2 In this experiment, you will investigate the resistance of a light-dependent resistor (LDR) using the light from a light-emitting diode (LED).

(a) (i) • Using the LED, set up the circuit shown in Fig. 2.1.

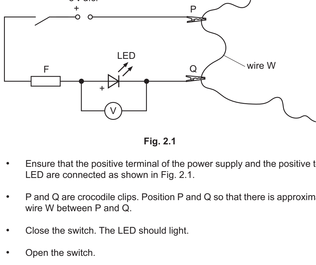

Fig. 2.1

- Ensure that the positive terminal of the power supply and the positive terminal of the LED are connected as shown in Fig. 2.1.
- P and Q are crocodile clips. Position P and Q so that there is approximately 10 cm of wire W between P and Q.
- Close the switch. The LED should light.
- Open the switch.
- Using the LDR and ohmmeter, set up a second circuit as shown in Fig. 2.2.

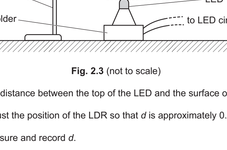

Fig. 2.2

- Arrange the apparatus as shown in Fig. 2.3.

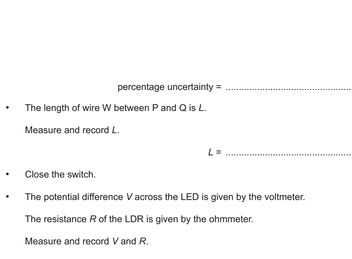

Fig. 2.3 (not to scale)

- The distance between the top of the LED and the surface of the LDR is *d*.

  Adjust the position of the LDR so that *d* is approximately 0.03 m.

- Measure and record *d*.

d = ... m [2]

(ii) Estimate the percentage uncertainty in your value of *d*. Show your working.

percentage uncertainty = ...% [1]

(b) • The length of wire W between P and Q is *L*.

Measure and record *L*.

L = ...

- Close the switch.
- The potential difference *V* across the LED is given by the voltmeter.

The resistance *R* of the LDR is given by the ohmmeter.

Measure and record *V* and *R*.

V = ...

R = ...

- Open the switch.

[2]

(c) • Change the length of wire W between P and Q so that *L* is approximately 90 cm.

- Repeat **(b)**.

L = ...

V = ...

R = ...

[3]

(d) It is suggested that the relationship between *V*, *d* and *R* is

$$V = \frac{Zd}{R} + k$$

where *Z* has the value $1.00 \times 10^3\,\text{V}\,\Omega\,\text{m}^{-1}$ and *k* is a constant.

(i) Using your data, calculate **two** values of *k*.

first value of *k* = ...

second value of *k* = ...

[1]

(ii) Justify the number of significant figures that you have given for your values of *k*.

.....

.....

..... [1]

(e) It is suggested that the percentage uncertainty in the values of *k* is 5%.

Using this uncertainty, explain whether your results support the relationship in **(d)**.

.....

.....

.....

..... [1]

(f) It is suggested that

$$k = \frac{hc}{e\lambda}$$

where h is 6.63×10^{-34} J s,
c is $3.00 \times 10^8\,\text{m}\,\text{s}^{-1}$,
e is 1.60×10^{-19} C and
λ is the wavelength of the light emitted by the LED.

Use your second value of *k* to determine λ.

λ = ... m [1]

(g) (i) Describe **four** sources of uncertainty or limitations of the procedure for this experiment.

For any uncertainties in measurement that you describe, you should state the quantity being measured and a reason for the uncertainty.

1 .....

.....

2 .....

.....

3 .....

.....

4 .....

..... [4]

(ii) Describe **four** improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

1 .....

.....

2 .....

.....

3 .....

.....

4 .....

..... [4]

[Total: 20]