OCR
RECOGNISING ACHIEVEMENT

Wednesday 5 June 2013 – Morning

AS GCE PHYSICS B (ADVANCING PHYSICS)

G492/01 Understanding Processes/Experimentation and Data Handling

ADVANCE NOTICE

Duration: 2 hours

G412040613

INSTRUCTIONS TO CANDIDATES

- Take the article away and read through it carefully. Spend some time looking up any technical terms or phrases you do not understand. You are **not** required to research further the particular topic described in part 3, although you might find it helpful to try out the measurement ideas described in part 2.
- For the examination on Wednesday 5 June 2013 you will be given a fresh copy of this article, together with a question paper. You will not be able to take your original copy into the examination with you.
- The values of standard physical constants will be given in the Advancing Physics Data, Formulae and Relationships booklet. Any additional data required are given in the appropriate question.

INFORMATION FOR CANDIDATES

- Questions in Section C of paper G492/01 (Understanding Processes, Experimentation and Data Handling) will refer to this Advance Notice material and may give additional data related to it.
- Section C will be worth about 40 marks.
- Sections A and B of paper G492/01 will be worth about 60 marks, and will examine the *Understanding Processes* section of the specification.
- There will be 2 marks for quality of written communication (QWC) assessed in Sections B and C.
- This document consists of **4** pages. Any blank pages are indicated.

1 Simple measurements using a temperature sensor

The data displayed in Fig. 1 shows the variation of p.d. V with celsius temperature θ obtained using two different temperature sensors **A** and **B**.

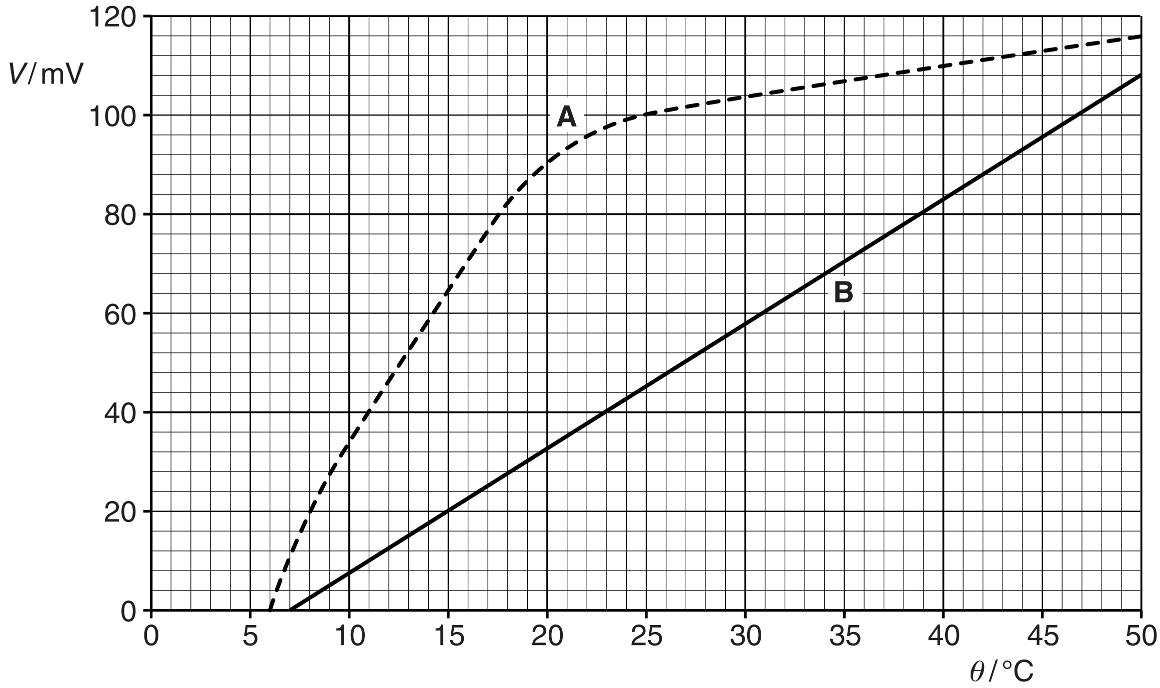


Fig. 1

The choice of a sensor for a given application depends on the following factors: range, resolution and sensitivity.

2 Trolley down a ramp

You may wish to try out these ideas in the laboratory so that you know in advance what the difficulties might be, how the experiment works and how the data can be used.

A trolley released from rest accelerates down a ramp. Its final velocity v is measured at a light gate. The simple arrangement of Fig. 2 can be used to carry out the practical task.

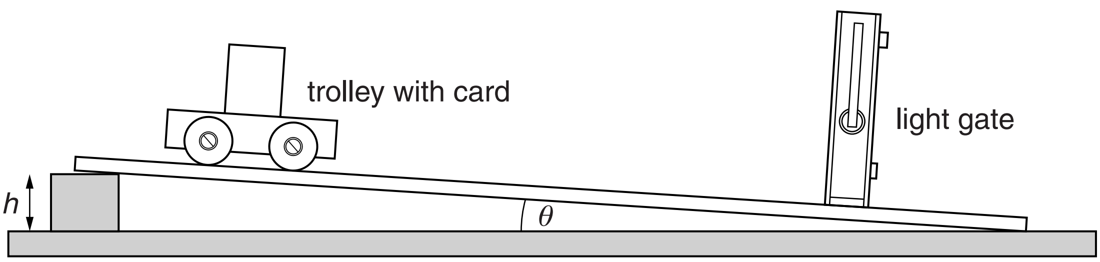


Fig. 2

The height h of the ramp can be raised to alter the angle θ of the ramp with respect to the horizontal.

The equation $v^2 = u^2 + 2as$ can be applied to the situation and used to determine a value for g, the acceleration due to gravity.

Factors that impact on the experiment and the consequent calculation of a value for g should all be considered. These could include friction on the trolley, energy loss, precision of the velocity measurement and measurement of the angle θ.

3 Measuring the speed of light

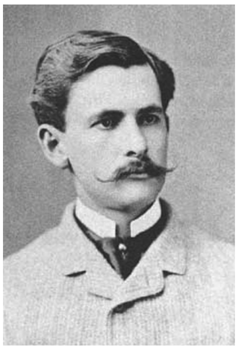
(Additional research is not required to answer the questions. **Do not try the 21st Century method described below except under supervision.**)

The modern value of the speed of light is, by definition, 299 792 458 m s^{-1}.

16th Century

Galileo attempted to measure the speed of light. He proposed to have two men with lanterns stationed about a mile apart. One man was to uncover his lantern, and the second was to uncover the other lantern as soon as he saw the light from the first one. The first man would then attempt to detect any delay in the light returning to him. Of course, there was a delay due simply to the human reaction times involved, and no increase due to the travel time of the light could be detected, so the conclusion could only be that light travels at a speed larger than a certain minimum.

19th Century



In the late 1870s the young US Naval Officer Albert Michelson realised that he could use modern Naval equipment to redesign and greatly improve the measurement of the speed of light, using light reflected out from and back to a rapidly rotating mirror, as previously done in 1850 by Foucault.

His published result of 299 910 ± 50 km s^{-1}, being many times more precise than the previous measurements, was featured in the New York Times in 1879 and made Michelson famous while still in his twenties. For the first time it became necessary to include a correction (adding about 60 km s^{-1}) to the measured speed of light in air to find the larger speed of light in a vacuum.

21st Century

Later measurements of the speed of light have used interference of microwaves. It is possible to make an estimate of the speed of light using a bar of chocolate and a microwave oven. A chocolate bar placed in a microwave for a few seconds, with the turntable removed, will develop 'hotspots'. A hotspot is where the chocolate starts to melt, or is more melted than the rest of the chocolate. Making the assumption that a standing wave is established in the microwave oven, and that this is responsible for the hotspots, then the distance between adjacent hotspots is a half-wavelength of the waves being emitted in the microwave oven. Knowing the frequency of the microwaves, typically 2.45 GHz, and using $v = f\lambda$ it is possible to estimate the speed of light to a reasonable accuracy, taking into consideration the uncertainty of approximately 1 cm in measuring the distance between hotspots.

END OF ARTICLE