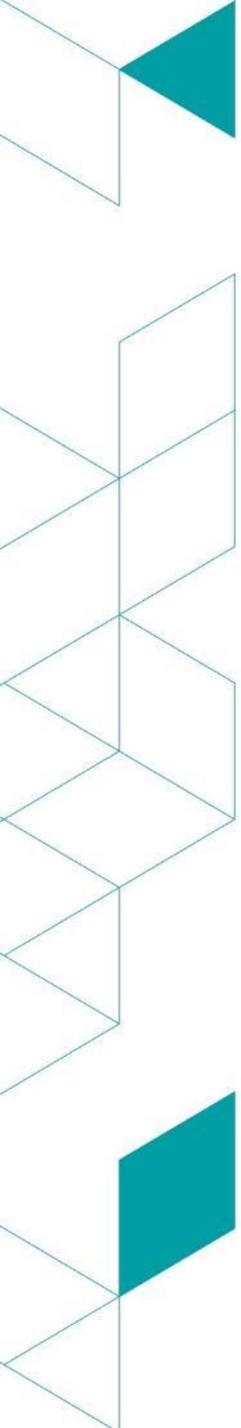
Buying a ticket for today's national lottery draw makes mathematical sense for the first time in its history.

The jackpot - which will be around £58m - is the largest since [the lottery began in 1994](#). But that's not what makes today's draw unusually interesting.

Today's draw is noteworthy because the rule changes made to the lottery last year have resulted in an anomalous situation where the “expected value” of each £2 ticket - that is, the amount you can expect to win per ticket on average - is more than £2.

January 2016

Credit: Alex Bellos, The Guardian



Lets play the Lottery!



Tuesday 17th April 2018 [Sign In](#)

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EuroMillions EuroMillions Superdraw Jackpot: **€130 MILLION** This Friday!

Ticket sales close in...
3 9 31 16
Days Hours Minutes Seconds

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Lotto Number Generator

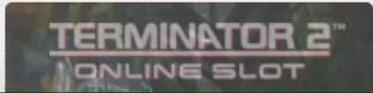
[Lottery.co.uk](#) > [Lotto](#) > [Number Generator](#)

Looking to buy a [Lotto ticket](#) but feeling uninspired when it comes to choosing your numbers? The Lotto Number Generator is here to pick up to ten lines for you completely at random! Simply click on the "Generate Numbers" button and watch your entry unfold.

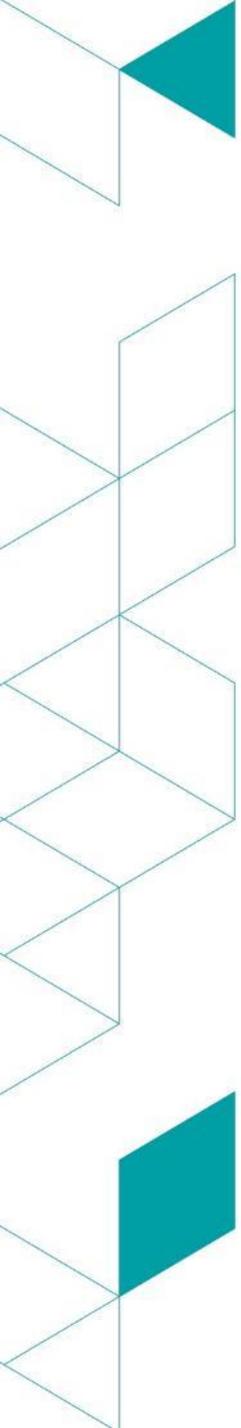
A row of six red circles, each containing a white question mark, representing the numbers to be generated. Below them is a blue button labeled "Generate Numbers". A mouse cursor is hovering over the third circle.

Generate another set(s) of numbers [Go](#)

Don't forget to make use of the [Lotto results checker](#) page after the draw to see if you are a winner!



Next Estimated Lotto Jackpot Time left to join [Don't delay](#)



Which numbers would you choose?

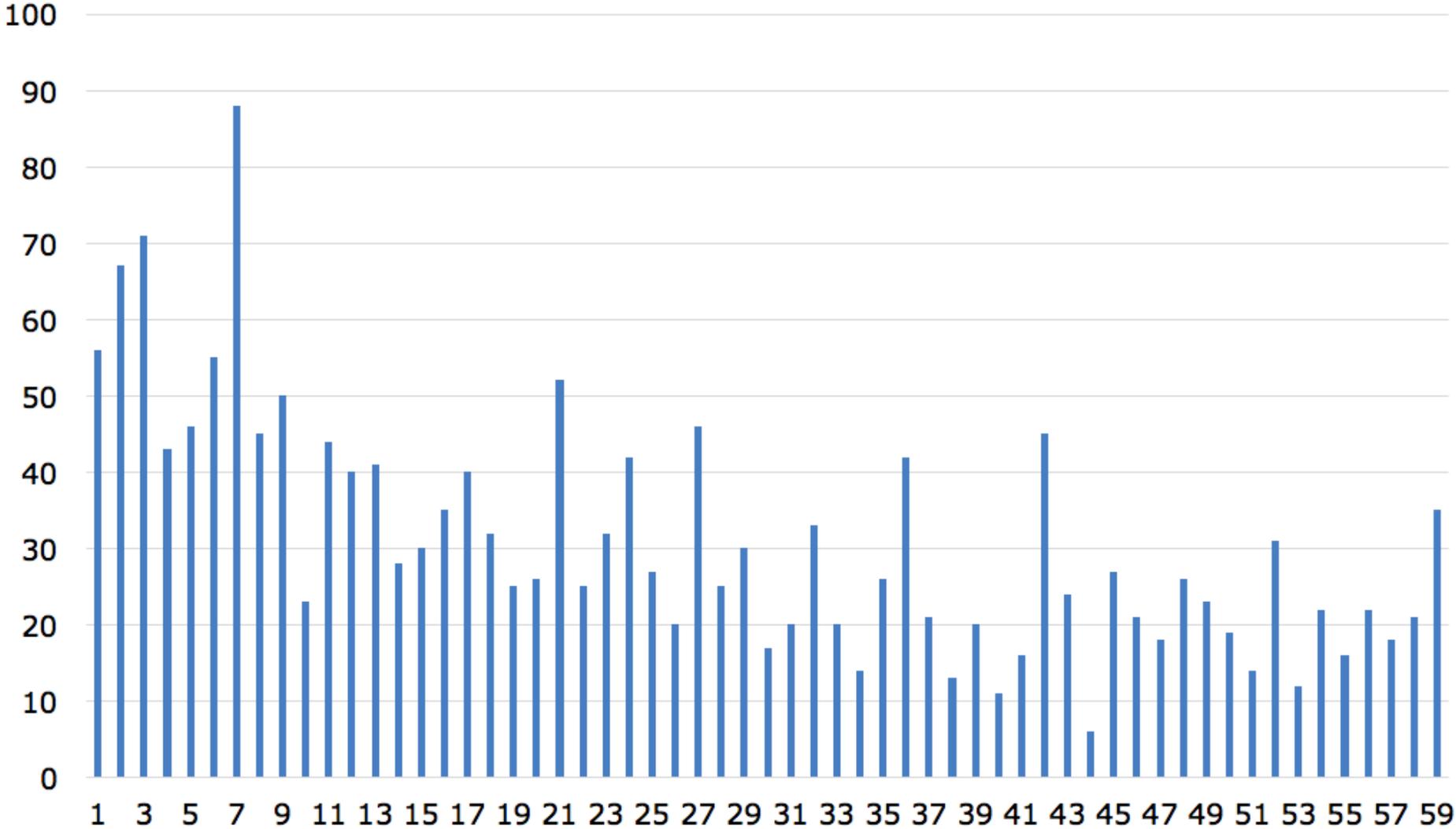
A) 7, 17, 26, 31, 49, 56

B) 1, 2, 3, 4, 5, 6

C) 3, 7, 11, 14, 27, 30

D) 36, 37, 39, 40, 52, 53

How frequently Ri Masterclass students chose each lottery number

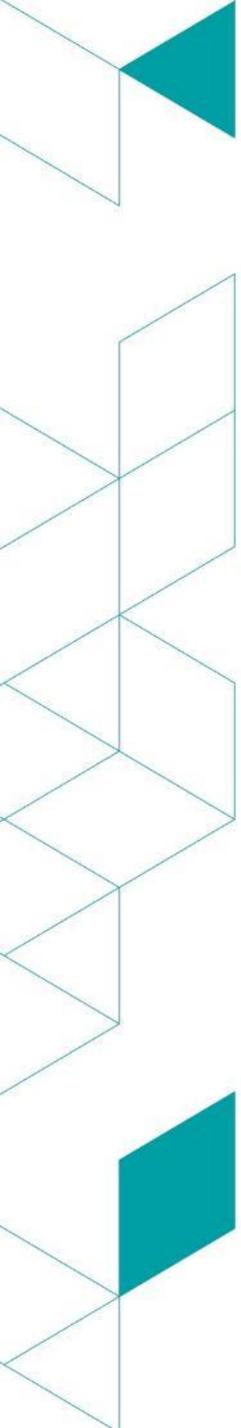


Popular numbers

23 March 2016, Lottery Results



No. of matches	No. of winners	Prize per winner
Match 6	0	£0
Match 5 + bonus	6	£10,016
Match 5	4,082	£15
Match 4	7,879	£51
Match 3	114,232	£25



We hope you have enjoyed exploring the maths of the National Lottery with us!

What questions do you have?

Any unanswered questions can be written down and emailed to “Ask the Ri Masterclass Team” using this email masterclasses@ri.ac.uk

We don't know all the answers instantly, but we will find out and get back to you before the next Masterclass.

Any comments you have about what you enjoyed or what you'd like to do more of can be written on the post-it note and handed in.

Go further: combinations and thinking systematically

Small Change <https://nrich.maths.org/754>

Stage: 3 ★ ★ ★

In how many ways can a pound (value 100 pence) be changed into some combination of 1, 2, 5, 10, 20 and 50 pence coins? Remember, the aim is not just to get the answer but to find a good method and to explain it well.

Greetings <https://nrich.maths.org/615>

Stage: 3 ★

There are 30 students in a class and it is found that in any subset of 4 students from the class each student has exchanged Christmas cards with the other three. Show that some students have exchanged cards with all the other students in the class. How many such students are there?



Image credits: XXXXX

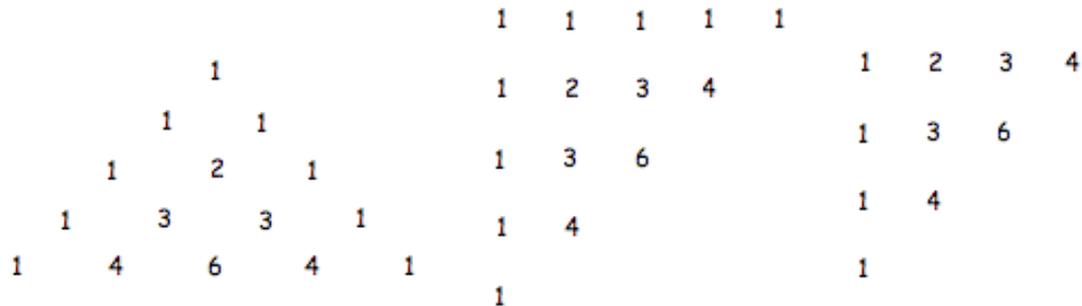
Go further: Pascal's Triangle

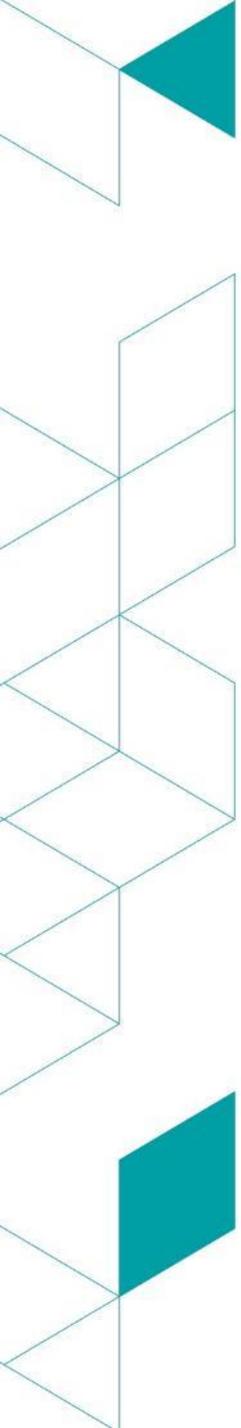
Investigating Pascal's Triangle <https://nrich.maths.org/5593>

Stage: 2 and 3 ★ ★

I think that it's time to look at Pascal's Triangle afresh. So, let's see what happens when we turn it around in a special way.

So we start with the layout as usual, turn it anticlockwise 45 degrees and then take off the top line of ones.





Royal Institution Primary Maths Masterclasses

Thank you!