Demonstrator # 3

PARACHUTE JUMP

TEACHER NOTES

Activity title:
Parachute Jump
Subject:
Physics
Student age:
> 14
Estimated duration:
5 x 50 minutes
Science content

General Information

acceleration - the rate of change of velocity over time (average acceleration = AV/At)

delta - the change in or difference between (symbol is Δ)

displacement - a change in position; $\Delta d = d_2 - d_1$

energy - the ability to do work

force - that which produces or prevents motion; that which can impose a change of velocity on a material

gravitational acceleration 9.8 m/s^2, or 32 ft/s^2, or 980 cm/s^2

gravity - that attractive force existing between all objects in the Universe

inertia - the reluctance of all matter to change its state of rest or uniform motion; the tendency of all objects to preserve its motion

kinetic energy -work done by a force along a given displacement; the energy involved in motion

mass - a measure of the inertia of that object; the greater the resistance something offers to being set in motion the greater its mass. The amount of matter being a definition for mass is a poor one.

motion - a continuing change of place or position

potential energy - stored energy due to composition, position, or condition

power - work divided by time; time required to exert force over a distance

scalar quantities - quantities involving only a given magnitude (examples: temperature, time, mass)

uniform motion - moving in a straight line at a constant speed

vector quantities - quantities which require both a magnitude and a given direction (for a complete description, examples: displacement, velocity, force, acceleration)

velocity - the rate of change of displacement over time; the ratio of motion in a particular direction; the distance traveled divided by the time taken (average velocity = Ad/At)

work

work - that which is when a force acts on matter and changes it direction

Newton's Laws

Scalars and Vectors

Physical quantities are divided into scalars, having only magnitude or size, and vectors, which have both magnitude and direction. **Distance is an example of a scalar**: 'The athlete ran two kilometers." **If a direction then is specified, it is called displacement, and is a vector**. "The athlete ran two kilometers toward the north."

A **force** is any influence that can produce a change in the velocity of an object. **It may produce or prevent motion. It has both magnitude and direction, and is therefore a vector**. If many forces act on an object at the same time, the **resultant**, or **net force** can be found by adding all of the individual forces. Of course, the direction must enter into the addition, and that makes vector addition different from the addition of scalars.

Learning objectives

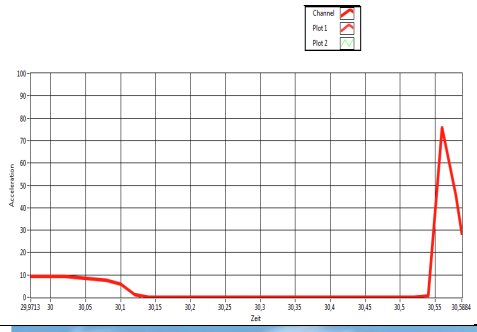
The differentiation between free fall and air resistance. How this action can be measured during a parachute jump.

Students should with force vectors calculate and interpret diagrams to describe

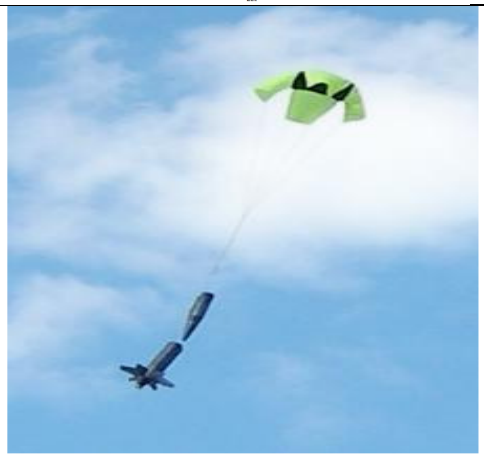
Inquiry-based character

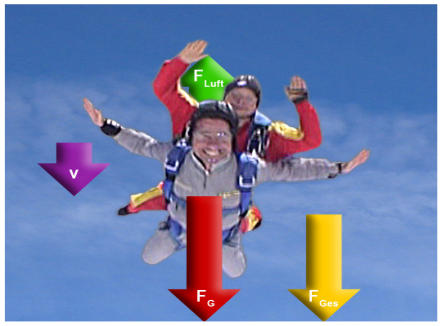
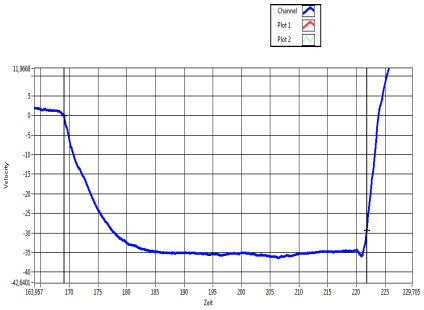
Stage 1 Discuss the History of Freefall and then
Describe the theory.
Demonstrate the basis of the theory with a free fall experiment involving the KLIC ball

Summarise, provide a link to information about freefall http://ne.lo-net2.de/selbstlernmaterial/p/m/lbo/lboindex.html
Provide a link to the world record attempt from 40m; http://www.redbullstratos.com



Stage 2 Develop answers and hypotheses to;
What effect does the air resistance on the falling motion?
For how long is there a speed increase?
What happens at top speed?
What happened when the parachute opened?
Considering the case of air resistance, conduct an experiment- Simulate a parachute fall in the school auditorium using various weights.
Collect and evaluate evidence and prepare for the actual parachute jump



Stage 3 Evaluate the plan, have students prepare an estimated calculation of the parachute fall and then complete an integrity check If the conditions are suitable, install the sensors Integrity checks of sensor measurement: Jump from the plane opening of the parachute Gliding with a parachute Landing	
Stage 4 Evaluate the evidence, compare the estimated calculations with the final results and develop a final report. Pay particular attention to the original hypotheses (which were correct?) and describe the various stages on the graph that has been downloaded from the sensors. Particularly describe what parameters induce change, the impacts on the outcome and what rates show the increase of speed before the decrease in speed.	
Stage 5 Final evaluation, making a linear function and answering the quiz	

Applied technology (if any)

Materials needed

Personal Computer with Internet Connection, InLot tools,
Setting: either parachute jumps (number) or tandem jump

Discussion guide

Type of Learning: Inquiry based learning utilising a Collaborative structure with Problem Solving activities
Activity: Collaborative and individual
Learning Sequence:
Establishing a common understanding- Students are organised into groups and the discussion question is how is air resistance measured against falling objects. Revise physics concepts relevant to this task, use the klic ball and require the groups to graph the movement of the ball from various heights using force and free fall to develop a comparison.
Once the groups have discussed their results and the physics concept is clear then conduct experiment with falling parachute in school gym. Specify a standard weight that all groups must try and then allow the groups to experiment with different weights. Have each group present their results and then ask students to synthesis the results individually for a common conclusion which should be discussed and agreed upon.
The experiment- Now that students have a common understanding of air resistance it is necessary to prepare and conduct the parachute jump. In groups again, groups define what they are measuring and what are some likely results given different weight variables etc. These estimates should be graphed so that students can compare the estimates to the real results.
Once the jumps have taken place the students are to analyse the data in their groups. Conclusions are to be drawn to support the results as well as to compare the real results with the estimates and why they were close or so divergent.

Conclusion, assessment and evaluation- Each group should present their result findings with a conclusion as to why they occurred.
Then individual assessment should be undertaken. Students should then evaluate their responses (depending upon the class this could be done individually or collectively).

Assessment

QUIZ
Start with some relatively easy multiple choice questions to some lore challenging questions e.g.
1. When the parachuter leaves the aircraft, what force operates?
(a) Centrifugal force
(b) Gravity
(c) Air resistance
2. How is the total acceleration of the falling parachute described?
(a) Remains constant
(b) Decreases
(c) Increases

TO
Calculate the theoretical top speed if the weight of two tandem jumpers combined is 150kg, $C_w = 1$, $A = 1m^2$ and the air density is 1.2 kg/m^3

(a) 40 m/s
(b) 50 m/s
(c) 60 m/s

TO
How can you explain the short acceleration at the end of the jump?