Mark schemes

1 (a) 2.9% ✓

Allow 3%

1

(b) $\frac{1}{3.5\times10^{3}}$ seen ✓

1

0.29 mm or 2.9 x 10^{-4} m✓ must see 2 sf **only**

1

(c) ± 0.01 mm ✓

1

(d) Clear indication that at least 10 spaces have been measured to give a spacing = 5.24 mm✓

spacing from at least 10 spaces
Allow answer within range ±0.05

1

(e) Substitution in $d\,sin\theta = n\lambda$✓

The 25 spaces could appear here as n with sin θ as 0.135 / 2.5

1

d = 0.300 x 10^{-3} m so
number of lines = 3.34 x10^{3}✓

Condone error in powers of 10 in substitution
Allow ecf from 1-4 value of spacing

1

(f) Calculates % difference (4.6%) ✓

1

and makes judgement concerning agreement ✓

Allow ecf from 1-5 value

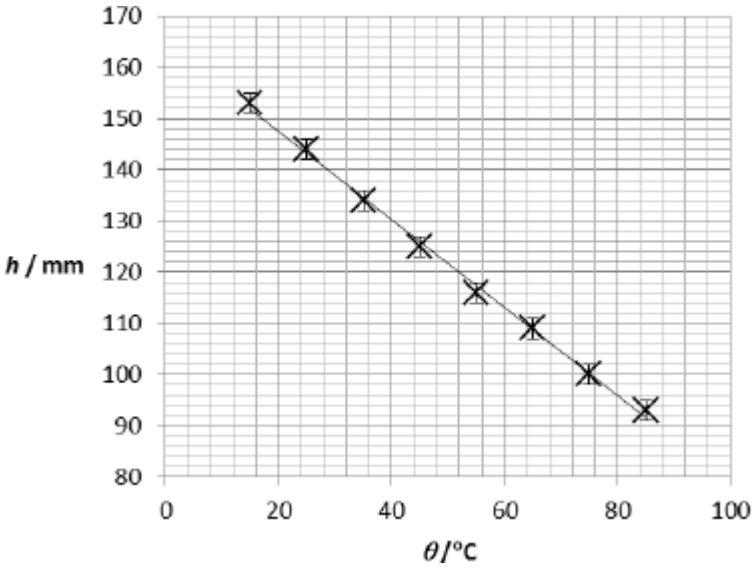
1

(g) care not to look directly into the laser beam✓
OR
care to avoid possibility of reflected laser beam ✓
OR
warning signs that laser is in use outside the laboratory✓
ANY ONE

1

[10]

2 (a) Straight line of best fit passing through all error bars ✓



Look for reasonable distribution of points on either side

1

(b) h_0 = 165 ± 2 mm✓

1

(c) Clear attempt to determine gradient ✓

1

Correct readoffs (within ½ square) for points **on line** more than 6 cm apart and correct substitution into gradient equation ✓

1

h_0k gradient =(-) 0.862 mm K^{-1} and
negative sign quoted ✓

Condone negative sign
Accept range -0.95 to -0.85

1

(d) $k = \frac{\text{candidate value for } h_0k}{\text{candidate value for } h_0}$

= 5.2 x 10^{-3} ✓

Allow ecf from candidate values

1

K^{-1} ✓

Accept range 0.0055 to 0.0049

1

(e) for h = 8000 mm, $d^{-1} = \frac{8000}{14.5}$ ✓

1

d = 1.8 x 10^{-3} mm ✓

1

(f) Little confidence in this answer because

One of

It is too far to take extrapolation ✓

OR

This is a very small diameter ✓

1

[10]

3

(a) Capacitor must not lose charge through the meter ✓

1

(b) Position on scale can be marked / easier to read quickly etc ✓

1

(c) Initial current = $\frac{6}{100000}$ = 60.0 μA ✓

100 μA or 200 μA ✓ (250 probably gives too low a reading)

Give max 1 mark if 65 μA (from 2.6) used and 100 μA meter chosen

2

(d) 0.05 V ✓

1

(e) Total charge = 6.0 x 680 x 10^{-6} (C) (= 4.08 mC) ✓

Time = 4.08 x 10^{-3} / 60.0 x 10^{-6} = 68 s ✓

Hence 6 readings ✓

3

(f) Recognition that total charge = 65 t μC and final pd = 0.098 t

so C = 65μ / 0.098✓

660 μF ✓

Allow 663 μF

2

(g) (yes) because it could lie within 646 – 714 to be in tolerance ✓

OR

it is 97.5 % of quoted value which is within 5% ✓

1

(h) Suitable circuit drawn ✓

Charge C then discharge through R and record V or I at 5 or 10 s intervals ✓

Plot ln V or ln I versus time ✓

gradient is 1 / RC ✓

OR

Suitable circuit drawn ✓

Charge C then discharge through R and record V or I at 5 or 10 s intervals✓

Use V or I versus time data to deduce half-time to discharge ✓

1 / RC = ln 2 / $t_{½}$ quoted ✓

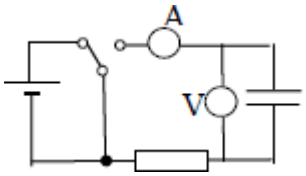
OR

Suitable circuit drawn ✓

Charge C then discharge through R and record V or I at 5 or 10 s intervals ✓

Plot V or I against t and find time T for V or I to fall to 0.37 of initial value ✓

$T = CR$ ✓



Either A or V required

For 2nd mark, credit use of datalogger for recording V or I.

4

[15]

4 (a) (i) Voltmeter across terminals with nothing else connected to battery / no additional load. ✓

1

(ii) This will give zero / virtually no current ✓

1

(b) (i) $\frac{VI}{\varepsilon I}$

Answer must clearly show power: εI and VI, with I cancelling out to give formula stated in the question ✓

1

(ii) Voltmeter connected across cell terminals ✓

Switch open, voltmeter records ε
Switch closed, voltmeter records V
Both statements required for mark ✓

Candidates who put the voltmeter in the wrong place can still achieve the second mark providing they give a detailed description which makes it clear that:

To measure emf, the voltmeter should be placed across the cell with the external resistor disconnected

And

To measure V, the voltmeter should be connected across the external resistor when a current is being supplied by the cell

2

(c) Vary external resistor and measure new value of V, for at least 7 different values of external resistor ✓

Precautions - switch off between readings / take repeat readings (to check that emf or internal resistance not changed significantly) ✓

2

(d) Efficiency increases as external resistance increases ✓

Explanation
Efficiency = Power in R / total power generated
$I^2R / I^2(R + r) = R / (R + r)$
So as R increases the ratio becomes larger or ratio of power in load to power in internal resistance increases ✓

Explanation in terms of V and ε is acceptable

2

[9]

5 (a) Peak power = 107 / 108 mW and load resistance = 290 / 310 Ω ✓

1

Use of power = I^2R with candidate values✓

1

0.0186 – 0.0193 A ✓

1

(b) Area of cell = 36 x 10^{-4} m^2 and solar power arriving = 730 × (an area)✓

1

$\frac{0.108}{2.63}$ seen✓

1

0.041 (correct answer only; lose if ratio given unit) ✓

1

(c) energy of one photon = $\frac{hc}{\lambda}$ = 4.0 ×10^{-19}J✓

1

Number of photons = $\frac{730 \times 36 \times 10^{-4}}{4.0 \times 10^{-19}}$ = 6.6 × 10^{18} s^{-1}✓

1

(d) **Two** from

Intensity of the sun at the Earth's surface
Average position of the sun
Efficiency of the panel
Power output of 1 panel
Weather conditions at the installation=
✓✓

Allow other valid physics answers=

2

[10]

Examiner reports

4

(a) (i) Students had to make it clear that the voltmeter ‘alone’ should be connected across the cell.

(ii) A correct explanation was given by a large proportion of students.

(b) (i) Answered well by the more able students.

(ii) A proportion of students seemed to understand how to use the voltmeter but failed to show the correct position on the circuit diagram.

(c) This question discriminated well. Many students failed to give sufficient detail as required by the mark scheme for the first marking point. The second marking point proved to be more accessible, with a greater proportion of students able to suggest an appropriate precaution.

(d) As anticipated this proved to be very demanding, with only the more able students successfully stating and explaining why efficiency would increase as external resistance increases.