Roger Fentem and Richard Smith

Datalogging with Handheld Technology

KS3 Science

Unit 9K Speeding up

How fast is it moving?

This year 9 unit offers a range of opportunities to exploit the learning potential offered by personal datalogging. Use of photogates is at the heart of the datalogging in the aspect covered here. The focus of this session is taken from the QCA specification:

How fast is it moving?

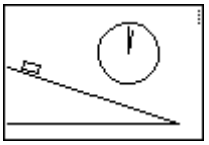
Learning Objectives	*Possible teaching activities*	*Learning outcomes* Pupils	*Points to note*
• That speed can be determined by measuring distance travelled and time taken. ▪ The units in which speed is measured. ▪ To manipulate and apply the quantitative relationship linking distance, time and speed. ▪ To plan and organize a group activity to solve a problem to make sufficient measurements using ICT. ▪ To compare and evaluate different ways of making measurements. ▪ That measurements for different purposes may not be equally precise.	• Introduce the formal relationship between speed, distance and time and help pupils use it in a variety of contexts. ▪ Pupils measure the time a toy car takes to roll down a ramp. Discuss what the values mean and whether the car is travelling at the same speed at each point. Introduce 'accelerate', qualitatively. ▪ Demonstrate how a light-gate can measure the speed of the car. ▪ Groups plan and make measurements of the car's speed at points on the slope, consider reasons for variations, predict the effect of increasing the slope's steepness or car's mass on the results obtained and test predictions. Use ICT to display results and ask pupils to describe the pattern and make a generalizations. ▪ Ask pupils to describe how times are found in school athletics activities, and compare this with the light-gate and with the electronic equipment used in major athletics events.	• Contribute to a group plan ▪ Identify the difference between average speed and speed at a point. ▪ Collect readings of speed at a point using datalogging equipment. ▪ Describe the pattern in results, e.g. the higher the ramp, the faster the car at the bottom; the car accelerates down the slope. ▪ Suggest reasons, e.g. reaction time, why hand-held timers may be less accurate than electronically triggered timers. ▪ Give reasons why some specific measurements need to be more precise than others.	• In unit 7K 'Forces and their effects' pupils had some experience of considering speed and how it might be measured. • Extension: pupils could be asked to find out about a range of land, water and air speed records, and why distances to stars are given in light years rather than the normal units of length. ▪ Extension: Pupils could measure the speed of sound in air using a suitable method. ▪ Extension: Pupils could be asked to find out how the speed of the tennis ball during a service, or the maximum speed of a racing car during a lap, is determined.

Within Unit 9 K, pupils might engage with other speed measuring datalogging in considering resistance to motion: "How do parachutes work?"

Activity:
How fast is it moving?

This activity introduces the formal relationship between speed, distance and time and extends the concept of motion to include acceleration (qualitatively). Pupils explore ways of measuring time considering the merits of the methods used. Cooperative group work is essential for success in this activity.

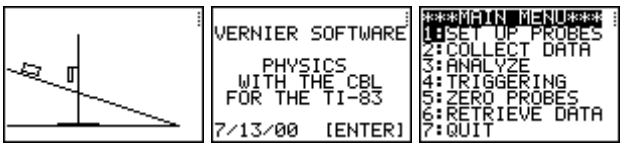
1. Set up a ramp at an angle, say about 10^o - 15^o, to the horizontal, place a toy car at the top and release it. Measure the time it takes to reach the bottom of the ramp using a stop-watch. (1.18s)



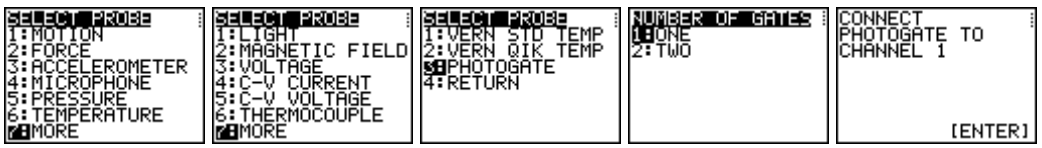
2. Make any other measurements you need (1.5m) and record your conclusions about the average speed of the car. (1.27 ms^{-1})
3. Repeat steps 1 and 2 for different time measuring devices e.g. wrist watch.

length of ramp	stop-watch	wrist-watch	…
			…
speed (ms^{-1})			…

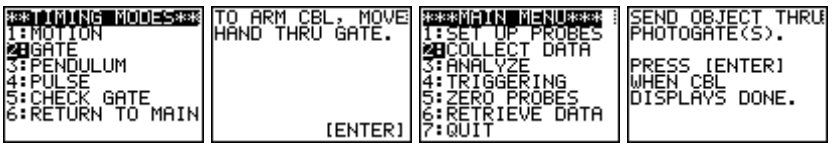
4. Discuss the accuracy, errors, calculation errors, …
5. Now prepare to measure time with greater accuracy and reliability. Attach the calculator to the CBL/CBL2 and one photogate to channel one on the CBL/CBL2.
6. Set up a single photogate on a stand about half way along the ramp (precision in location may/not be important) so that the car will pass clearly though the gate.



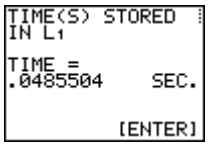
7. Use Physics APP/prgm and set up the system for one photogate.



8. The system needs to be in GATE mode to measure the time that the car takes to pass through the photogate starting from the same position as in step 1.



9. Record the time displayed and interpret this, make any measurements (0.08m) you need to determine the speed of the car at that point on the ramp. (1.6 ms^{-1})



length of car (m)	time (s)
speed of car (ms^{-1})	

10. REPEAT the experiment to measure the speed of the car at a different part(s) of the ramp.

11. Note that you can set up two photogates using the **dual photogate adapter** so that the speed of the car is measured on the same run at different parts of the ramp. Setting this up still requires you to indicate that you have ONE PROBE when you are prompted for the number of probes. But you indicate that you have TWO GATES when asked for the NUMBER OF GATES.

12. What do the different times indicate about the speed of the car in the different places on the ramp? Calculate the speeds at these places. (0.23 and 0.78 ms^{-1})

time (s)	speed (ms^{-1})

13. What can you say about the nature of the motion of the car travelling down the ramp?
14. Repeat the experiments with the ramp at a different angle.

Possible Extension Work

- Measure speed of car using a SONIC device such as the CBR (Calculator Based Ranger) of Motion Detector.
- Explore relationship between average speed and speed at a point on a slope.
- Devise a way of measuring the speed of sound in air.
- Find out how the speed of the ball in a a tennis serve or a bowl in cricket is measured.

Links

- Unit 7K "Forces and their effects" presented issues on speed and its measurement; unit 7C "Environment and feeding relationships" considered streamlining and increasing speed.

Health and Safety

Risk assessments are required for any hazardous activity. In this unit pupils:

- **work with fast moving, massive objects**

Datalogging kit

- TI-73, TI-82, TI-83 or TI-83 Plus graphing calculator
- CBL or CBL2
- 2 Photogates and adapters for CBL/CBL2
- Dual Photogate adapter
- Motion detector (or CBR)
- TI-GRAPH LINK™ and cable
- Physics APP (TI-83 Plus) or program group (TI-73, TI-82 or TI-83)
- optional: ViewScreen™, vs-calculator and OHP

Apparatus required

- toy car
- ~1.5m ramp
- stop-watch, wrist watch with second hand, other common timing device
- various blocks
- metre stick
- retort stands

Useful web sites

www.ti.com/calc/docs/graph.htm
www.vernier.com
www.oxford-educational.co.uk
www.qca.org.uk