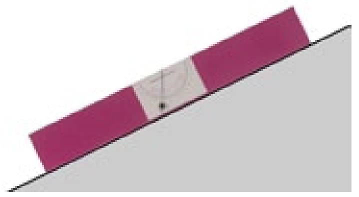
Tracking engineers

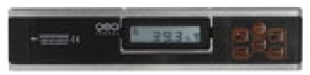
Own activity

Slope.

Measure the slopes simulated on the wall first with the analogue and then with the digital inclinometer in degrees and %.



Analogue inclinometer.



Digital inclinometer.

1. **Find the degree** numbers that fit the percentage numbers of the objects given below.

Object	**Pilatusbahn** steepest rack-and-pinion railway in the world	**Gelmerbahn** steepest funicular in the world	**Stechelberg** steepest aerial tramway in the world
maximum slope	48%	106%	162%
degrees			

The maximum gradient of the Lauberhorn downhill run slope is 93%. Using an inclinometer, illustrate how this part of the slope looks.

2. **Estimate the slope** of the nearest flight of stairs. Then measure in degrees and in %.

3. **What is the** gradient of slope 1 (= 100%) and slope 2 (= 200%)? Find out why slope and gradient angle are not proportional to each other.

4. **Let the gradient** of the inclinometer approach 90 degrees. What happens with the slope values?

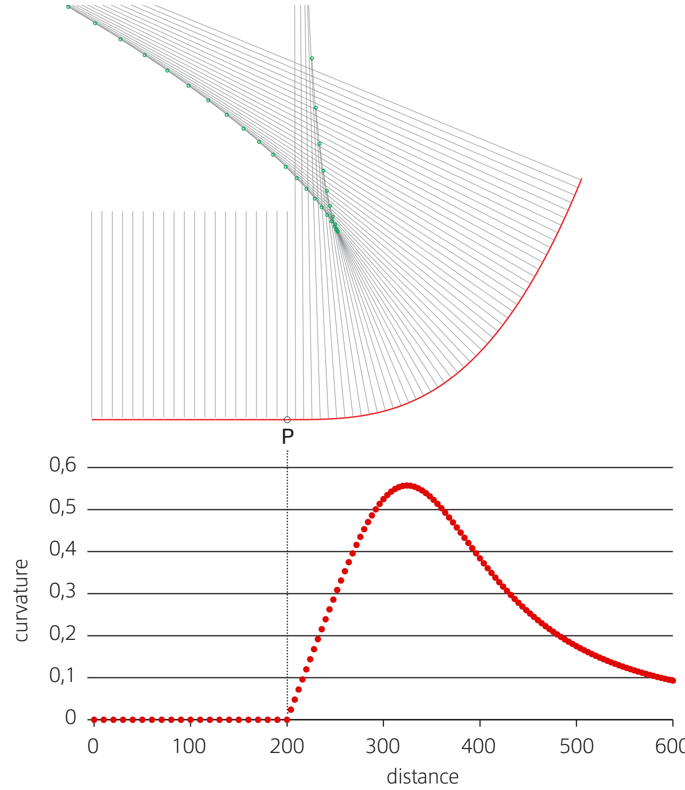
Well adjusted: Route optimisation

5. **Draw a circle** with the circle disk and construct its centre.
6. **How do slope** and curvature depend on the position of a curve in the coordinate system?

On city roads, sometimes only a circle section with larger radius is inserted between a straight line and a circle (with radius *r*). Draw a curvature diagram.

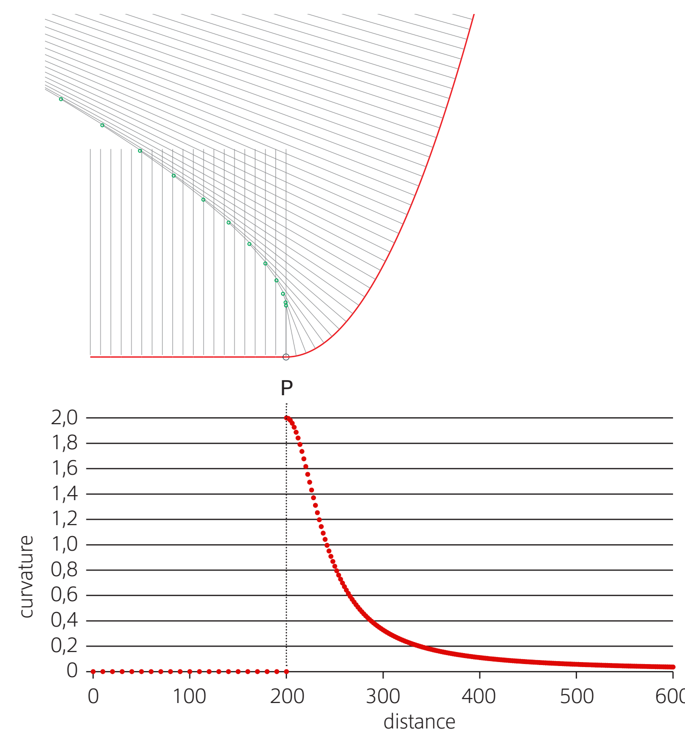
7. **What are the** advantages and disadvantages of this solution?

The Rhätische Bahn railway track uses transition curves with suitable sections from a cubic parabola as transition curves (see graph).



Transition from straight line to cubic parabola.

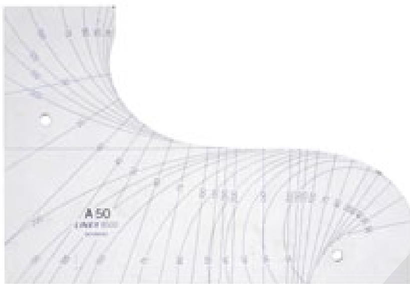
8. **Which section of** the cubic parabola comes quite close to the clothoid solution?



Transition from straight line to quadratic parabola.

9. **The quadratic parabola** is even easier to handle than the cubic parabola. Is it suitable for a transition curve?

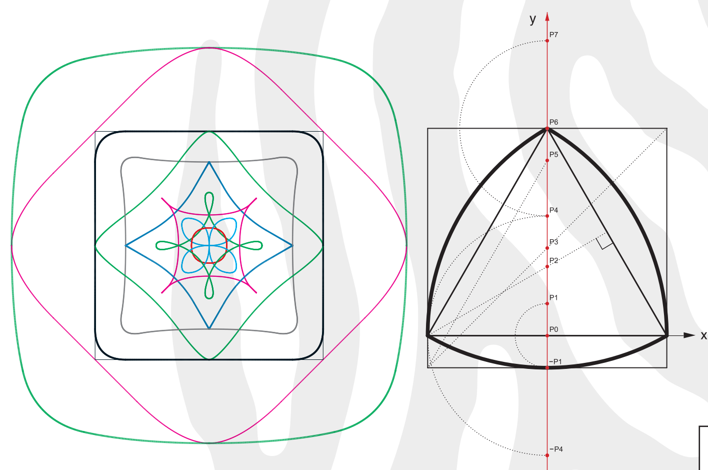
10. **In pre-computer times,** street designers used clothoid templates. What is the meaning of the markings on the template?



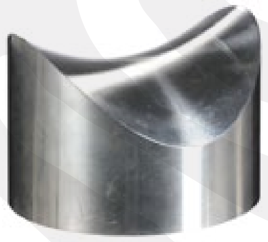
Moving Reuleaux triangle.

Make a Reuleaux triangle from cardboard with about 10cm diameter and a fitting square frame. Put a few holes into the triangle. Observe the rotation process. Put a pen into one of the holes and draw the lines that are caused by the movement. Repeat with the other holes.

11. **Associate the coloured** paths with the holes making them.



Saddle surface.



12. **There are many** famous buildings worldwide whose roofs or shells are saddle surfaces. Can you find examples on the internet?

Cooling towers and electric hyperboloid contacts.

Twisting a cylinder results in a more or less tapered hyperboloid.

13. **Why are cooling** towers built with such a shell?

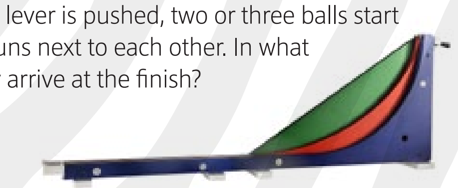
14. **How do hyperboloid** contacts in electric plugs work?
15. **Search for photographs** on the internet using the term ***"Skulptur Effnerplatz"***.
16. **Also search for** the term ***"ruled surface"***.

"Helen of Geometers" and cycloidal gear.

Quite often, street underpasses are built in a smilar way to the model of the ball run: pedestrians must use the horizontal run, bicyclists and car drivers the U-shaped run. Is the bicyclist at a disadvantage with his 'detour' compared with pedestrian?

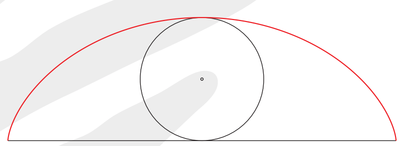
17. **You can find** the answer by experiment by letting the balls roll at the same time. How can the unexpected outcome of the race be explained?

18. **After the starting** lever is pushed, two or three balls start rolling down the runs next to each other. In what sequence will they arrive at the finish?



19. **Let two balls** start running at various points on the cycloid model (red track). Notice anything?

20. **Weighing experiment: Cut** from cardboard the area between cycloid and ball run and the corresponding circle.



Determine their masses. What do the masses tell you about their areas?

21. **Now measure the** radius of the circle and (using a thread) the length of the cycloid. What would you deduce from a comparison of these two values?

22. **Search the internet** for the terms ***"cycloid profile"*** and ***"cycloidal gear"***.

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