1. Students Activities

1.1. Tasks:

You are asked to reconstruct the course of events and to determine who is at fault in an accident in which a car knocked down a student on a pedestrian crossing. A scenario and further details are given in the following lines.

1.2. Scenario:

A student was crossing the road at a pedestrian crossing with traffic lights when he was hit by a car.

This particular pedestrian crossing indicates when it is safe to cross the road by giving a 'green man' indicator by means of a set of traffic lights.

When the green man shows towards the pedestrian, a red light is shown towards the traffic.

The point of impact between the student and the car on the pedestrian crossing was 4.6 m from the kerbside.

Another pedestrian who was behind the student waiting to cross the road acted as a witness to the accident.

The following comments were made to the police after the accident.

Student: I crossed the road immediately the 'green man' came on. I thought the car would stop, but it didn't.

Driver of car: I was travelling at 40 km·h^{-1}. The traffic light was green for me when the student stepped off the kerb. I slammed on the brakes immediately as hard as possible, but I still hit him - at no more than 10 km·h^{-1}.

Witness: I was behind the student waiting to cross the road. The student walked across the road quickly as the 'green man' came on.

1.3. Additional information:

The witness was asked to walk 5 m several times at the same pace as the student did when crossing the road. His average time measured over the 5 m was 2.9 s.

From the student's slight injury, the impact speed would be at most 10 km·h^{-1}.

Four skid marks were left by the car, the longest being 19.8 m

The coefficient of tyre/road friction was found by a skid test to be 0.76.

The phasing of lights for traffic was that the yellow light lasted 3 s before the 'green man' and the red light for traffic came on together.

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1.4. Student Activities:

1. Draw a reconstruction of the scene. Indicate on this:
- the pedestrian crossing,
- the point of impact,
- the distance the student walked across the road,
- the approximate position where the skid marks began.

2. By using the available data, and your background in undertaking calculations using the laws of motion, undertaking calculations to determine how long it took the student to cross the road before he was hit by the car.

3. Mark the outcome from your calculations from 2 on your reconstruction diagram.

4. Think and put forward suggestions about how to determine how long it took the car to stop. (Hint: note the skid marks).

5. To determine how long it took the car to stop because it was skidding, it is necessary to know the factor that affects the skidding process. This depends on the material skidding (the rubber) and the material on which it was skidding (the road surface), but the overall effect is that the car loses kinetic energy as work is done against the friction of the rubber and the road surface. This requires determine the relationship between change in kinetic energy and work done against friction.

6. Explain why the change of kinetic energy of the car is the same as the work done against friction when the car is skidding.

7. The relationship in 5 and 6 includes a coefficient that is related to the friction between the surfaces. Explain this coefficient, called the coefficient of friction. Suggest a way in which it is possible to determine the coefficient of friction for different surfaces.

8. Following instructional guidance from the teacher, determine the coefficient of friction for some surfaces.

9. Using the above expression and noting the coefficient of friction between the car types and the road surface under normal conditions is 0.76, determine the time it took the car to stop.

10. If the car driver's reaction time is 0.8 s, determine the position of the car when the lights went red and the student started to cross the road.

11. In a small group, discuss the findings from the calculations undertaken in steps 2, 9, and 10. By also bearing in mind the reliability of the data provided, errors in measurement and other variables, determine whether the car driver was liable for the accident. Fully justify your decision and seek consensus on the decision within the group. Be prepared to justify your assumptions.