

Angry with Maths? Bored with keeping on learning the same way? Ready to new challenges? Suggest your teacher using some special scientific app, like the game that has changed our approach to Gravitational Physics, and to Maths of course, all over the world. Rovio's **Angry Birds** is simply a slingshot-based projectile (bird) launcher, which creates parabolic trajectories when launching birdies. The goal is to destroy all the pigs on the screen, possibly along with the most of the structures protecting them. Here are some abilities of Angry Birds crew:



Red Bird



Blue Bird



Yellow Bird



Green Bird (Boomerang)



Black Bird (Bomb)



Big Brother (Terence)

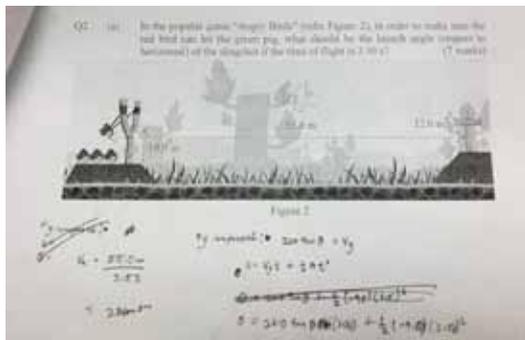


White Bird (Chicken)

[ANGRY PHYSICS]

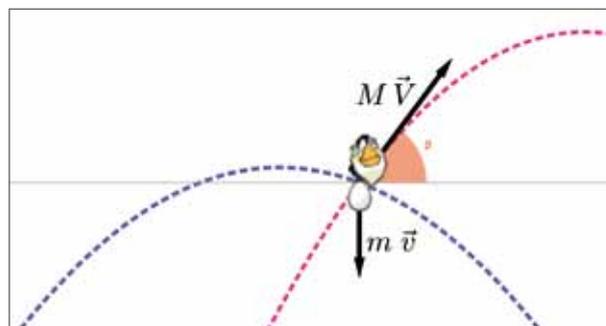
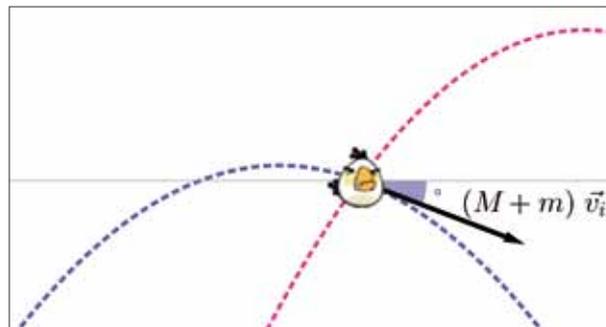
On the web you can find a lot of educational materials dealing with the Physics associated to different birds. There are many examples of teachers using Angry Birds to teach Physics to their students: some of them actually use Angry Birds as a reference for questions in their physics class tests...

Why don't we?



http://cdn2.techie-buzz.com/images2/keith/Angry-Birds-Question-in-Physics-Exam_11012/angry_birds_physics.jpg

Our aim is to emphasize the White Bird's trajectory: after dropping its egg-bomb, it follows a different path. How is the latter related to the former one? We suppose the White Bird conserves its **momentum**, the same way the Blue Bird seems to do when splitting into three. It comes down to:



Following the conservation of linear momentum:

$$(m + M) \vec{v}_i = M\vec{V} + m\vec{v}$$

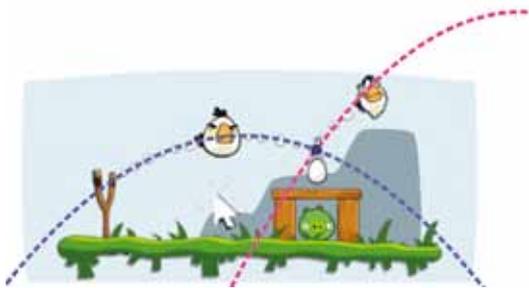
and by decomposing the vectors into their x and y components:

$$\begin{aligned} y: & \quad -(m + M) v_i \sin\alpha = MV \sin\beta - mv \\ x: & \quad (m + M) v_i \cos\alpha = MV \cos\beta \end{aligned}$$

Supposing that egg-bomb is somehow allowed to fall vertically, $v = 0$ then, dividing term by term:

$$\tan\alpha = -\tan\beta \rightarrow \alpha = 180^\circ - \beta \vee \alpha = -\beta$$

but since none of the conditions comes to be verified, we conclude that the White Bird actually makes a big effort to rear-eject its egg-bomb. Thus, neglecting all the other variables (launch speed, launch angles, **maximum range** and so on), we'll determine the **angle between two main curves**, the "before dropping" path and the "after dropping" one, by means of the traces the game software draws on the screen and with the help of Geogebra (like we use to do).

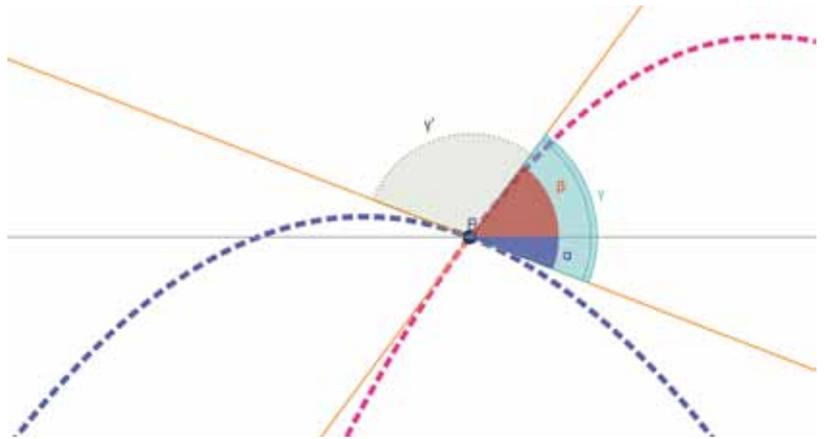


[ACTIVITY TO-DO LIST]

1. Make a snapshot of your White Bird's egg-drop and insert it in a Geogebra sheet
2. Let P be the intersection point between the two paths, i.e. the point where the egg is dropped
3. Locate the vertex V of the "before dropping" path, clearly a parabola
4. Let $a : x = x(P)$ and P' be the symmetrical to P with respect to line a
5. We get the first parabola by the command: *Polynomial* [{V, P, P'}]
6. Put A and B points on the "after dropping" path, marked by the deflated bird

7. We get the second parabola by the command: *Polynomial* [{P, A, B}]
8. Draw the tangent lines t and t' in P with respect to each parabola
9. The angle between the two curves is given by the command *Angle* [t,t']

The angle we're looking for is $\gamma = \alpha + \beta$ or its **supplementary** γ' . We'd better choose the so-called **reference angle**.



We can use the slopes m and m' of the tangent lines t and t' in P to calculate it by a well-known formula:

$$\tan \gamma' = (m - m') / (1 + mm') = -\tan\gamma$$

where, supposing $\alpha > 0$,

$$m = \tan(\gamma' + \beta) = -\tan\alpha, \quad m' = \tan\beta$$



At the end of this laboratorial CLIL lesson, we're sure your Maths teacher has become an Angry Birds addicted like some of you and like one of the authors of this article.

[GLOSSARY]

1. **momentum** is the product $m\vec{v}$ of the mass times the velocity of an object (ITA: "quantità di moto")
2. **maximum range** (ITA: "gittata massima")
3. **angle between two curves** is defined as the angle between the tangents at the point of their intersection
4. **supplementary angles** are pairs of angles which sum is a straight angle (180 degrees)
5. **reference angle** is an acute version of a given angle, i.e. the smallest angle between the terminal side and the x-axis; its trig values are the same, except at most a minus sign. (e.g. γ instead of γ' and α instead of $180^\circ - \alpha = \gamma' + \beta$)



[WEB REFERENCES]

www.wired.com/wiredscience/2010/10/physics-of-angry-birds/

www.angrybirdsnest.com/forum/discussion/comment/24064

[THE FINAL PUNS]

Dedicated to Steve Job, courtesy of www.isarcastici4.it



http://www.isarcastici4.it/immagini/umorismo/angry_bird_steve_jobs_apple.jpg

Don't play 24/7 with little HUNGRY birds, rather feed them...



<http://tx.english-ch.com/teacher/jasper/hungry-birds.jpg>