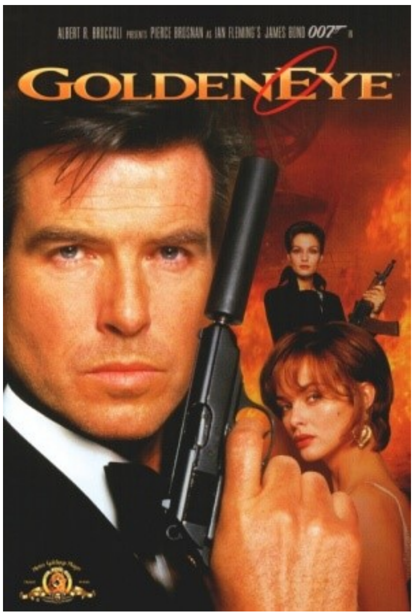
James Bond
and
High School Physics

The project “James Bond and High School Physics” is inspired by the book “Geschüttelt, nicht gerührt” (“Shaken, not stirred”), edited by Metin Tolan and Joachim Stolze (Piper Verlag 2008, ISBN 978-3-492-05082-1). In the book two teams of university students calculate and explain a number of examples of situations involving physics in James Bond movies, but without making experiments.

Our course has mainly been aimed at promoting the experimental aspect of physics teaching in ‘gymnasium’ (‘upper secondary school’), including control experiments, models and considerations of analogies. We have watched the entire movie “Goldeneye”, but used ‘only’ the first part of the opening sequence for experimental observations. This and other James Bond movies contain material for many further physics projects.



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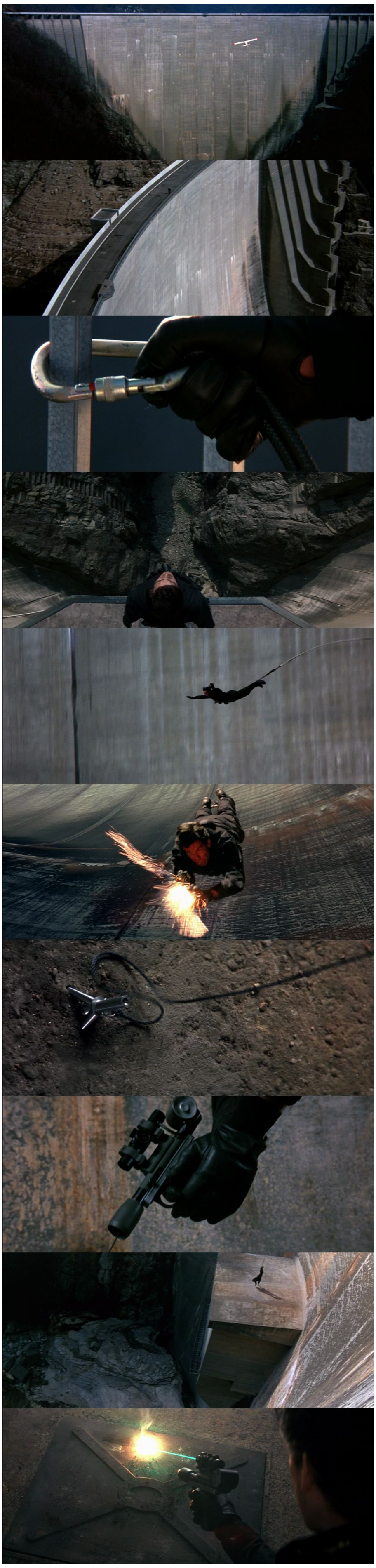


Introduction

James Bond survives, sometimes because of his own strength, speed and intelligence, sometimes thanks to Q's incredible inventions. And sometimes James Bond is simply lucky.

We work with clips from James Bond movies and use them to investigate what is physically possible or impossible. We attempt to find explanations if some of the things that James Bond experiences seem to contradict the laws of physics, and we assess whether the inventions in the film clips are realistic.

The aim of the project

- to give the students insight into scientific methods and ways of thinking, in particular how the use of models can explain physical phenomena.
- to put forward and test hypotheses to see if they can be used to explain or dismiss some of the phenomena that appear in the James Bond movies.
- to inspire the students to be actively seeking the data needed to carry out quantitative or qualitative investigations.
- to allow the students to experience physics teaching as exciting and relevant, in order to make them want to keep working with physics and other scientific subjects in which natural phenomena are explained without necessarily involving the rote learning of textbook formulae.

The opening sequence of "Goldeneye"

In the movie "Goldeneye" James Bond must sabotage a Russian poison gas plant situated at the foot of a tall dam. In the opening sequence James Bond flies across the dam, lands (which is not seen in the movie), runs to the middle of the dam, carries out a bungy-jump which he stops at its lowest point. He achieves this by firing a wire into the roof of the gas plant, letting the motor of the gun drag him down to the roof, and using a laser beam from the gun to cut his way into the plant!

Which experiments have the students carried out?

1 James Bond's run to the middle of the dam

By seeking information about Goldeneye and bungy-jump the students found out which dam was used, and they found the dimensions of the dam. Thus they had the data necessary to assess the distance that James Bond covers in the opening sequence.
The time could be read on the video player, and thereby they could calculate the speed and compare with 100-metre and 200-metre races.

2a Bungy-jump in films

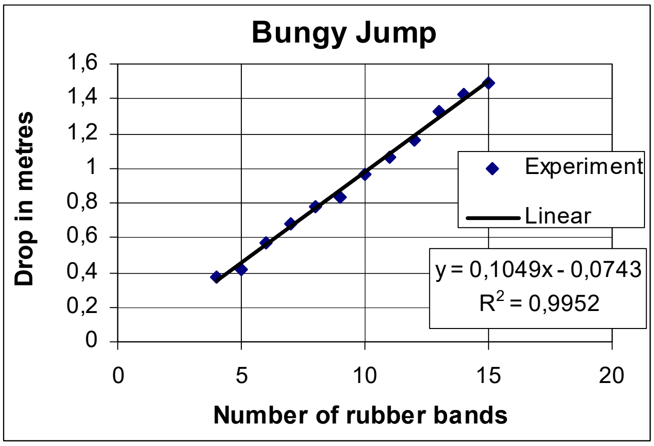
The students compared James Bond's bungy-jump with authentic footage of bungy-jumping from the dam and measured the time it took to stretch the rubber cord fully. The time found was about half that of James Bond's performance in the movie.
The explanation offered by the students was that the sequence was put together from footage taken by different cameras, and this footage is edited so that you never see James Bond's bungy-jump in one sequence. The cinematographic effect is convincing: One bungy-jump from a great height! What bravery!

2b Bungy-jump as experiment

The students made bungy-jump rubber cords by tying more and more rubber bands together and letting a 50 grams weight drop from a height of 2 metres.
The students compared the number of bands and the length of the drop, and were asked to predict the number of rubber bands necessary to make a drop that would bring the weight "close" to the floor. "Close" was here taken to mean that the distance to the floor – after a drop from 2 metres' height – had to be less than 0,10 m. That is similar to James Bond after his 200 metres drop stopping less than 10 metres from the roof of the gas plant (and not hitting the roof either!).

By reading the graph the students found drops using 19 and 20 rubber bands:

Number of rubber bands	Drop in metres
19	1,92
20	2,02



It is thus possible to get "close enough" by using 19 rubber bands.

The prediction is verified or falsified by carrying out bungy-jumps using 19 and 20 rubber bands.

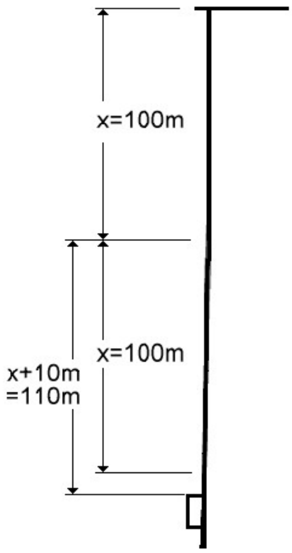
2c Egg-bungy-jump

In the "Egg-bungy-jump" competition the weight was replaced by an egg, and the task was again to predict the number of rubber bands needed to bring the egg close to the floor, without breaking the egg.

2d Springs and rubber bands

The students carried out controlled experiments where they measured corresponding values of mass and the stretching of springs or rubber bands, made graphic presentation of data, and found spring constants for springs and rubber bands.

2e Bungy-jump as a mathematical assignment (Intermediate and high level)



The students made a hypothesis about the free fall in the first part of James Bond's bungy-jump and the slowing down in the last part, and by using relevant energy equations they could calculate the spring constant in the rubber cord used by James Bond and compare with the spring constant they had found for their own springs and bungy-jump rubber bands.

3 How strong must the motor in the gun be?

The students calculated how much energy was necessary to stretch the bungy-jump cord the extra 10 metres, and could then calculate the effect of the motor.
The students also compared James Bond's gun with battery operated screwdrivers and found that a powered screwdriver with an effect of a few hundred Watts takes up as much space as James Bond's gun which would have needed a motor of at least 2000 Watts! The students found that Q had been unrealistically clever!

Proposal for further investigations

- Find out if the bungy-jump in the film is made by showing part of the movement in slow motion, and assess if that can explain the long lasting bungy-jump.
- Measure bungy-jumps with an accelerometer and find out if the hypothesis of a free fall in the first half and a slowing down in the second half is correct.
- Bungy-jump as part of an oscillation. Record a bungy-jump on video, make a video analysis using LoggerPro, and find out if this forms a damped sinewave. At high level you can work with the mathematical formulae of the wave, and determine the spring constant of the oscillation based on the frequency of the oscillation.
- Investigate the energy contents of various kinds of batteries. Compare the size and energy contents of the battery.
- Can a laser beam cut a hole in the roof of a building? Theoretical assignment where the students must seek information about laser beam cutting, compare with James Bond's gun, the energy needed for laser beam cutting etc.