The Twelve Tasks of Asterix – The Throw of the Javelin

Movie / Year:
The Twelve Tasks of Asterix / 1975

Scientific subject and topic:
Physics / Gravitation

Movie producer:
Studio Idefix

Director:
René Groscinny, Albert Uderzo

Cast:
Asterix (voice): Roger Carel, Obelix (voice): Pierre Tornade, Cesar (voice): Jean Martinelli

Website of movie:
Filmography links and data courtesy of The Internet Movie Database
http://www.imdb.com/title/tt0072901/

Description of movie:
The Gaul villagers withstand Cesar's troops for years. The idea arises in Rome that they could be demigods. Cesar creates 12 tasks in order to prove this idea. If they really succeed the Gaul villagers should become the rulers of Rome.

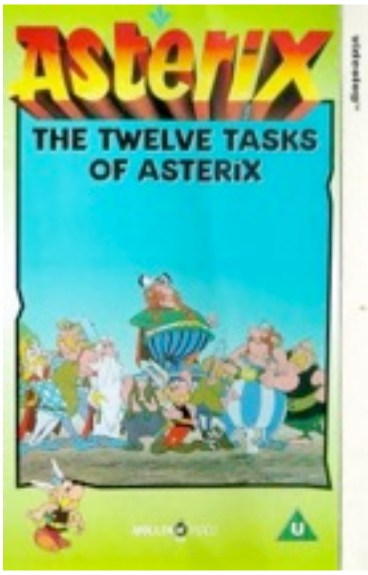
Link to Trailer Site:
Filmography links and data courtesy of The Internet Movie Database
http://www.imdb.com/title/tt097291/trailers

DVD: The Twelve Tasks of Asterix, U.K.
http://www.amazon.co.uk/Asterix-12-Tasks-DVD/dp/B0009S4VXU/sr=1-10/qid=1170167665/ref=sr_1_10/203-2505246-8430336?ie=UTF8&s=dvd

DVD: The Twelve Tasks of Asterix, U.S.A.
http://www.amazon.com/s/ref=nb_ss_gw/102-7439071-9976907?url=search-alias%3Ddvd&field-keywords=The+Twelve+tasks+of+Asterix

Title of scene:
The Throw of the Javelin

Still:



DVD cover scan from the movie “Twelve Tasks of Asterix”, claimed as fair use

Time interval:
00:16:50-00:18:20

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Scientific keywords:
Gravitation, Trajectory, Kinetic Energy, Potential Energy, Atmosphere

Description of scene:
In this scene Obelix defeats Hermes from Persia, known as the best javelin thrower in the world. Hermes throws the javelin from what is today known as France across the Atlantic Ocean over to the America. Obelix defeats him by throwing the javelin around the world and even further.

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Basic Level:

This short movie scene is ideal for the discussion of ballistic projectiles. The question is, if even with the force of Hermes or Obelix the possibility exists to throw a javelin as far as shown in the movie.

The creators of the movie seemed to have cared more about detail when Hermes throws the javelin. A projectile would follow a parabolic path being thrown if there would be no atmosphere. The javelin that is thrown by Hermes seems to match such a path. Hermes also throws the javelin very high, if not out into space. For intercontinental ballistic objects this is very important as the air's density decreases with height. Therefore the air resistance becomes also smaller at high altitudes than in regions close to Earth.

Obelix throws the javelin way further then Hermes. The actual flight path is quite unknown. One sees the javelin travelling around the Earth in the scene. Even though after the javelin has travelled once around the Earth Hermes has to run away from the javelin that chases him. Such a low flight path would deform the trajectory very hard from the parabolic way, and the flight path shown is very unphysical.

Even not taking the atmosphere into account accelerating a projectile to a velocity to travel around the Earth would take enormous amounts of energy. An approximate calculation shows that it would equal the energy as simultaneously lifting about 6 Eiffel towers having a weight of 10000 tons into the air. Obelix with his powers can release even more energy in a few seconds.

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Advanced level:

Trajectories of thrown objects are typically described to be parabolic for short-range projectiles. Due to the air resistance however the real trajectory differs from a parabolic form. For a thrown object thus the optimal angle under gravity is well known to be at 45º. However, due to the air resistance however the optimal angle is a bit less than 45º.

The above considerations can only be used for short-range projectiles. For long-range projectiles one has to take into account that the Earth is not flat as well as that the atmosphere is not uniform: This allows shooting further into the sky, since the air resistance vanishes.

Shooting up high into the sky is well known for intercontinental ballistic missiles, which even may reach space on their way to the target. However different rules apply for us since all the energy to accelerate the javelin has to be put into the javelin at launch.

An object in motion keeps its kinetic energy. The faster an object travels the more kinetic energy it has. In order to accelerate an object energy has to be put into the object. Thus to reach the velocity to throw a javelin around the Earth a high amount of kinetic energy is needed. The amount would even be way higher if one would take the air resistance into account.

Not taking air resistance into account the equations of motion for a thrown projectile are given by:

$$\begin{pmatrix} x_t \\ y_t \end{pmatrix} = \frac{1}{2} g t^2 \begin{pmatrix} 0 \\ 1 \end{pmatrix} + \begin{pmatrix} v_{0x} \\ v_{0y} \end{pmatrix} t + \begin{pmatrix} x_0 \\ y_0 \end{pmatrix},$$

where g denotes the gravitational acceleration close to the Earth surface, v_{0x} and v_{0y} are the components of the initial velocity and x_0 and y_0 represent the location from where the object is thrown. A projectile governed by these equations has a parabolic trajectory. One can show that the longest range of a projectile in dependence of the shooting angle is acquired at 45º. If one takes air resistance into account however it is known that the optimal angle for the longest range is below 45º. All this applies only for short-ranged projectiles.

For long-range projectiles one has to take into account that the air resistance is proportional the air density. The air density however decreases with the height of the projectile above ground. A well-known method to model the atmosphere is to use the barometric height formula, which is given by

$$\rho = \rho_0 e^{\frac{-\rho_0 g r}{kT}} .$$

The formula shows that the air density is way lower at high trajectories, from which long-range projectiles such as Intercontinental Ballistic Missiles take advantage in order to save energy.

We further have pointed out how high the amount of energy is that is needed to throw a javelin around the Earth, without taking the atmosphere into account. For the javelin to sustain its orbit the centrifugal force has to equal the gravitational force that acts on him.

The centrifugal force is given by

$$F_C = \frac{mv^2}{R}$$

and the gravitational force by:

$$F_G = mg \; .$$

Here m = 2 kg is the mass of the javelin and R = 6300 km is the radius of the Earth and g = 9,81 m/s^2 denotes the gravitational acceleration.

Thus one can obtain the velocity v of the javelin needed in order to obtain a circular stable orbit:

$$v = \sqrt{\frac{R}{g}} \; .$$

The corresponding kinetic energy is therefore:

$$E_{kin} = \frac{mv^2}{2} = \frac{mR}{2g}$$

Now one can compare this kinetic energy with the potential energy

$$E_{pot} = mgh$$

that is needed to lift objects into the air that would be equal the kinetic energy allowing to estimate that the energy needed to throw a 2 kg javelin around the Earth. It is about of lifting 63.000 tons one meter. This would be the same energy as about simultaneously lifting about 6 Eiffel towers having about a total weight of 60.000 tons into the air. Obelix releasing this energy in less than a second can thus be called a really very powerful machine for sure.

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Websites about film:
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Websites about gravity, air resistance, kinetic energy, potential energy, atmosphere:
http://en.wikipedia.org/wiki/Gravitation
http://en.wikipedia.org/wiki/Trajectory
http://en.wikipedia.org/wiki/Potential_energy
http://en.wikipedia.org/wiki/Kinetic_energy
http://en.wikipedia.org/wiki/Atmosphere