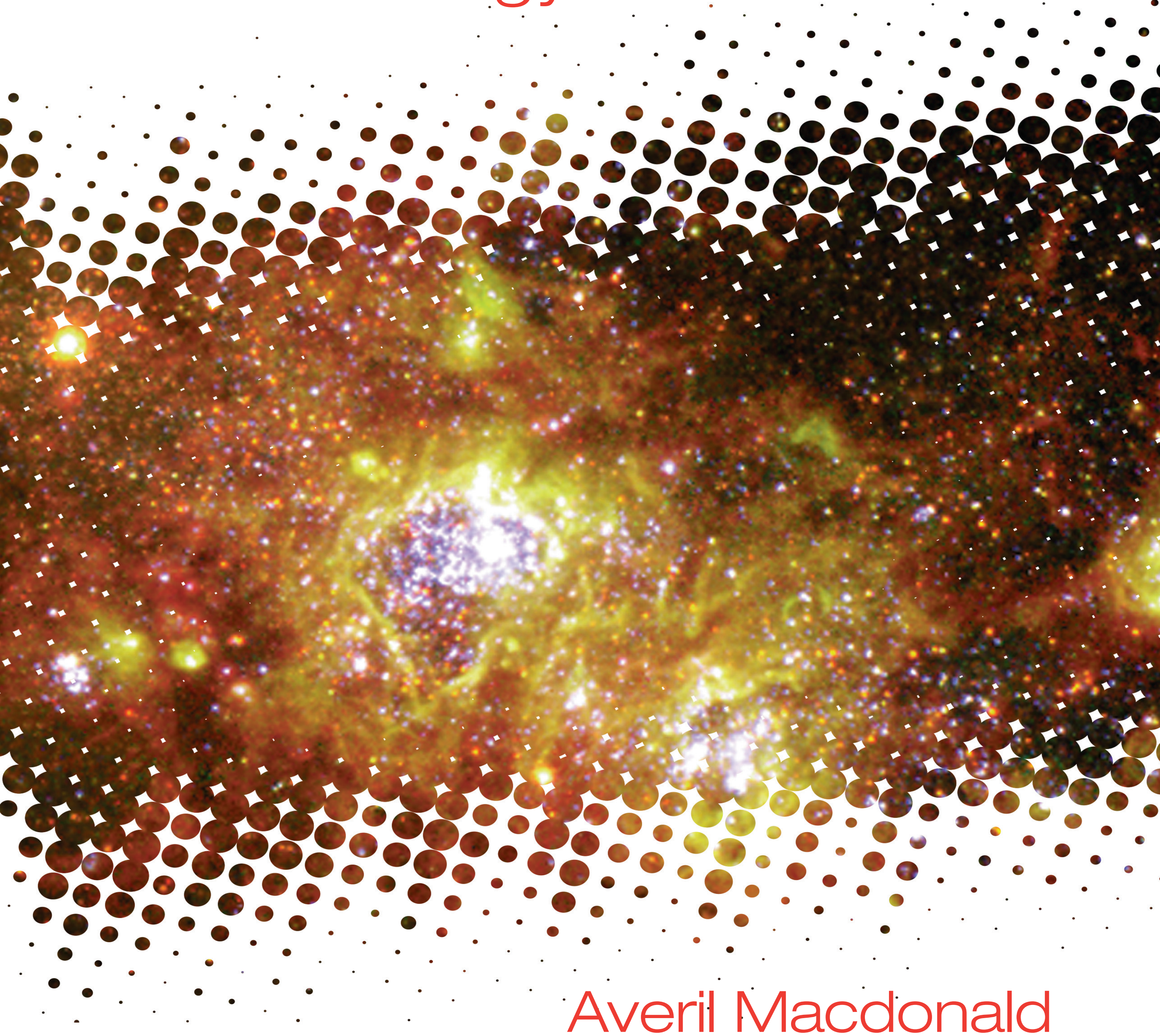
Physics through Hydrogen

Clean Energy for the Future



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Contents

Part 1

Experimental sessions

These sessions cover a range of topics from post-16 Physics syllabuses addressed within the context of sustainable energy supplies.

Using this section:

The Student Guides. Students are guided in planning, undertaking and evaluating the experiment. Preparatory and follow-up questions ensure that the experimental work has a firm theoretical basis and is set in a real-life context. The students develop experimental skills of circuit design and assembly as well as laboratory, IT, data analysis and report writing skills. The guides may be photocopied for student use.

The Teacher Guides offer specific information regarding the learning objectives of each experiment, details of the experimental set-up and the anticipated learning outcomes. There is also a full explanation of the underpinning theory and how to interpret the data. If students require additional support when undertaking their investigation then photocopied sub-sections of the teacher guides may be offered at the teacher's discretion, for example to prompt students or specify precisely the circuit design or how the experiment might be done.

Key physics syllabus requirements targeted:

- DC electricity – characteristic curves for non-ohmic devices
- Power supplies in series and parallel
- Power transfer in a circuit
- Efficiency
- The inverse square law
- Current as flow of charge carriers

Key experimental skills developed:

- Designing circuits and planning experimental strategies
- Use of preliminary work to decide what to measure and the appropriate techniques to use
- Manipulation of circuits to optimise outputs
- Data analysis and interpretation, including use of ICT
- Evaluation of experimental techniques and quality of results

Contents:

Students investigate the effect of loading an illuminated solar cell by varying the load resistor and monitoring the current and voltage output with constant illumination. They observe that the current remains constant over a range of output voltages up to a limit – the Maximum Power Point. Introduces idea of electrical efficiency. Extension work on the operation of a solar cell is included.

Students investigate the behaviour of a solar cell under dark conditions (i.e. acting as a diode). This enables students to practise setting up a simple circuit, monitoring the variation of current with applied voltage across a load (diode). Extension work considers use of by-pass diodes.

An ideal revision of characteristic curves – students investigate the effect of putting a range of voltages across the electrolyser and observe the resulting current values. **C**

Note: Certain experiments marked **C** also appear in the Chemistry book '*Chemistry through Hydrogen – Clean Energy for the Future*'.

Investigating photocurrent as a function of **light source distance**

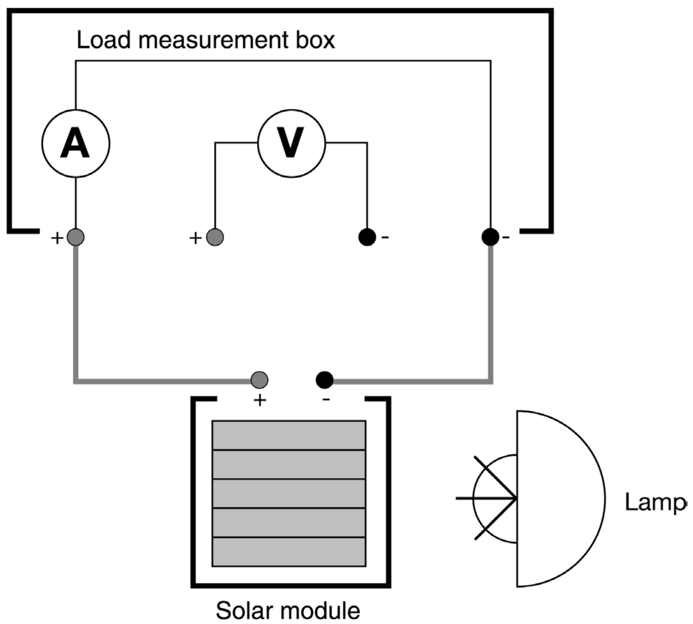
Apparatus required:

- Solar module
- Load measurement box
- Connecting leads

Additional components:

- Lamp 100 – 150 Watt
- Ruler

Fig. 1



Safety: Please follow the operating instructions.
Solar module becomes hot.
A full risk analysis must be undertaken before beginning any experiment.

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Instructions

1. Set up the apparatus as shown in fig. 1. Set the rotary switch of the load measurement box to 'SHORT CIRCUIT'.
2. Position the solar module and illuminate it well with the lamp (to reach a current of approx. 150 mA). The distance between the lamp and the solar module is normally about 50 cm in this case.
3. Adjust the distance d between the lamp and the solar module and measure the photocurrent at different distances (in 10 cm steps between 50 and 150 cm).

Evaluation

1. Draw the I–d– and I–$1/d^2$–diagram.
2. What are the functional relations and what effects do they have on practical applications?

Table of measurements

Distance/cm	Current/mA

Learning objectives:

- **that the photocurrent varies with intensity of illumination**
- **that the photocurrent follows an inverse square relationship with distance between lamp and solar module**

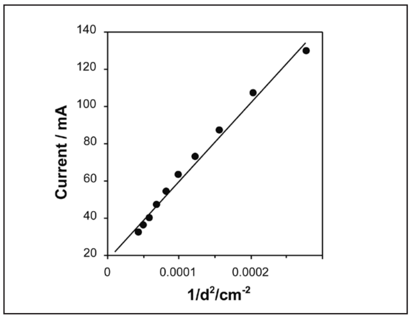
Interpretation

The power output of solar modules and/or solar generators is directly determined by the irradiation conditions. A solar module or solar generator cannot compensate for fluctuations in the supply of radiation.

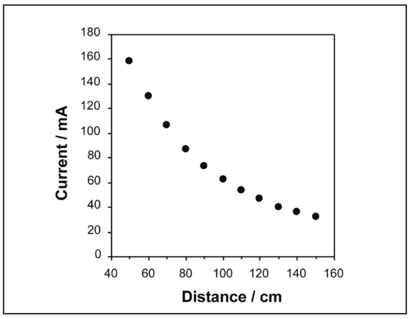
The experiment shows that the photocurrent of the solar module decreases in proportion to the increasing distance of the light source. Depending on the type of lamp used, the decline in the current follows the law of radiation from a certain distance.

The photocurrent of the solar module is inversely proportional to the square of the distance of the light source ($I \propto 1/d^2$).

This functional relation corresponds to the laws of radiation in physics, which are connected to the theory of the diffusion of light.



Photocurrent as a function of $1/d^2$ from the light source



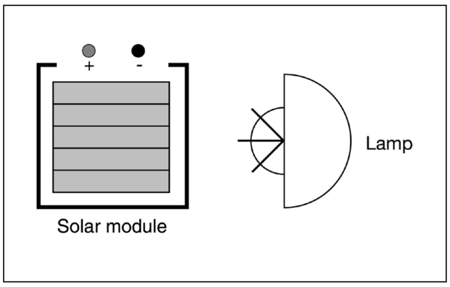
Photocurrent as a function of distance

Investigating how solar cell photocurrent varies with **distance to light source**

Apparatus required:	Additional components:
• Solar module • Load measurement box • Connecting leads	• Lamp 100 – 150 Watt • Ruler

Safety: Please follow the operating instructions.
Solar module becomes hot
A full risk analysis must be undertaken before beginning any experiment.

Introduction



A solar cell is a specially designed semiconductor diode which generates an e.m.f. when exposed to light. The solar cell absorbs light energy and converts it to electrical energy so the amount of light falling on the solar cell will affect the current output.
A solar module is a number of solar cells connected in series.

Objectives

To investigate how the behaviour of a solar cell varies with the amount of light falling on it, e.g. due to changing the distance between the module and the light source.

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Preparatory work

Answer these questions before you begin any experimental work.

1. Devise and draw a circuit which allows you to measure the current output from the solar module when illuminated.
2. Outline what you plan to do to vary the amount of light falling on the solar module and, therefore, to obtain appropriate data.

Procedure

- Construct your circuit and check that the apparatus gives readings over a suitable range.
- Vary the amount of light falling on the solar module and measure the corresponding current output. Ensure that there is no load resistor across the solar module.

Hint: Wait until the solar module has reached a stable temperature before beginning the experiment.

Product

1. Draw the circuit diagram and explain the experimental technique used to acquire the data.
2. Devise and complete a suitable results table to record your data, either on paper or on a computer spreadsheet.
3. Plot the data for current output against distance.
4. Comment on the shape of the curve.
5. There is an 'inverse square law' relationship between light intensity and separation distance. Use your data to find out whether the inverse square law holds for the relationship between photocurrent and light source distance.
6. Comment on any problems you encountered during the experiment, any precautions taken to ensure accuracy and any changes you made to your original plan.
7. Finally evaluate the experimental technique you used and suggest any further improvements for the experiment.

Question

- Why is life on earth possible but not on other planets of the solar system?
  (Hint: consider the radiation emitted from the sun and the respective distances of the planets).