Abstract

In the PROFILES module “CrimeScienceInvestigationsJoensuu: Traffic Accident: who is to blame?” the students will clarify who is guilty in the traffic accident in which a poodle was knocked down by a car on a pedestrian crossing. An elderly lady was walking the poodle. Working together in groups, the students will have the opportunity to discuss the accident and its guilty party. The module is compiled for upper compulsory school (grades 7-9). The students reconstruct the accident by drawing it, they will learn to clarify the traffic accident by calculations using the concepts of motion, velocity, and acceleration. The students learn to make a justified decision about the guilty party. They will actively participate in the discussion in pairs, in a group of four students and in class.
Subject: Physics

Grade level: 7th to 9th grade

Curriculum content: Velocity and acceleration

Kind of activity: Group discussions, drawing, calculations, inquiry

Anticipated time: 4 lessons of 45 minutes

Overall Objectives/Competencies: Basic understanding of concepts motion, velocity and acceleration, inquiry skills, graphical skills, communication skills (esp. discussion), group working skills, informed decision making and appropriate judgement skills.

Attached files

1. Student activities
   Describes the scenario in more detail and the tasks the students should carry out

2. Teaching guide
   Suggests a teaching approach

Acknowledgement:
These materials are taken from the Teaching-Learning Materials Tool compiled by the PARSEL Consortium (namely by Jack Holbrook, 2007) as part of the EC FP6 funded PARSEL Project (SAS6-CT-2006-042922-PARSEL) and adapted by the UEF-PROFILES Working Group – Member of the PROFILES Consortium. For further information see: www.parset.eu.
In the PROFILES module “CrimeScienceInvestigationsJoensuu: Traffic Accident: who is to blame?” you should solve who is guilty in the traffic accident in which a poodle was knocked down by a car on a pedestrian crossing. Working together in groups, you will have the opportunity to discuss the accident. You reconstruct the accident by drawing and making some necessary calculations. Afterwards, you will be able to understand velocity concept and make a justified decision. The following worksheets will help you to carry out the necessary investigations.

Acknowledgement:
These materials are taken from the Teaching-Learning Materials Tool compiled by the PARSEL Consortium (namely by Jack Holbrook, 2007) as part of the EC FP6 funded PARSEL Project (SAS6-CT-2006-042922-PARSEL) and adapted by the UEF-PROFILES Working Group – Member of the PROFILES Consortium. For further information see: www.parsel.eu.
Crime Scene Investigation Joensuu: Traffic Accident: who is to blame?

These worksheets belong to: .................................................................

Description of the accident, data from the interviews and report of the crime scene

The task is to define the guilty party in a traffic accident in which a car knocked down a poodle on a pedestrian crossing. An elderly lady was walking the poodle. More detailed information will be given below.

The lady was crossing the road on the pedestrian crossing when the car knocked down her prized poodle, resulting in its death. At that site, there are traffic lights for pedestrians and the green light shows safe crossing. The car and the poodle collided 4.6 m from the kerb on a pedestrian crossing. Another pedestrian behind the lady who was also waiting to cross the road, acted as a witness in the situation.

The following comments came up in the police interviews after the traffic accident:

- **Lady:** "I began to cross the road immediately when the green light came on. I thought the car should stop but it did not, then that horrible driver speeded over darling Sebastian!!"

- **Driver:** "I was leisurely driving at speed 40 km/h. The light was green for me when that missus and her moot rushed from the pavement onto the road. I immediately braked hard when I saw the dog move onto the pedestrian crossing. I succeeded in stopping the car but perhaps the bumper hit the mutt. Fortunately nothing happened to the missus."

Developed by: Ilpo Jäppinen and Kari Sormunen. Translated by: Tuula Keinonen
Institution: School of Applied Educational Science and Teacher Education, University of Eastern Finland – Finland
Homepage: [www.uef.fi](http://www.uef.fi) - Mail: Ilpo.Jappinen@uef.fi; Kari.Sormunen@uef.fi
Witness: "I was behind that lady waiting to cross the road. When the green light came on for pedestrians, the lady quickly walked with her dog onto the road. The car started to brake when the poodle stepped onto the road, then I suppose it hit the dog."

Information about the crime scene:

- The witness was asked to walk the distance of 5 m several times at the same speed as the lady and the poodle used to cross the pedestrian crossing. The mean value of walking the distance of 5 m, was 2,9s.
- The brake skids left on the asphalt by the car were 19,8m long.
- The braking tests done by crime police showed that the car’s deceleration was 5,9m/s².
- Speed limit at the crime scene is 40km/h.
- The traffic lights did not function rhythmically at the crossing in question: The red light came on for cars at the same time as the green light for pedestrians.

Further information came on the following day:

- Veterinary surgeon made an autopsy on the poodle and found that the poodle did not die from injuries due to the crash but from a heart attack caused by fright.
- Both parties are going to court with the following claims:
  - If the motorist is found guilty, then he has to pay the lady 6,500 € compensation for the poodle and 2000 € for the sorrow caused as well as the veterinary surgeon’s costs of 257,40 €.
  - If the lady is found guilty, then she is liable to pay the man’s hourly wages of 8€ for the time of 1,5 h, because the man was late for work.
  - Further the guilty party has to pay the court costs of the counter party and she/he can be condemned to pay a fine due to the endangerment of traffic.
Instructions

Your task is, in order to clarify the guilty party, to find out if the driver obeyed the velocity limits.

Working in pairs. Both of you have to make notes in your own inquiry record.

1. **Draw a picture of the situation. It must include:**
   - the site of the collision between the poodle and the car
   - the distance the poodle covered on the pedestrian crossing
   - the length of the skidmarks.

2. With the aid of the given information, clarify how much time it took for the poodle to walk from the kerb to the collision site. Make **notes** about your conclusions!

3. Write down the **result** on the record.

4. Think about, how you could determine the time the car took to brake. Make exact notes about your reasoning and calculations.

5. Plot the braking time in the figure on your record.

6. Based on the fact above, your task is to reason and calculate the speed of the car before braking.

7. Write down the result on the record.
Decision making

Discuss with another pair about the results in points 4 and 6. Think about the reliability, measuring errors and other possible variables too.

Decide whether the driver is responsible for the accident. Justify your decision and try in groups to get a unanimous solution. Prepare to demonstrate that your presumption is correct.

Common conclusion

Groups present their results to the class.

Class discussion about the results and how the event is connected to real crime police work.
Crime Scene Investigation Joensuu

RECORD OF INVESTIGATION

Case: _________________________________    Investigator: _______________________

Drawing of the situation.

The time taken for the poodle to walk:

The time taken for the car to brake:
Speed of the car before the braking:

Proposal for the guilty and justifications (if needed continue on the other side):
Module Content

In the PROFILES module “CrimeScienceInvestigationsJoensuu: Traffic Accident: who is to blame?” the students will clarify who is the guilty party in the traffic accident in which a poodle was knocked down by a car on a pedestrian crossing. An elderly lady was walking the poodle. The background knowledge needed constitutes the laws of motion and concepts of velocity and acceleration. Working together in groups, the students will have the opportunity to discuss the accident and its guilty party. The students reconstruct the accident by drawing it. They will be able to solve the traffic problem by calculation, using the concepts of motion, velocity, and acceleration. The students will learn to make a justified decision about who is guilty. They will actively participate in the discussion in pairs, in a group of four students and in class.
CSI (Crime Scene Investigation; also C.S.I.) is an American television series created by Anthony E. Zuiker. The series follows the work of investigators from Las Vegas police station. Perhaps even more popular are the so called spin-off series such as CSI Miami and CSI New York, all of which have been popular in Finland too. If the teacher wants to connect this task to CSI, the series’ home pages can act as a stimulus.

This study module has been modified from the original PARSEL-module by greatly simplifying the scenario. For example, the delay in time when traffic lights change and the purpose of yellow light, have been ignored, as well as the delay in time of human reaction.

Further information is given to create the context and embellish the task but these should have no impact on decision making.

Suggestion for the phases and timing of the study module

First lesson:
- teacher introduces the scenario in as interesting and diverse a way as possible using either the Internet, data projector or whiteboard
- each student reads the instructions and the record of the investigation
- either the students form pairs themselves or the teacher decides them
- if time allows students draw the accident

Second lesson:
- if necessary, discussion about the scenario
- drawing or finalizing the drawing of the accident
- working in pairs according to phases 2 to 7 of the instructions; teacher provides guidance when relevant and checks that every student works meaningfully with the inquiry task

Third lesson:
- pairs recall the scenario and check both the drawing of the scene/situation as well as the record of the investigation
- two pairs form a quartet in order to make a unanimous and justified decision based on
their inquiries

- by using a Power Point presentation for example, the quartet prepares to present their finding with justifications and suggestions for the sources of errors
  - besides measuring and calculating errors, sources of errors may include factors due to the limitations of the given situation; for example, in regard to the function of traffic lights which change directly from red to green and the motorist’s reaction time

Fourth lesson:

- quartets present and justify their decisions about the guilty party in the accident and answer questions presented by the other quartets
- finally the teacher guides a class discussion about the scenario, inquiry process and especially the decision making phase, as well as how this matter is connected to the work of crime police, possibly including the visit of a policeman

Solution options

The witness was asked to walk the distance several times, at the same speed as the lady and the poodle used to cross the pedestrian crossing. The mean value of walking the distance of \( s = 5 \text{ m} \) was \( t = 2.0\text{s} \), and we find the velocity \( v \)

\[
v = \frac{s}{t} = \frac{5\text{m}}{2.9\text{s}} = 1.72\frac{\text{m}}{\text{s}}.
\]

The poodle walked the distance \( s = 4.6\text{m} \) with the velocity \( v = 1.72 \text{ m/s} \), and we find the time the poodle used to walk as being \( t_{\text{poodle}} \)

\[
t_{\text{poodle}} = \frac{s}{v} = \frac{4.6\text{m}}{1.72\frac{\text{m}}{\text{s}}} = 2.67\text{s}.
\]

The car started to brake at the same time as the poodle started to walk and the car’s braking time \( t_{\text{car}} \) is the same as the poodle’s walking time \( t_{\text{poodle}} \),

\[
t_{\text{car}} = t_{\text{poodle}} = 2.67\text{s}.
\]
The car decelerated its velocity in the time $t_{\text{car}}$ and after that it stopped. The deceleration of the car was $a = 5.9 \text{m/s}^2$, when the car’s velocity before braking was

$$v_i = at_{\text{car}} = 5.9 \frac{\text{m}}{\text{s}^2} \times 2.67 \text{s} = 15.753 \frac{\text{m}}{\text{s}} \approx 57 \frac{\text{km}}{\text{h}}.$$ 

Thus, the car was speeding.

The car’s braking time can be also clarified with the aid of the constant acceleration and the distance, $s = \frac{1}{2} at^2$ where $s$ is the braking distance, $t$ is the braking time and $a$ is the car’s deceleration. The assignment can be solved in this way but for grades 7-9 it is rather difficult. Primarily, clarifying the braking time will be done by reasoning based on the text, because the poodle’s walking time and the car’s braking time are equal.

Scenario option

Carleborgs school’s crime police

Your task is to define the guilty party in a traffic accident in which a moped car collided with a pupil who was crossing the road on a pedestrian crossing. The pupil only suffered some bruising and a broken jacket and the windscreen wiper of the moped car was broken.

Widening the content of the study module, for possible use in higher secondary school (grades 10-12)

In the original PARSEL-module, the determination of the car’s velocity is based on investigation of the skid marks and on the concept of friction giving the coefficient of friction between the car and asphalt. More detailed instructions can be found in the original PARSEL-module in its Material for Students and Material for Teacher. Teacher Notes also present the computational solutions.
Assessment

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Criteria</th>
<th>Pair 1</th>
<th>Pair 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Picture</td>
<td>Picture responses the given information</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Picture has a meaningful size</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Variables in the picture are named</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calculated phases and results</td>
<td>Poodle's walking time is calculated</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All the phases in all calculations are written down</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Report</td>
<td>Results which are required are in report</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reasoning</td>
<td>Braking time has been reasoned with the aid of dog's walking time.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guilty</td>
<td>Decision about the guilty party in collision has been done</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Justifications</td>
<td>Decision is justified meaningful</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discussion</td>
<td>Participates in discussion concerning making the unanimous decision</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Can discuss in a meaningful way the reliability of the inquiry</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

S = Satisfied, F= Fair, E= Excellent

Acknowledgement:

These materials are taken from the Teaching-Learning Materials Tool compiled by the PARSEL Consortium (namely by Jack Holbrook, 2007) as part of the EC FP6 funded PARSEL Project (SAS6-CT-2006-042922-PARSEL) and adapted by the UEF-PROFILES Working Group – Member of the PROFILES Consortium. For further information see: www.parsel.eu