PROPOSAL FOR AN INTERNACIONAL ACTIVITY

SOLAR CELL CAR-SOLAR INCLINATION

I am doing a document where I will include the Spanish teams with some cells dedicated to this solar car activity. I will send an email to some teachers who took part in a workshop to learn the use of Tracker in the classrooms. When they answer me, I will include the name of the schools and teachers.

The solar cell car activity is simple and easy to carry out.

All teams have to use the same solar cell car. We could use a solar cell car from Tiger shops. There are Tiger shops in all of our countries. Anyway, we could send a car to a concrete team. The car is very cheap (4€ in Spain):

- **First step:**

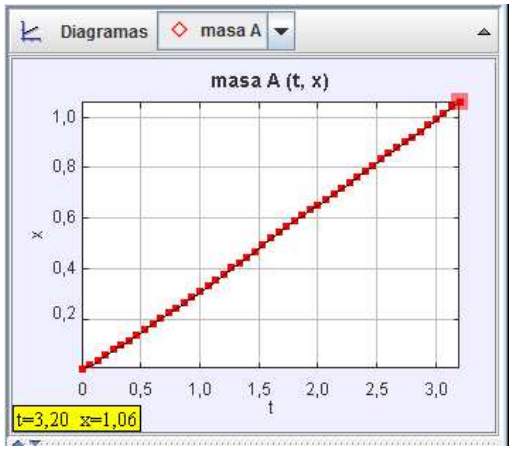
Each team record videos of the movement of the car at the same solar hour (at the noon in each place of the school, for example). They have to record two different movements. The solar car has a small piece to paste the solar cell to the car. If we use the small piece to paste the solar cell, the solar cell will be in the upper part of the car, parallel to the ground:

Students record a video of the movement of the car (with a tripod) and a mobile or a camera).

In a second video, students have to record the movement of the car, but with the solar cell in a position which receive the solar rays vertically. They have to measure the inclination angle of the solar cell:

Students have to import to Tracker program these two videos (The Tracker program was mentioned by Adrian some months ago).

They will obtain two graphs. One for each situation or video:



Graph of the movement of the solar car of the precedent photograph obtained with Tracker

It is a linear movement (constant velocity), but the velocity will be different in each situation. In the second situation (solar cell receiving the solar rays vertically) the velocity will be more than the first situation (solar cell parallel to the ground). The velocity is the slope of the straight line ($v = \frac{x}{t} = constant$). They could export to GeoGebra or Excel the data obtained with Tracker to obtain the mathematical model of the movement.

- ## Second step. The videoconference

During the videoconference, each team exposes their data. When students compare data, they will observe the velocity is different in each country. They have to debate what is the reason of these differences: it was the same model of car and the data were obtained at the same solar hour. The reason is the sun rays come to earth with a different angle in each meridian. So, when you want install a solar cell or panel, the correct inclination of the cell or panel is different (for example, in England or Spain). Even in different places of Spain the angle must be different. This fact implies it's no possible to design a support for a solar panel equal for all countries or for different places of one concrete countrie. It is necessary the support allows change the inclination angle.

This last conclusion is related the sun movement along one day and one year. It is related to the reason the sun heat more in Spain than in Finland too. To obtain data about these questions, there are a lot of resources in Internet. A very good resource is SunEarth Tools:

http://www.sunearthtools.com/dp/tools/pos_sun.php

sun position	Elevation	Azimuth	latitude	longitude
04/12/2016 14:17 | GMT-5	17.83°	216.38°	40.76° N	73.984° W
twilight	**Sunrise**	**Sunset**	**Azimuth Sunrise**	**Azimuth Sunset**
twilight -0.833°	07:04:12	16:28:25	119.28°	240.65°
Civil twilight -6°	06:33:34	16:58:59	114.43°	245.48°
Nautical twilight -12°	05:59:24	17:33:09	109.23°	250.68°
Astronomical twilight -18°	05:26:17	18:06:16	104.3°	255.6°
daylight	**hh:mm:ss**	**diff. dd+1**	**diff. dd-1**	**Noon**
04/12/2016	09:24:13	-00:01:02	00:01:07	11:46:18

Step (minute): 60 execute download Excel table

Date:	04/12/2016 | GMT-5	
coordinates:	40.76, -73.984	
location:	721 7th Ave, New York, NY 10019, EE. UU.	
hour	Elevation	Azimuth
07:04:12	-0.833°	119.28°
8:00:00	7.91°	128.78°
9:00:00	16.01°	140.3°
10:00:00	22.22°	153.43°
11:00:00	25.97°	168.06°
12:00:00	26.81°	183.52°
13:00:00	24.6°	198.72°
14:00:00	19.66°	212.71°
15:00:00	12.52°	225.08°
16:00:00	3.75°	235.94°
16:28:25	-0.833°	240.65°

Note: In the youtube channel of KIKS project, there is a video-tutorial to explain the initial use of Tracker (https://www.youtube.com/watch?v=_OOL4KeCXEs; solar car: 3:57-4:19). It is in Spanish language. If anyone wants to do an English version, we could try to do it. Respect the astronomical hours, the Spanish team could send the hour of each country. We only need the geographical coordinates of the school. The day to record the videos is not neccesary to be the same. It is enough if all teams record the video in the same week. But the solar hour to record the videos must be the same.

It is very possible a teacher-school of your countries don't want learn the use of Tracker. Spanish teams can analyze the videos with Tracker and send data to the foreign teacher-school. It means one school of your country can do this activity recording the videos and to analyze the data sent by Spanish teams.

To do the activity, Ramon Cid (one Spanish teacher) told me some questions we have to decide. I didn't think about this questions but I am agree with him they are important: the surface (to guarantee the same frictional force) and the weight of the material used to modify the solar cell inclination (to guarantee the same weight for the two cars). Both are questions easy to solve but they are important to help students to understand the science work must be a "serious work". The initial conditions for a experiment must be the same if you want compare results and use the obtained data in different places.

For the surface, we could use wrapping paper on a plain surface. All schools have a wrapping paper roll. To modify the inclination of the solar cell, we could use a small quantity of adhesive putty (blu-tack or similar)