M1.(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

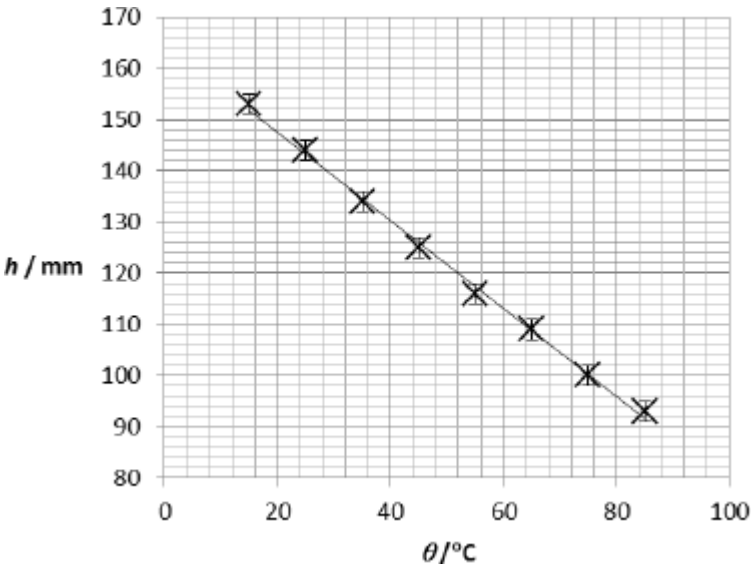
warning signs that laser is in use outside the laboratory✓

ANY ONE

1

[10]

M2.(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]

M3.(a) 6.5 × 10^{10} Pa ✓

1

(b) $kg\ m^{-1}\ s^{-2}$ ✓

1

(c) Direction of movement of particles in transverse wave perpendicular to energy propagation direction ✓

1

Parallel for longitudinal ✓

1

(d) $\rho_1 c_1 = \rho_2 c_2$ ✓

$E = \rho c^2$ or $\rho c = \frac{E}{c}$ seen

1

$\left[\frac{E_1}{c_1} = \frac{E_2}{c_2}\right]$

1

(e) $\left[\frac{\rho_x}{\rho_y} = \frac{c_y}{c_x}\right.$ and $c_x = 2c_y$]

0.5 ✓

1

(f) speed of the wave in seawater is less than speed of the wave in glass ✓

1

argument to show that $_{water}n_{glass}$

1

so tir could be observed when wave moves from water to glass ✓

1

[10]

M4.(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]

M5.C

[1]

M6.D

[1]

M7.D

[1]