



**Advanced Mathematics
Support Programme®**

Pringle Permutations!

- Do you like Pringles?
- Have you ever eaten a triple-decker-stack??
With different flavour combinations?



Pringle Stacks!

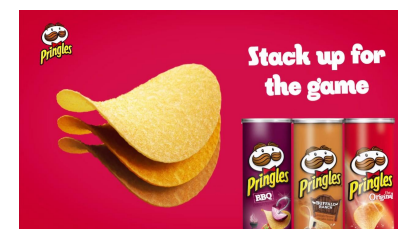
- Start by watching this clip from YouTube

<https://www.youtube.com/watch?v=-tYrXkw6sYk>



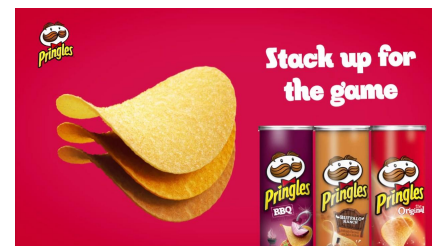
Pringle Stacks

- Did you notice how many combinations they said were possible??
- Does that sound right?
- How many flavours are there?
- And how big is a stack?
- Let's investigate...



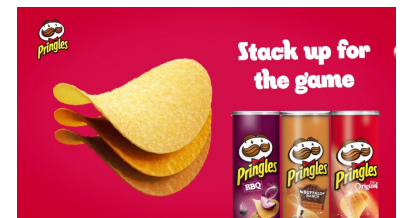
Pringle Stacks

- We'll start with a stack that **must** contain **3 different flavours**
- The **order doesn't matter** (in mathematics we call this a *combination*)
- So if you had **3 flavours** to choose from, you could only make 1 stack – can you explain why?



Pringle Stacks

- What if you had **4 flavours** to choose from?
- How many different 3 pringle stacks could you make then?



Pringle Stacks

- See if you can list all the combinations, picking from 4 flavours
 - Original (O)
 - Salt & Vinegar (S)
 - Paprika (P)
 - Cheese (C)



Pringle Stacks

- Did you get all 4? And no more?
- Here is the list of all of the **combinations**, picking from **4 flavours** (O, S, P, C):

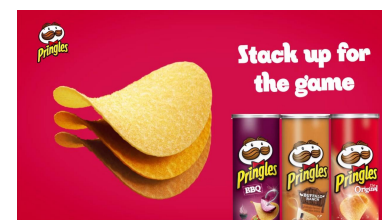
OSP, OSC, OPC, SPC

*(remember, it doesn't matter what **order** the letters appear: OSP is the same as SOP)*



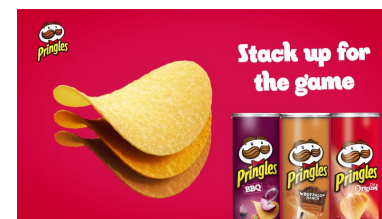
Pringle Stacks

- What if we add another flavour?
Hot & Spicy – H
- Can you list all the stacks, picking **3 Pringles** from these **5 flavours**
- **Write them all down** before you check on the next slide



Pringle Stacks

- You should have found **10**:
OSP, OSC, OSH, OPC, OPH, OCH
SPC, SPH, SCH, PCH
- Why are the answers written in this **order**?
- Keeping your answers structured will help you find them all.



Pringle Stacks

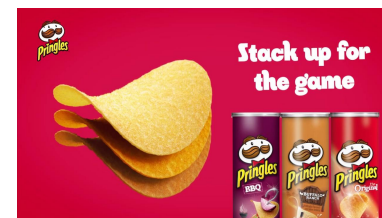
- Let's **add one more flavour at a time**. Choose your own letters/flavours. Remember you are always picking 3 flavours from your choice.

Number of Flavours	Number of Stacks
3	
4	
5	
6	
7	

- Can you find patterns in the table to predict what the answers will be for 8,9 and 10 flavours (choosing 3 each time)

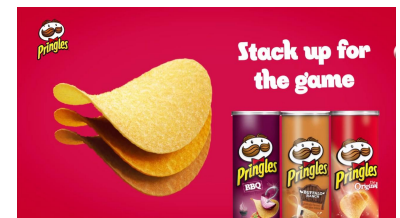
Pringle Stacks

- You should have noticed that the numbers were increasing by the triangle numbers.
- Do you think this would be the same if we were picking 2 flavours? Or 4?
- There is a **formula** - this is beyond the scope of this investigation but it does come up in A Level Maths.
- If you want to read about it, there is a good article [here](#).



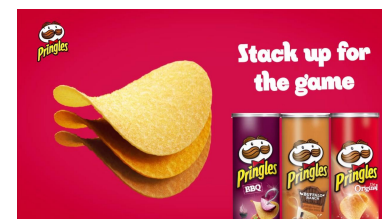
Pringle Stacks

- I think you **deserve a rest** – and a **snack!**
(Hmmm, I wonder what you could have....?)
- Why don't you try a triple Pringles stack?
- And maybe do a **taste test** to see if the **order** you stack them actually does matter?
- If you haven't got Pringles, try eating jam on toast upside down! (the toast not you!) – does it taste different??



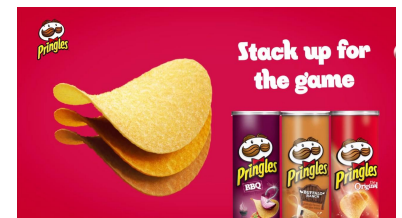
Pringle Permutations

- Pringles decided that the order in the stack **does matter** after all...! (you may want to decide whether you agree with this).
- In this case, we call it a *permutation* instead of a combination.



Pringle Permutations

- So going back to our first 3 flavours, the different **permutations** are:
OSP, OPS, SOP, SPO, POS, PSO



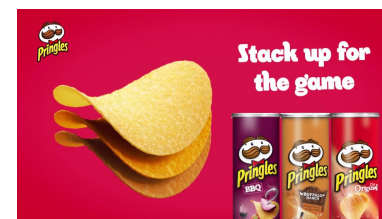
Pringle Permutations

- How many permutations would there be if you had **4 flavours** and wanted to combine all 4?, Can you find them all? (for example OPSH, OPHS, OHPS,...)
- How many ways of choosing 3 Pringles are there with **5 flavours** to choose from?



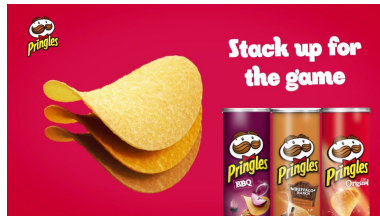
Pringle Permutation Formula

- Let's start with **3 flavours** for our triple stack.
- The top of the stack can be any of the **3** flavours.
- The middle Pringle can be any of the **2** remaining flavours.
- The bottom Pringle has to be the **final** flavour
- That gives us $3 \times 2 \times 1 = 6$ permutations.

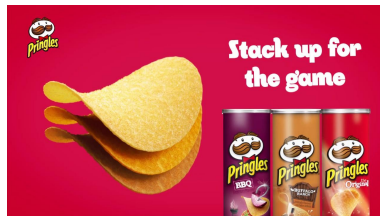


Pringle Permutation Formula

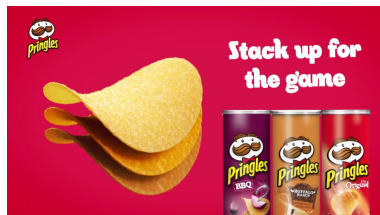
- What about choosing 3 crisps from **4 flavours**?



1st = 4 flavours
to choose from



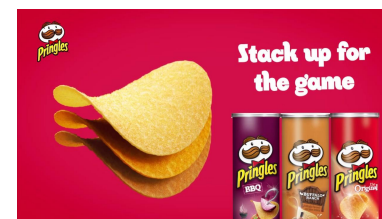
2nd = 3 flavours
to choose from



3rd = 2 flavours
to choose from

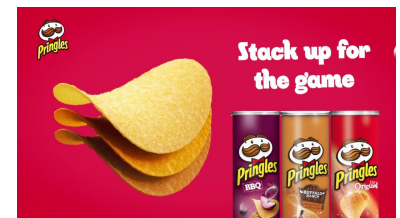
Pringle Permutation Formula

- Can you predict the calculation for choosing 3 crisps from **5 flavours? 6 flavours? 7 flavours? 10 flavours?**



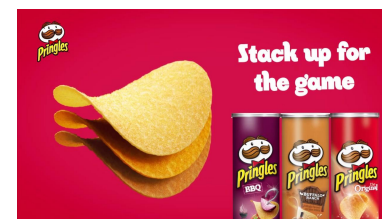
Pringle Permutation Formula

- Here's the answer for **10 flavours** and a triple stack? $10 \times 9 \times 8 = 720$
- For a general formula, we use the **factorial function** (*symbol: !*)
- The **factorial function** means you multiply a the descending integers from the starting number down to 1:
- $3! = 3 \times 2 \times 1 = 6$
- $5! = 5 \times 4 \times 3 \times 2 \times 1 = 120$



The Factorial Function

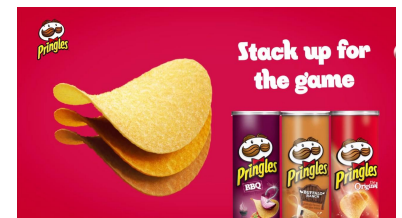
- With 5 flavours and 3 Pringles to choose we found the calculation to be: $5 \times 4 \times 3$
- Notice how this is $5!$ but without the “end bit”
- 10 flavours would be $10 \times 9 \times 8$
- Again, this starts like $10!$ but has $7!$ Missing
- How could you ‘remove’ $7!$ from $10!$?



The Factorial Function

- $\frac{10!}{7!} = \frac{10 \times 9 \times 8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1}{7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1} = 10 \times 9 \times 8 = 720$

- $n \times (n - 1) \times (n - 2) \times \cdots (m + 1) \times m =$
 $\frac{n!}{m!}$

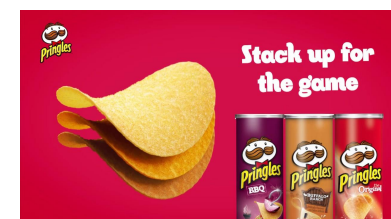


The Factorial Function

- So a general formula to give the number of stack permutations (S) for F flavours and using 3 Pringles would be

- $$S = \frac{F!}{(F-3)!}$$

- What would the general formula of stack permutations be for F flavours and n Pringles?
- How many permutations would there be if there were 10 flavours and you could choose 2 or 3 pringles?



The advert

- Can you go back to the video clip and work out how many flavours they were choosing from?
- See the next slide if you need a hint.



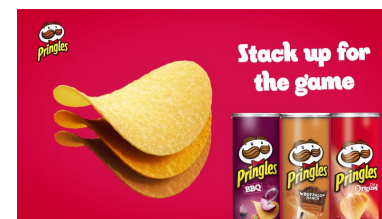
The advert

- Hint: Pringles decided you could eat 2, 3 or 4 pringles at a time.



318,000?

- What are your thoughts?
- Does the number seem reasonable now you know how they got it?
- Would COS taste different to SCO?
- Would you ever put 4 different flavours in your mouth?



Contact the AMSP



01225 716 492



admin@amsp.org.uk



amsp.org.uk



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