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ASPECTS THAT CONCERN ASSESSING LOWER SECONDARY SCHOOL STUDENTS AT THE PHYSICS NATIONAL CONTEST EXEMPLIFICATION FOR THE 7TH GRADE

Gabriel Florian

Abstract: In the present article, we aim at analysing the results obtained by the 7th grade students who participated in the 50th edition of the Physics National Contest, which took place in Cluj-Napoca between the 6th and the 11th of April, 2014. Why have we chosen the 7th grade? One of the reasons is represented by the good results obtained by the contestants, 71 % of the students having been awarded. The second reason is the significant difference of the score got by the students, between the practical test and the theoretical one: 93,3 % of the students got more than half of the score related to the practical test and 50,56 % of the contestants got more than half of the score related to the theoretical test. The analysis of students' results show that the subjects and the marking schemes for both tests (practical and theoretical) did not put students into great difficulty. The analysis of the subjects demonstrates that the way they were formulated respected the specific competences and the contents associated to the present Physics curricula and that the enunciations formulated by the authors for the subjects concerning both tests (practical and theoretical) did not surpass the scientific language required from the 7th grade students who participated in the contest.

Key words: Physics, performance, scientific language, specific competences, contents, assessment

1. Introduction

The objectives aimed at in [1] are of high interest as far as students' performance at Physics is concerned, namely:

- Forming and developing competences specific to the science field, to students with abilities and who are motivated for this field: problem solving, making experiments, interpreting and communicating, in writing, the results, critical and analytical thinking.
- Attracting students, beginning with the 6th grade, to sciences study, in general, and to Physics study, in particular.
- Identifying students capable of performance in the field of Physics, Sciences and Astrophysics.
- Stimulating and motivating teachers' training for approaching differentiated didactic methods, oriented to identifying and preparing students capable of performance.
- Motivating teachers for specialty, theoretical and experimental training, by approaching advanced topics included in the curriculum for the international stage of the contest.

For the 7th grade students as well as for all the other classes students who participate in the National stage of the Physics Contest in accordance with [1], it is compulsory to be tested both practically and theoretically, the former being the practical test. The practical test ends up by achieving a written paper which may be marked with a maximum of 20 points, 2 points being given for granted. The theoretical test consists of 3 subjects and each subject within this test may be marked with a maximum of 10 points, 1 point being given for granted. Both tests last 3 hours.

For each of the 6th to 12th grade, the set of topics which is compulsory for the Physics National Contest is included in [1] and it is in accordance with the specific competences and the contents associated to the present Physics curricula [2, 3, 4, 5, 6].

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2. 7th Grade Assessment

Subjects

For the 7th grade students who participated in the Physics National Contest, the subjects for the practical test have been presented in Annex 1 and the subjects for the theoretical test have been presented in Annex 2. For both tests, the subjects were achieved within the Central Board of the Physics National Contest, 2014 Edition.

The total number of 7th grade contestants was 89, both for the theoretical and practical test. For our study, the subjects for both tests, practical and theoretical, were taken from the contest site [7] and translated into English.

Practical Test

The results obtained by the students at the practical test were taken from the contest site [7] and processed in order to get an overall image on them. The score categories, the absolute and relative frequencies of the score for the practical test subjects, 7th grade, given at the Physics National Contest, 2014 Edition, have been presented in Table 1.

Table 1. Score categories, absolute and relative frequencies for the practical test subjects, 7th grade, Physics National Contest, 2014 Edition

Score Categories	Absolute Frequencies of Score	Relative Frequencies of Score (%)
2-2,99	2	2,25
3-3,99	0	0,00
4-4,99	0	0,00
5-5,99	0	0,00
6-6,99	1	1,12
7-7,99	0	0,00
8-8,99	1	1,12
9-9,99	2	2,25
10-10,99	2	2,25
11-11,99	7	7,87
12-12,99	6	6,74
13-13,99	2	2,25
14-14,99	4	4,49
15-15,99	10	11,24
16-16,99	7	7,87
17-17,99	3	3,37
18-18,99	4	4,49
19-19,99	22	24,72
20	16	17,98

From the results obtained at the practical test, presented on the contest site [7], one may notice that the average score obtained at the practical test is 16,10, and 93,3 % of the total number of contestants got more than 10 points, a score corresponding to half of the maximum score got at the practical test.

Also, 4,72 % of the contestants got a score between 19-19,99 points while 17,98 % got the maximum score of 20 points.

We believe that the good and very good results got by the students at the practical test were due, to a great extent, to the experimental topic “Determining the friction quotient at gliding, between a plastic ruler and the surface of a sheet of paper”, which put students into minor difficulty, these ones being familiarized with the compulsory experiments included in the lower secondary school Physics curriculum [2]. On the other hand, these results confirm the hardworking training for the practical test,

the students being initiated by their teachers into their documentation activity, by using a material varied as much as possible, and into the scientific method and formation of some abilities and skills for independent individual work [8], as we noticed after discussing with the teachers.

Theoretical Test

To continue, we are going to present, in brief, the results obtained by 89 students who passed their theoretical test. They have been taken from the contest site [7] and processed in order to obtain an overall image on them. The score categories, the absolute and relative frequencies of the score for the theoretical test subjects, 7th grade, at the Physics National Contest, 2014 Edition, have been presented in Table 2. In this Table, we have noted by S1, S2 and S3 subjects 1, 2 and 3 for the theoretical test. When elaborating the subjects for the theoretical test, the authors had in view that these ones would have degrees of different complexity, and that, by the way they had been formulated and by their requirements, they would cover an area which would be as much representative as possible, for all work registers of students (actional, figural, symbolic), aspects which were in evidence and analyzed in [9]. At the same time, the authors of the subjects respected the methodological guides for applying the Physics curricula [10, 11].

Table 2. Score categories, absolute and relative frequencies of score for the theoretical test subjects, 7th grade, Physics National Contest, 2014 Edition

Score Categories	Absolute Frequencies of Score			Relative Frequencies of Score (%)		
	S 1	S 2	S 3	S 1	S 2	S 3
1-1,99	2	2	13	2,25	2,25	14,61
2-2,99	6	4	23	6,74	4,49	25,84
3-3,99	11	9	20	12,36	10,11	22,47
4-4,99	9	7	13	10,11	7,87	14,61
5-5,99	15	17	11	16,85	19,10	12,36
6-6,99	18	34	5	20,22	38,20	5,62
7-7,99	9	12	2	10,11	13,48	2,25
8-8,99	12	3	2	13,48	3,37	2,25
9-9,99	6	1	0	6,74	1,12	0,00
10	1	0	0	1,12	0,00	0,00

In Figure 1 we have presented, in brief, the distribution of the relative frequencies of the score (%) obtained by the 7th grade students for subjects S1, S2 and S3, theoretical test, at the Physics National Contest, 2014 Edition.

From the results obtained at the theoretical test, presented on the contest site [7], we may notice that the average score got at the theoretical test is 15,03, and the average score per subjects are 5,86 for S1, 5,63 for S2 and 3,54 for S3. So, S3 was the differentiation subject, when the score was equal, followed by S2 and respectively S1, according to [1].

The contestants met great difficulties when they solved the tasks for S3 A and S3 B, points (b) and (c). For item A, subject S3, most students did not succeed in writing correctly the equilibrium conditions for the cylinder. For item B, subject S3, students met difficulties in achieving the drawing correctly, from which it would result that the reel can rotate clockwise for point (b), as well as in achieving the drawing correctly, from which it would result that the reel can rotate clockwise. We consider that the difficulties met by the students are partially due to difficulties in understanding the physical phenomenon and also difficulties in representing forces. In this last case, we identify the cause as being the aspects which are not in accordance with one another, included in the curricula for Mathematics and Physics, vectors being studied at Mathematics when students are in the 9th grade.

The data in Table 2 and the graph in Figure 1 show that, in the case of students who got more than 5 points, that is, they achieved more than half of the score corresponding to each problem, the relative frequencies of the score are 68,54 % for S1, 75,28 % for S2 and 22,47 % for S3. Only one student got

the maximum score for S1, whereas for the other subjects, the maximum score was not obtained by any student.

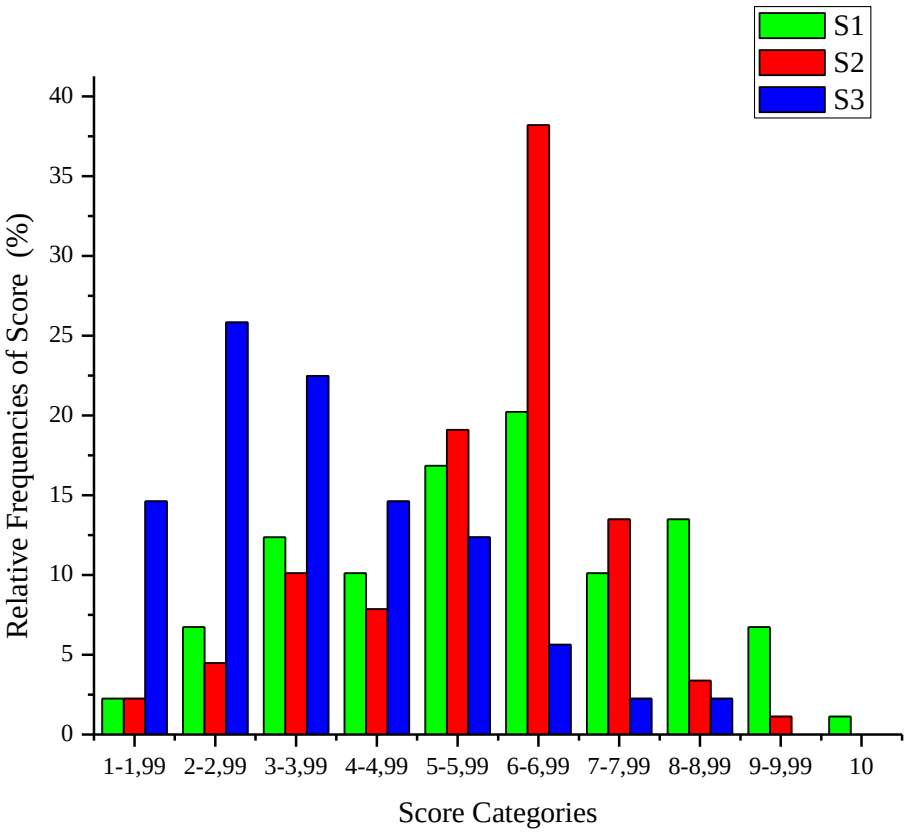

Figure 1. Distribution of the relative frequencies of the score (%) obtained by the 7th grade students for subjects S1, S2 and S3, theoretical test, Physics National Contest, 2014 Edition

Final Results

The final results obtained by the 7th grade students at the Physics National Contest, 2014 edition, were obtained by calculating the sum of the results obtained by each student at both tests, practical and theoretical. In Table 3, there have been presented, in brief, the score categories, the absolute and relative frequencies of the final score, 7th grade, Physics National Contest, 2014 Edition, and the distribution of the relative frequencies of the final score (%) has been presented in Figure 2.

Table 3. Score categories, absolute and relative frequencies of final score, 7th grade, Physics National Contest, 2014 Edition

Final Score Categories	Absolute Frequencies of Final Score	Relative Frequencies of Final Score (%)
5-9,99	1	1,12
10-14,99	1	1,12
15-19,99	5	5,62
20-24,99	13	14,61
25-29,99	15	16,85
30-34,99	20	22,47
35-39,99	25	28,09
40-44,99	9	10,11
45-49,99	0	0,00
50	0	0,00

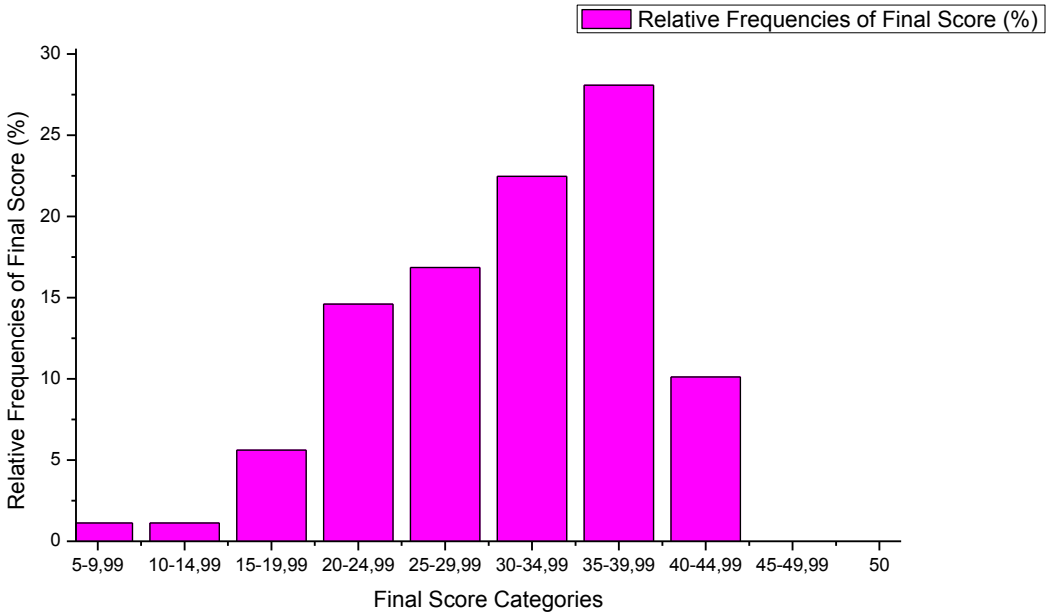

Figure 2. Distribution of relative frequencies of final score (%), 7th grade, Physics National Contest, 2014 Edition

From Table 2 we notice that the average final score is 31,13, and 77,53 % of the total number of contestants got more than half of the maximum score obtained by calculating the sum of the results obtained by each of them at both tests. The explanation to that is given by the high and very high score obtained by students at the practical test where, as far as the formulatin of subjects is concerned, students benefited from a detailed presentation of the working way for each of the practical test tasks.

From the final results presented on the contest site [7], we can notice that for the 7th grade, the Ministry of National Education awarded one 1st prize, one 2nd prize, one 3rd prize and 9 mentions, while the Physics Romanian Society awarded 7 gold medals, 16 silver medals, 23 bronze medals and 17 honourable mentions.

3. Conclusions

The subjects formulated within the Central Board of the Physics Contest did not surpass, as far as the level of difficulty is concerned, what is specified in the present curricula. The subjects and the marking schemes for the two tests (practical and theoretical) respected the specific competences and the contents associated to the present Physics curricula and they did not surpass the scientific language mentioned in the present norms, as it happened on the occasion of some previous editions (for example, the 2010 Edition). Both for the practical and theoretical test, the formulation of the subjects aimed at stimulating students'interest in science, in general and in Physics, in particular.

By the way the requirements for the practical test were formulated, the time necessary for drawing up the paper report was considerably reduced. The good and very good results obtained by the 7th grade students at the practical test confirmed the fact that they were efficiently trained by their teachers, by training activities, which led to forming new abilities and skills, to developing the spirit of observation etc.

The teachers who accompanied the students for participating in contests emphasized the fact that the results obtained by the 7th grade students who were present for supplementary classes within the excellence centers are superior to those who did not benefit from this supplementary training. These activities make students face different problems, less typical ones, which request students' way of thinking and their creativity, stimulating their intrinsic motivation for studying Physics.

Even if there was significant difference between the score obtained by the students at the practical test and the theoretical one, the final results obtained by them led to a very much quantified distribution of the results. Out of the total of 89 students, 63 students (71 % of the students) were awarded.

The subjects formulated within the Central Board of the Physics Contest did not surpass, as far as the level of difficulty is concerned, what is specified in the present curricula. The subjects and the marking schemes for the two tests (practical and theoretical) respected the specific competences and the contents associated to the present Physics curricula and they did not surpass the scientific language mentioned in the present norms, as it happened on the occasion of some previous editions (for example, the 2010 Edition). Both for the practical and theoretical test, the formulation of the subjects aimed at stimulating students'interest in science, in general and in Physics, in particular.

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Annex 1. 7th grade subjects, practical test at the Physics National Contest, 2014 edition

Topic of the work: Determining the friction quotient at gliding, between a plastic ruler and the surface of a sheet of paper

A. Determining the friction quotient μ_1, between two surfaces, the inclined plane method

1. Materials: A 20 cm ruler fixed in vertical position to a rack (wooden parallelepiped), plastic ruler of 15 cm, plastic ruler of 10 cm, sheet of paper, pencil.
2. Working Way:

- With the materials which are in the tool box, achieve the system given in the Figure 1.

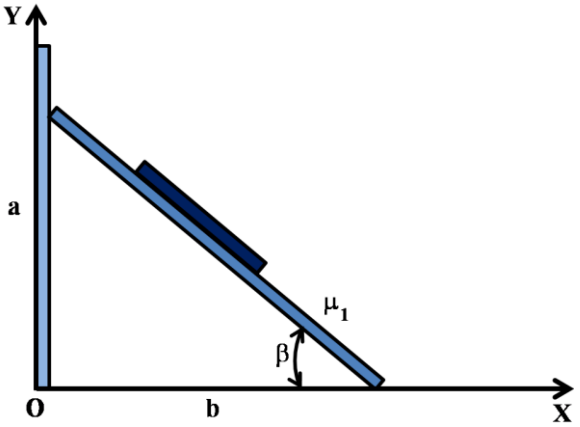

Figure 1.

- Modify the angle of the inclined plane and hit carefully the 15 cm ruler, so that the shorter ruler would glide uniformly.
- In the above conditions, measure the right-angled sides a and b of the rectangular triangle.
- Repeat the measurements 5 times.

3. Write a report which would include:

- Representation of forces on the drawing.
- Determination of the relation for the friction quotient between the two rulers, μ_1.
- Filling in the table of values.

Determining the number	a (cm)	b (cm)	μ_1	μ_{1m}	$\Delta\mu_1$	$\Delta\mu_{1m}$	The result of the determination of
1							
2							
3							
4							
5							

- Mentioning at least three error sources.

B. Determining the friction quotient μ_2, between the plastic ruler and the surface of a sheet of paper

1. Materials: A 20 cm ruler fixed in vertical position to a rack (wooden parallelepiped), plastic ruler of 15 cm, sheet of paper, pencil.
2. Working Way:

- Achieve the montage in the Figure 2.

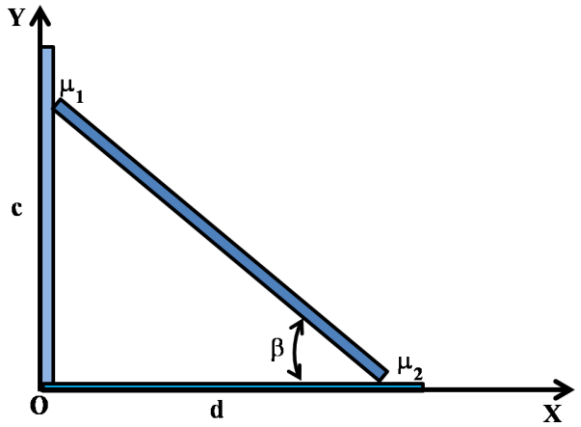

Figure 2.

- Modify β angle so that the inclined ruler would glide on the surface of the sheet of paper.
- Measure the right-angled sides **c** and **d** of the rectangular triangle, in the above conditions.
- Repeat the measurements at least 5 times.

3. Write a report which would include:

- Representation of forces on the drawing.
- The equilibrium equations for translation and rotation.
- Determination of the relation for the friction quotient μ_2 from the system of equations obtained by considering the friction quotient between the linears μ1as having been determined in the first part of the work.
- Filling in the table of values.

Determining the number	c (cm)	d (cm)	tgβ	μ_2	μ_{2m}	$\Delta\mu_2$	$\Delta\mu_{2m}$	The result of the determination of
1								
2								
3								
4								
5								

- Mentioning at least three error sources.

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Annex 2. 7th grade subjects, theoretical test at the Physics National Contest, 2014 edition

1. *Small Ships...*

Ştefan is on the bank of the Someşul Mic river with the *Iara* small ship and he is participating in a nautical model contest. There is a buoy on the river, situated at half the distance between the parallel banks of the river. The distance between the banks is $d = 100\,\text{m}$, and the velocity with which water flows is $v_{water} = 2\,\text{m/s}$, the same for each point situated on the water surface.

a. At a certain moment, three small ships, *Aluniş Băişoara* and *Căprioara* start simultaneously from next the buoy B_0, on the routes $B_0 - A - B_0$, $B_0 - B - B_0$ and $B_0 - C - B_0$, see Figure 1. After going away from the buoy with the same distance $d_0 = 36\,\text{m}$ to this one, the small ships come back to the buoy. The velocity of each small ship as compared to the water velocity is $v = 2\,v_{water}$, and the period of time necessary to each small ship for the manoeuvre of coming back from the points A, B, respectively C, is $\Delta t = 5\,\text{s}$. Write in ascending order the values for the duration corresponding to the movement of each small ship.

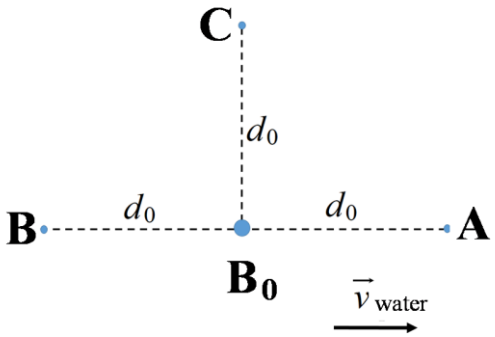

Figure 1

b. Knowing that the ratio between the duration that is necessary to *Iara* to cross the river by following the shortest route and the minimum duration that is necessary to this one to cross the river is 2, calculate the velocity of the small ship as compared to that of the water.

c. Next to the buoy, there has been installed a horizontal plan mirror above the water, which can rotate round a horizontal axis. In order to determine the height of a tree placed on the opposed bank of the river, Ştefan sends to the mirror a horizontal laser beam which is perpendicular on the rotation axis of this one. If the mirror is horizontal, the laser beam reaches the basis of the tree, and if the mirror is rotated by an angle $\gamma = 30^\circ$ against the horizontal line, the laser beam reaches the top of the tree. Calculate the height of the tree.

2. *Băișoara Summer Camp*

A. In order to arrange a summer camp in the Big Mountain in Băişoara , it is necessary to use several homogeneous wooden trusses, parallelepipedic shaped, of length $\ell = 5\,\text{m}$ each. A parcel made of 9 identical trusses (see **Figure 2**) is dragged in a uniform way with the velocity $\vec{v}$, on a horizontal route, by a horse. Then, the parcel has to be shifted on a slope of angle $\alpha = 30^\circ$, in which case, it is necessary to use three equally strong horses who are going to move in a uniform way, with the same velocity $\vec{v}$. During the movement, the parcel keeps contact with the soil, and the force which moves it is permanently parallel to the soil. The gravitational acceleration is considered to be $g = 10\,\text{N/kg}$.

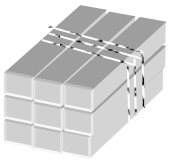

Figure 2

a. Calculate the friction quotient when gliding between trusses and soil, considering that it has the same value throughout the route.

b. What power has one of the horses knowing that the moving velocity of the horse is $v = 3{,}6\ \text{km/h}$, and the mass of a truss is $m = 35\ \text{kg}$?

c. In order to fix up a lamp which is necessary to illuminating, one of the trusses has to be brought into vertical position. Calculate the mechanical work done by the force of gravity when bringing the truss from horizontal into vertical position.

B. The horizontal platform of a scales has its mass m_0 and is sustained by four identical resorts, see **Figure 3**. Ten wooden trusses are placed on the scales in turns, each truss being of mass M. The trusses are placed carefully on the platform which is in an eqilibrium position so that the system reaches its equilibrium position each time. After placing a truss on a scale, the elastic forces in the springs perform mechanical work. Determine how many times the mechanical work done by the elastic forces when the 10th truss is placed increases as compared to the mechanical work done by the elastic forces when the 2nd truss is placed. Take into consideration that during the weighing the platform keeps staying in its horizontal position and the springs keep staying vertical.

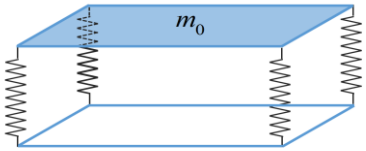

Figure 3

3. *Equilibrium ... movement ...*

A. An empty cylinder, open at its two endings, with a thin smooth wall and of diameter $d = 20\ \text{cm}$ is placed in a vertical position on a horizontal surface. Inside it, there are two polished balls, identical ones, of mass $m = 1\ \text{kg}$ and ray $r = 7{,}5\ \text{cm}$, see **Figure 4**. What is the minimum value that the mass of the cylinder must have so that this one would not turn over?

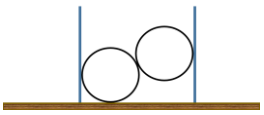

Figure 4

B. On a horizontal surface, there is, at rest, a reel of R = 2 cm, on which thread has been rolled up, the rolling ray being $r = 1\ \text{cm}$. There is friction between the reel and the horizontal surface. At a certain moment, at the ending of the thread, a constant force of mode F is being pressed, following the direction which forms angle α with the horizontal line, see **Figure 5**. Under the pressure of force $\vec{F}$ the reel is not detached from the horizontal surface.

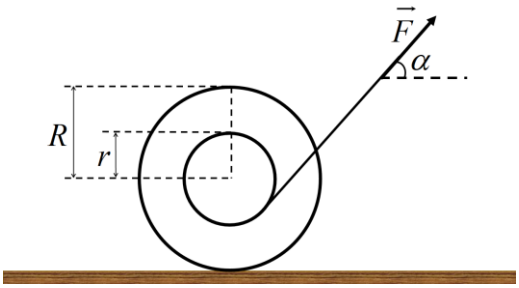

Figure 5

a. Calculate the value of angle α so that the movement of the reel would be, exclusively, one of translation.

b. Make a drawing from which it would result that the reel can rotate contrary to the clock hands. Which is the condition that angle α must carry out in this case?

c. Make a drawing from which it would result that the reel can rotate clockwise. Which is the condition that angle α must carry out in this case?

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