Growth and shape

Own activity

Polynomial growth.

1. **The braking distance** of a car grows with the square of its speed. Sound intensity decreases with the square of distance. Name other polynomial growth and decay processes.

2. **Why do polar** foxes have short ears, while desert foxes have long ears?

3. **Why do dry-environment** animals such as ants or snakes have a chitin exoskeleton, scales, or a wax shell?

It is assumed that an animal's requirement for food is proportional to its volume.

4. **Why do very** small animals search for food almost all the time?

5. **Why does gravity** set limits to growth?

6. **Why does the** blue whale - the largest animal - live in the water? Is that a coincidence?

7. **When peeling potatoes,** fingers are easily scalded. Is there a difference between starting with a smaller potato and starting with larger one?

8. **The giant Gulliver** is to receive a daily assignment of food and drink as would suffice for 1,728 Lilliputians, based on the „similarity in physical stature". What is the relative size of Gulliver compared with a Lilliputian?


Keld Moseholm, On the staircase 2005. 3. Triennale der Skulptur in Ragaz 2006.

The stout men in the sculpture by artist Keld Moseholm are geometrically similar. They are approximately 1, 2, 3, and 4 length units tall. Let us imagine the figures in full bronze, the smallest with a mass of two kilogrammes.

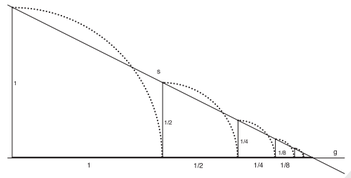
9. **What is the** mass of the other three?

Exponential growth.

Examples of exponential processes:
- population growth under certain conditions
- change of air pressure with altitude
- heating and cooling
- capacitor discharge
- radioactive decay

10. **Give more examples** of exponential growth and exponential decay.

11. **What is the** difference between polynomial and exponential growth?



12. **At which factor** of change will the lines g and s no longer intersect (or at most, only if extended backwards)?

Note! The infinite series

$$1+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\cdots+\frac{1}{n}+\cdots$$

does not have a finite value.

13. **What could be** the reason for this?

Doubling of capital
A hidden rule of thumb

With compound interest processes, the following approximate association between interest rate p and time to double d applies to interest rates between 0% and 10%: $p \cdot d \approx 70$

14. **Consider the significance** of the rule on capital doubling/ interest rate doubling. What does it mean in everyday life and in politics?

15. **Why does this** rule apply regardless of the amount of the capital or the amount insured?

16. **Follow a few** growth processes from p = 11%.

The Tower of Hanoi and the end of the world

17. **How often must** the disks be moved at least if the number of disks is 1, 2, 3, 4, 5, 6 or more ***(n)***?

18. **Can you see** a rule which makes it possible to move the disks systematically?

19. **The monks move** one of the 64 golden disks per second, day and night. Estimate how long it will take them to finish. Is the end of the world near?

20. **What is the** connection to the legend about the chessboard and the grain of wheat?

21. **How will the** game (Tower of Hanoi) change if a fourth rod is added?

Put in shape: standard paper size.

22. **Halve a printer** sheet at the long edge. Keep one half and halve the other one, once again at its long edge. Repeat this. What becomes apparent if one compares the sheets of paper produced?

23. **Repeat the experiment** with a sheet of paper that has other dimensions than our printer sheets - such as a sheet of paper of US Letter size. What has changed?

24. **The paper halves** from the first experiment can be geometrically arranged as shown. Find other interesting ways to divide the sheet! You may also stack sheets.

There is an **infinite process behind the pattern shown.**

25. **Find a connection** to the following series:

$$\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+\frac{1}{16}+\cdots=?$$

What is the sum?