

## NEW POSSIBILITIES IN PHYSICS ASSIGNMENTS AND IN FACILITATING SOLUTIONS – THE QR CODE

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### ABSTRACT

*Smart phones offer new opportunities in assigning physics exercises, in experimental illustration of the problem occurring in the exercise or, in making results be descriptively proven. Exercises printed on paper or given electronically can have a QR Code attached. The user will be able – with the help of a QR Code read through a phone – to get immediate access to the desired website. There, depending on the given exercise, we will be able to upload photo or video illustrations, data charts, namely, many exercises can be started based on reality or even, prove correctness of results with a simple phenomenon-presenting video-experiment. The QR Code can also be used to offer our weak-performance students optional help at the critical steps of the complex difficult exercises.*

### OPPORTUNITIES OF THE QR CODE IN EDUCATION

The QR Code was invented by Japanese programmers in 1994 (it means Quick Response). This two-dimensional grid of dots is based on the idea of the barcode, but can store much more information than the barcode itself. The codes can also be read by smartphones, independently from their screen rotation [1].

Students spend more and more time with their mobile phones. But just like with any common equipment, we can convert our environment with mobile phones, too. However, we need to set objectives.

#### Application possibilities of QR Codes in teaching:

- To download extra exercises e. g. from the school notice board
- To download auxiliary materials
- For lexical addenda
- To check the results of the exercises
- To download films to support the Physics exercises
- For demonstration purposes

Exercise sets printed on paper are hardly motivating for students. However, the use of mobile phones, even without specific goals causes “functional joy” for them. Touching and pressing the phone screens convey a certain message: “We belong to a newer generation!”. When we use mobile phones in teaching, besides motivating, our goal is to wrap up the appropriate content [2], [3], [4].

## How to generate our own QR Code?

Naturally, we do not need to devise this pictorial information incomprehensible for the human brain, because there are QR Code generator programmes (Fig.1.) to conveniently create them. We can find online QR Code managing sites, and there are free downloadable software, too.

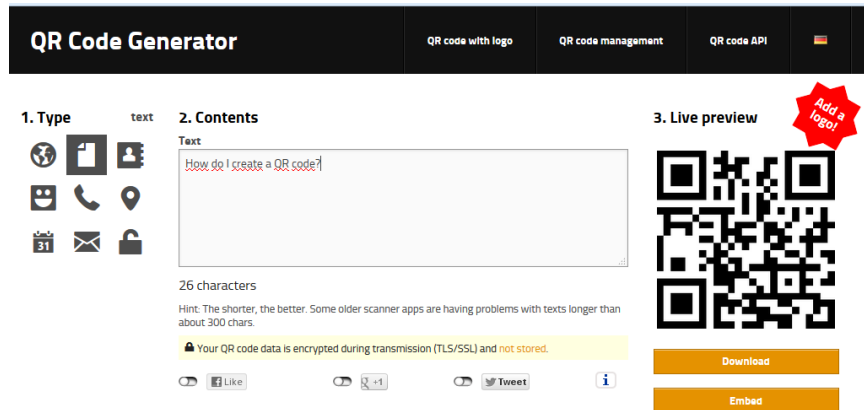


Fig.1. The online software transforms the content of the text window into a QR Code [5]

Teachers can easily create QR Codes and direct their students to the sites they choose. In the case of films the free video sharing portal YouTube is readily applicable, and teachers can upload sets of their own films there. They can put small icons in the middle of the QR Codes (Fig.2.) to indicate the content, and with the help of the small signals suitable for classification, students can quickly select from the codes just by viewing them.



Fig.2. There is a water drop in the picture in the middle of the QR Code, which refers to the theme of the movie to be played

Teachers can send messages to the users with the small icons (Fig.3.): e.g. it is a text note, a link, a video film, some photos, or the process of solving the specific problem, or the result can be accessed with the specific code.



Fig.3. The icons can mean e.g. photo, film, lexical data, help, result

## Using QR Codes for solving Physics problems

### The exercise:

*The speed of the clouds was measured with time-lapse technique in an experiment. This means that pictures of the target object are shot at set intervals with fixed camera position. What is the horizontal speed of a cloud rack in km/h if the camera shoots the pictures of the target object every 15 seconds and we know that the cloud covers 400 metres between shooting the 1st picture and the 10th picture? (Fig.4.)*



Fig.4. With the help of the codes students can: watch the time-lapse film, have a look at the typical picture of a cloud set, read about the cloud family and the formation of clouds, receive help in solving the problems, or simply double-check their own results.

We can also create multiple-choice questions with humorous drawings (Fig.5.), which can even be uploaded to a blog. QR Codes will direct the students to the exercises on the blog.

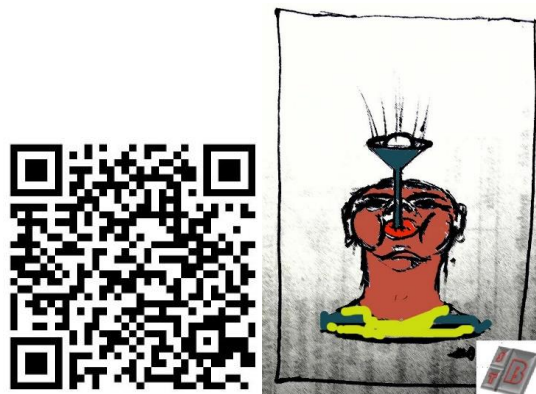


Fig.5. The code helps the user get to the exercise which deals with a classical physics problem

### The making of QR Code-accessible films to support Physics exercises

I consider it important that solving problems with calculations should not be only of abstract and theoretical importance in the teaching of Physics, but students should feel that exercises present real situations the results of which can be checked experimentally. I have linked films to the exercises with the help of the QR Code. One group of films show the experiments carried out based on the exercises. Another group of films contain the experimental check of the calculated results. This latter can be such a film that shows the control measuring, or students themselves can measure the time with the stopwatch in their own smart phones while watching the film, and if the calculation is correct, then the two results are the same.

Task: Calculate (with the help of the photo, Fig.6.) the speed of the person sitting on the carousel.

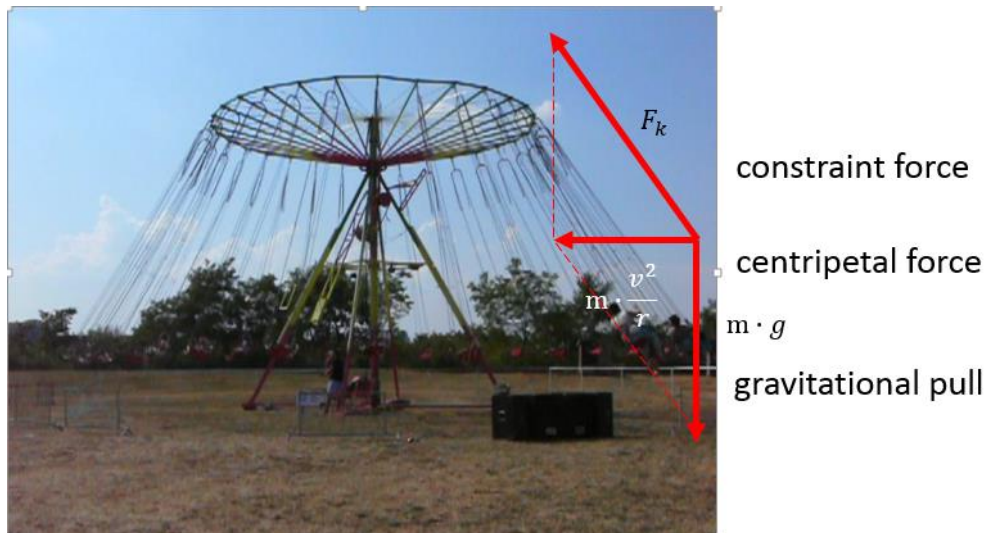
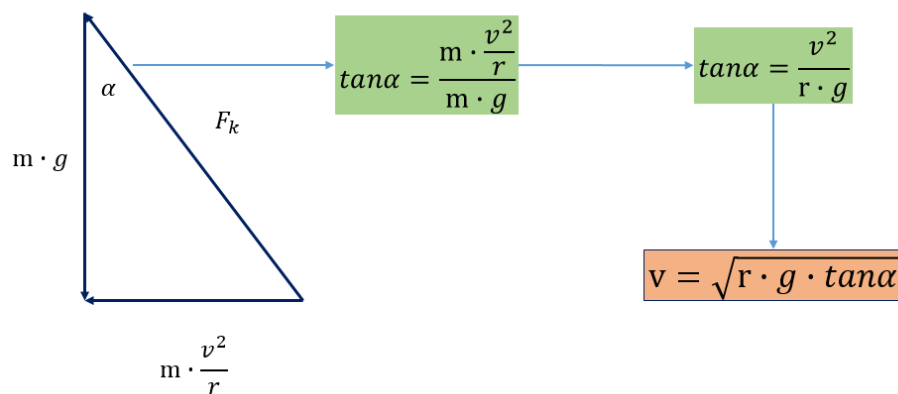


Fig.6. Drawing the forces affecting the person sitting on the carousel into the picture, we can edit a closed vector triangle

The speed can be expressed from the closed right-angled vector triangle:



So we can calculate the speed of the person sitting on the carousel from the radius, the gravitational acceleration and the  $\alpha$  angle.



Fig.7. The  $\alpha$  angle can be measured with a goniometer, the radius with a pixel bar

To do that, short films would help us, and we can introduce those into our smart phones with the help of the QR Codes seen in Fig.7. The radius can be calculated from the height of the man:

Radius	Man height
293 pixel	54 pixel
r	1.72 m

$$r = \frac{1.72 \text{ m} \cdot 293 \text{ pixel}}{54 \text{ pixel}} = 9.33 \text{ m} \quad (1)$$

$$v = \sqrt{r \cdot g \cdot \tan \alpha} = \sqrt{9.33 \text{ m} \cdot 9.81 \frac{\text{m}}{\text{s}^2} \cdot \tan 36^\circ} = 8.15 \frac{\text{m}}{\text{s}} = 29.34 \frac{\text{km}}{\text{h}} \quad (2)$$

One calculation error is due to perspectival distortion. If we drop a line perpendicular to the plane of a two-dimensional angle through its vertex and have a look at the angle from any point of this perpendicular line, we see the real size of the angle. However, if we look at the angle from any other point, the size of the angle looks different. Since we have looked at the carousel slightly from below, the angle looked bigger than its real size (Fig.8.).

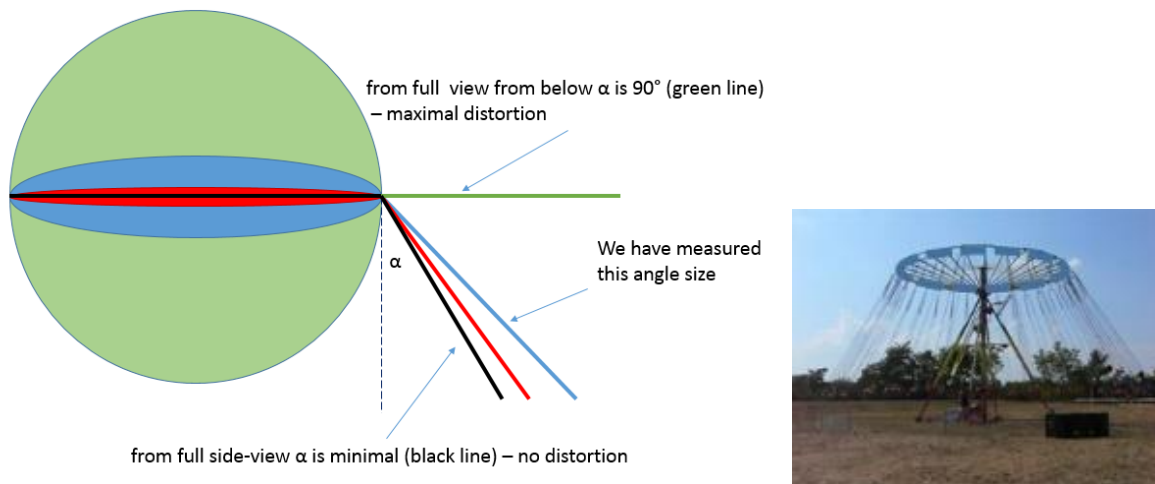


Fig.8. Left panel: the possible angle-value ranges resulting from perspective distortion  
 Right panel: in the picture the carousel is like as seen a bit from the bottom sight

It is clearly seen that the measured angle is greater than the real one, thus we have measured a greater speed, too.

$$v < \sqrt{r \cdot g \cdot \tan \alpha} = \sqrt{9.33 \text{ m} \cdot 9.81 \frac{\text{m}}{\text{s}^2} \cdot \tan 36^\circ} = 8.15 \frac{\text{m}}{\text{s}} = 29.34 \frac{\text{km}}{\text{h}} \quad (3)$$

$$v < 29.34 \frac{\text{km}}{\text{h}} \quad (4)$$

### Double-checking the result with the video

If we dispose of not only a photo but also of a film, then the speed of the person sitting on the carousel can also be defined through another procedure (Fig.9.). This way checking the previous calculation will also become possible.

- Let's measure the period (the measurement will be more accurate if we measure 10 rounds and then divide the result by 10)
- Let's substitute the radius defined earlier in the following formula:

$$v = \frac{2r\pi}{T} \quad (5)$$

$$v = \frac{2r\pi}{T} = \frac{2 \cdot 9.33 \text{ m} \cdot 3.14}{7.3 \text{ s}} = 8.03 \frac{\text{m}}{\text{s}} = 28.91 \frac{\text{km}}{\text{h}} \quad (6)$$



Fig.9. The QR Code seen in the picture helps us play the film and - with the help of a chronograph - measure the period time. The short film will also provide the measurements with further necessary information

If we compare it to the value calculated based on Fig.7., see Eq.(4), we get a more accurate smaller value:

$$28.91 \frac{\text{km}}{\text{h}} < 29.34 \frac{\text{km}}{\text{h}} \quad (7)$$

## CONCLUSIONS

The QR Code is a popular information carrier surface, its use in education will not only be important in motivating students who use modern technics but also can play a sort of virtual support in individual problem solving. This way the QR Code plays a kind of a mediating role between the teacher and the student.

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