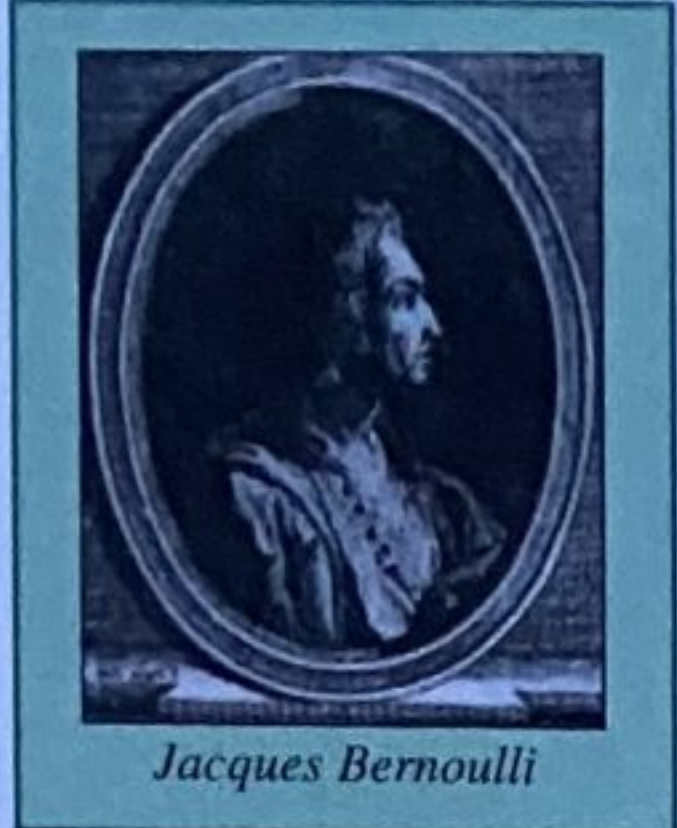
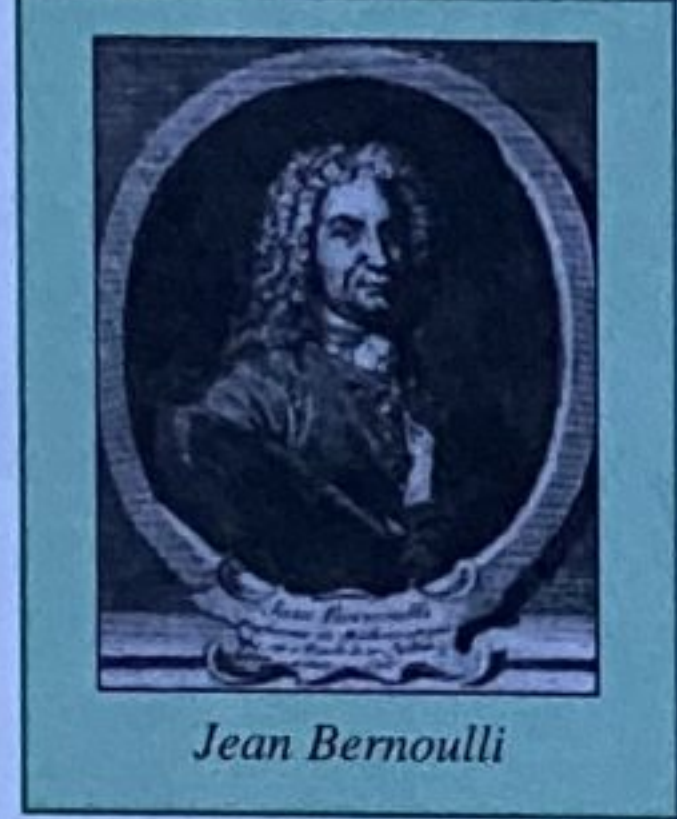


and grandfathers and grandsons (not forgetting Mrs Bernoulli, the family expert in multiplying)

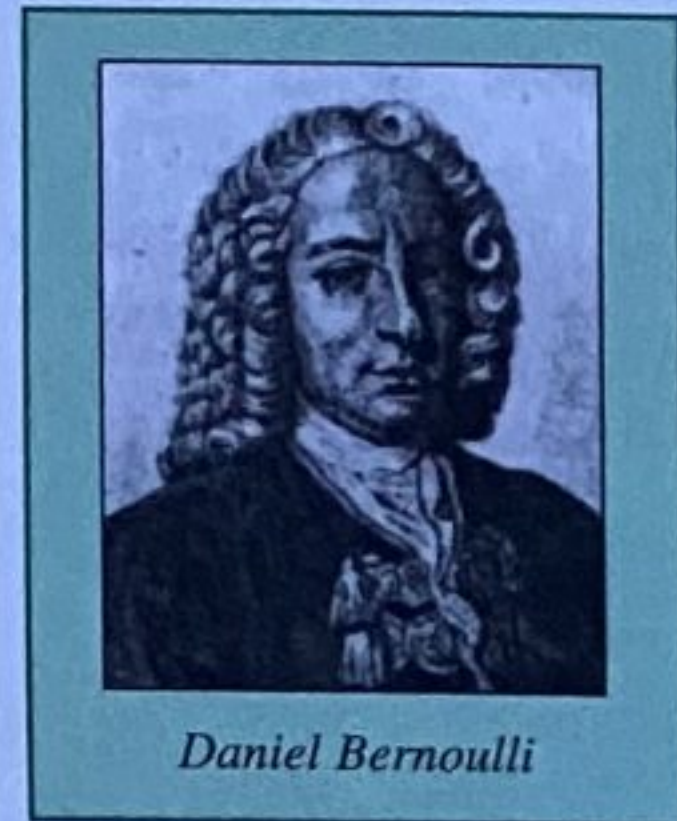
and fathers and sons ... and uncles and nephews



Jacques Bernoulli

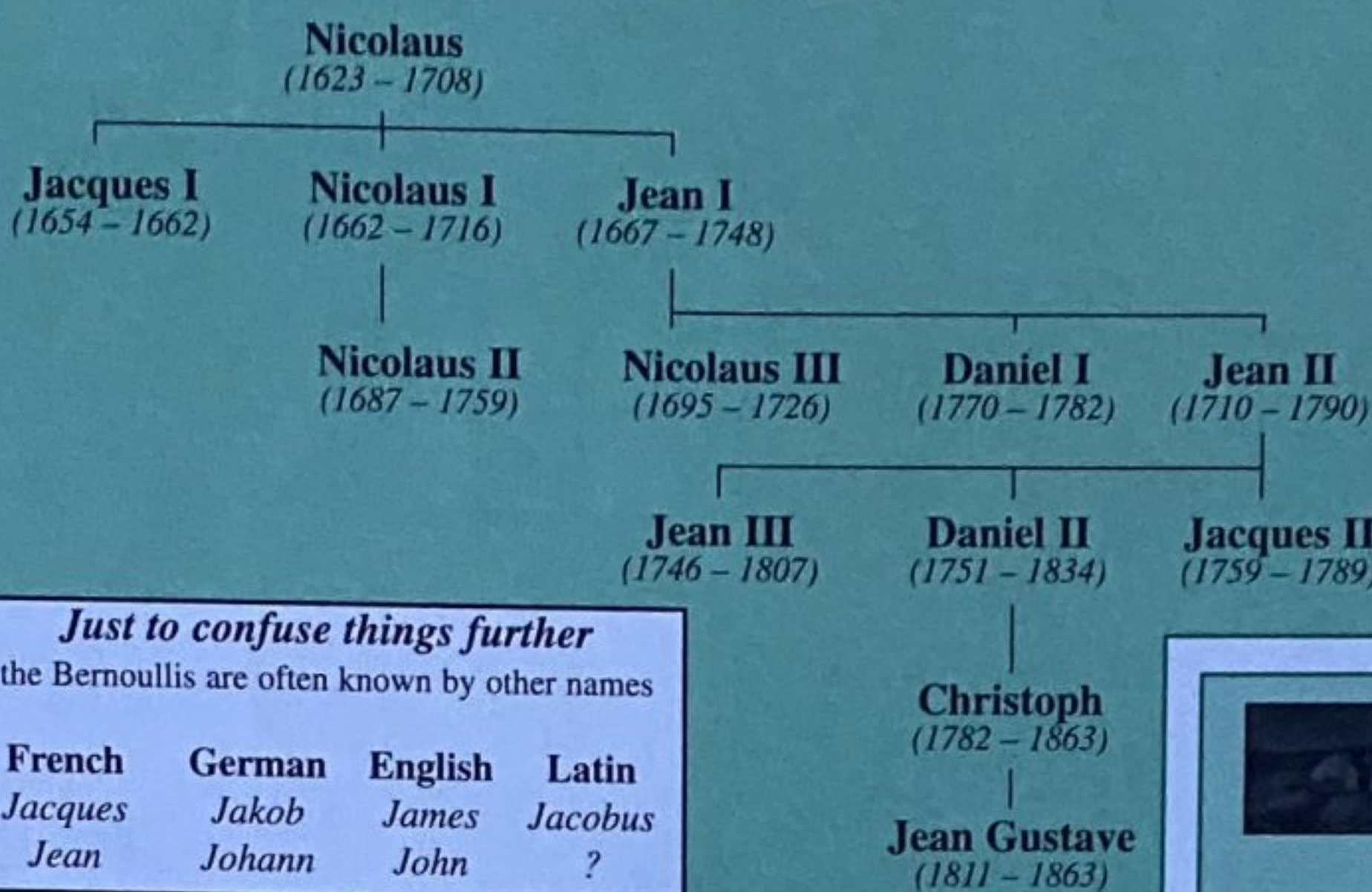


Jean Bernoulli



Daniel Bernoulli

The Bernoulli family over six generations



Bernoulli Numbers

$1, -\frac{1}{2}, \frac{1}{6}, -\frac{1}{30}, \frac{1}{42}, \dots ?$

See what you can find out about them!



Bernollie!

The cycloid.

Imagine a bug on a moving bike wheel. It traces out the shape of a cycloid, which is also ideal for playground slides: it maximises the speed of slippage from one point to another (assuming smooth bottoms!).



Algebra meets geometry

This month sees a tercentenary relating to perhaps the most important mathematical dynasty of all time - the Bernoullis of Basel. In February 1695 one of their number, Nicolaus Bernoulli III was born.

In the 1690's, algebra and geometry were coming together. That *equations* can represent *curves* was a new idea, which the Bernoullis applied enthusiastically.

1. The catenary. This shape is taken by a freely hanging cable (Latin: catena = chain). It is particularly important for engineers designing suspension bridges - or arches.



Can you find the equations of the catenary, the cycloid and the logarithmic spiral?

3. The logarithmic or equiangular spiral. This has the fractal-like property that if transformed (enlarged and rotated), it remains unchanged. Jacques Bernoulli's tomb included this spiral with the motto *Eadem mutata resurgo* ("Though transformed I remain unchanged").

Hints 1 Spell the number. 2 Careful! 5 'Counting on'; 1, 2, 3, etc. 10 You'll need a fraction. 12 Try examples with 3 different numbers, try every arrangement - then with A & B the same - find example that doesn't work. 15-18 Avoid rotations. 19 Unit length is distance between two holes, so 4 hole strip allows 3 units long and 5 hole strip is 4 units long - and sum of any 2 sides must exceed the third - be systematic 21 Depends on the size of your ice cube tray. 22 A chip off the old block! 23 There is a recommended range. 24 Mirror & rotational symmetry. 26 Or..., is 50p the same thickness as £1? Thanks! to Josh Hull (age 13) of Perranporth, Cornwall for helping us with the hints and solutions.

Solutions 1 Thirty-one - any more? 2 One-sixth 5 O - P - N - O - E - F (ONE = POP; TWO = UXP; THREE = UISF 10 (44/4) - 4 11 One answer is 33 + 77 = 110 - there are 3 more. 13 13 is known as a baker's dozen. 14 A quarter, of course - don't you just love it? 15 We think there are 14 ways. 16 Another 3 possible. 21 The QED 12 cube ice tray holds about 300ml of water, so 1 cube about 25ml - does the volume increase or decrease when it freezes? 22 Cutting and shaping ice blocks. 23 0° to 5°. 24 6 mirror axes and 6 points of rotational symmetry. 25 32° F 26 No. 50p is thinner than £1 so 5cm of £1's is worth more than twice 5cm of 50p's. 27 One solution is: 138 x 42 = 5796 - there are others. 28 1738 x 4 = 6952; one other solution ??? x 4 = 6952; one other solution ??? x 4 = 6952.

Su

M

Tu

W

Th

F

Sa

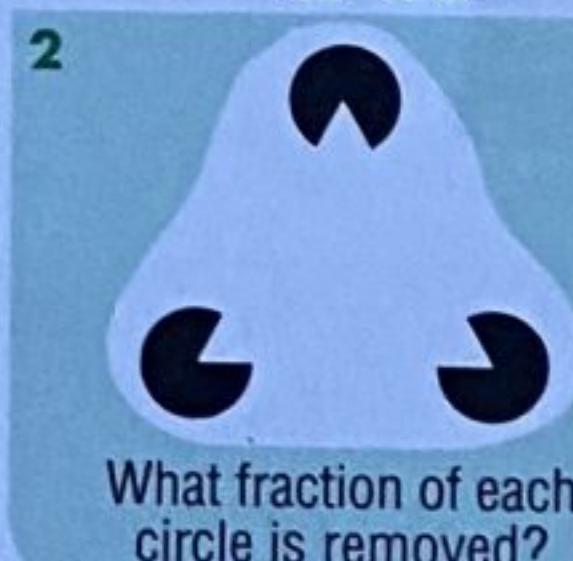
Further Reading

Companion Encyclopedia of the History and Philosophy of the Mathematical Sciences (Guinness 1994, 2 hardback volumes: £150)
A classic on the history of maths, and - at 1850 pages - cheap at the price. (£50 worth of free books if you buy from QED!)

A History of Mathematics (Boyer/Merzbach: £18.50)
Contains a significant chapter on "The Bernoulli Era".

1 "This sentence has _____ letters"

Complete so it is correct.



What fraction of each circle is removed?

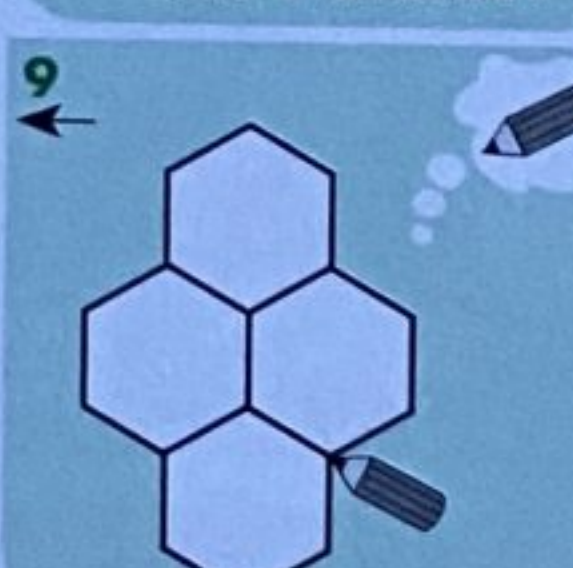
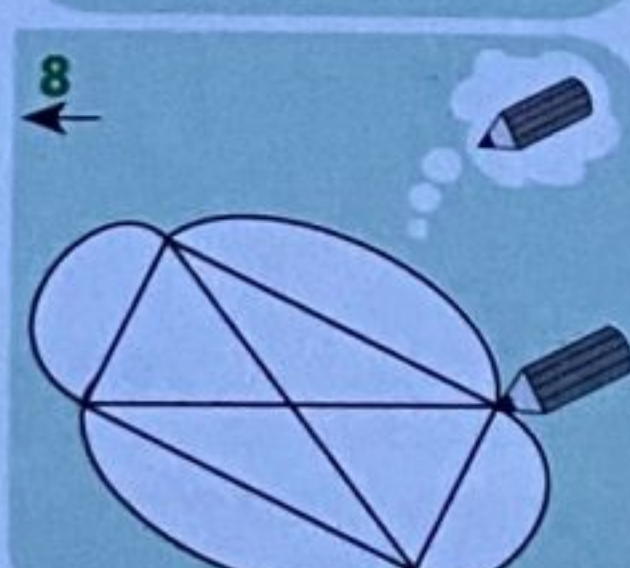
3 FEBRUARY
... how many words can you make?

4 ...which month makes the most?
JAN FEB MAR APR MAY

5 'Counting on' you to break this code
POF, UXP
UISFF

6 Nicholas Bernoulli
b. 27.2.1695
N.B. III

7 Draw this.
...don't lift your pencil



10 4 4 4
... arrange to make 7

11 AA + BB = CCD
How many possible sums are there?

12 Is (A + B) x C always greater than A + (B x C)?

13 What is the connection with bakers today?

14 Roses are red
Violets are blue
Try and work out
Half a quarter times two

15 shade 1/3
How many ways?

16 ... shade 1/2

17 ... shade 1/4
...are all the ways different?

18 ... shade 1/2
... shade 1/4

19 Join at the holes
how many Δ's are possible?

20 ... and now?

21 How much water in a cube of ICE?

22 How is an IGLOO made?

23 How cold in a FRIDGE?

24 How much symmetry in our ICE CRYSTAL?

25 ...at what °F does it melt?

26 Is 5cm of £1's worth twice 5cm of 50p's?

27 ??? x ?? digits 1 to 9
????

28 1 to 9
???? x ? ... try this
????

Further Further Reading

Mathematics in Civilization (Resnikoff/Wells: £11.95) The chapter "The Algebrization of Geometry" describes the Bernoullis' role in developing equations for various curves.

The History of Mathematics (Fauvel/Gray: £17.99) This Open University Reader includes several extracts not anthologized before, including one relating to the young Jean Bernoulli.

A Source Book in Mathematics (DE Smith, 700 pages: £14.95) Includes several Bernoulli sources, including one on Bernoulli numbers and some mathematical verse penned by Jacques Bernoulli.