

Name of the Student: _____

Max. Marks : 24 Marks

Time : 24 Minutes

Mark Schemes

Q1.

- (a) ray is incident along/at the normal owtte ✓
 Allow perpendicular/90° to the surface/block.
 Allow 'angle of incidence is 0°'.
 Reject 'towards the normal'. 1
- (b) correct use of Snell's law ✓
 21° ✓
 Expect to see $1.84 \sin 15 = 1.33 \sin \theta$
 Calculator value for θ is 20.9814° 2
- (c) (intensity increases because) total internal reflection occurs owtte ✓
 Reject 'more total internal reflection occurs'.
 'There is more reflection' is insufficient.
 idea that the lower intensity to left of **T** is due to partial reflection ✓
 MP2 must be in terms of reflected, not refracted, light.
 Allow answers in terms of x . 2
- (d) **T** will move to right **OR** x will increase ✓
 (because) critical angle will increase ✓
 MP1 requires some relevant justification
 e.g. ratio $\frac{n_2}{n_1}$ will be closer to 1. 2
- (e) uses $\tan \theta = \frac{69}{60}$ to calculate correct θ_c to 2 sf min ✓
 MP1: Calculator value for θ_c is 48.99091°
 uses $\sin \theta_c = \frac{n}{1.84}$ to determine refractive index ✓
 MP2: Allow ecf from MP1. Expect $n = 1.388$.
 uses their refractive index to at least 4 sf to obtain the concentration ✓
 MP3: Allow ecf from MP2. Expect 33.5%. 3

Q2.

(a) Uses

$$\sin c = \frac{1}{n}$$

to get 1.51 ✓

*Must see relevant work to award the mark.**Minimum 3 sf must be seen*

1

(b) (Each) angle of incidence is 45° (at 2nd and 3rd surfaces)

AND

total internal reflection occurs / which is greater than the critical angle. ✓

Angle of incidence as ray leaves block is 0°

OR

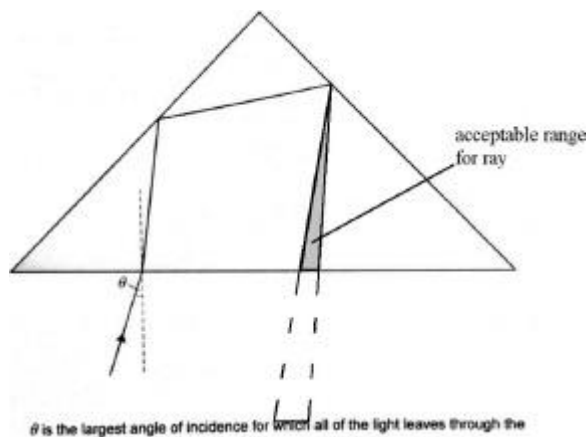
The ray leaves along the normal (and so the ray emerges parallel to the incident ray). ✓

2

(c) Only (totally internally) reflected ray seen at 2nd reflecting boundary ✓

Reflected ray parallel to first refracted ray (by eye) ✓

Ray leaves parallel to initial ray (by eye) ✓

For MP2:

3

(d) Angle of incidence at 2nd reflecting boundary = 41.5° ✓*MP1 is an identification of angle at 2nd reflecting boundary*Angle of reflection at 1st reflecting boundary = 48.5° ✓*MP2 is (90° - their angle at 2nd reflecting boundary)*Angle of refraction at entry = $(90^\circ - 45^\circ - 41.5^\circ) = 3.5^\circ$ ✓*MP3 is (45° - their angle at 2nd reflecting boundary)*Use of $n = 1.5$ and Snell's law to give 5.3° to at least 2 sf ✓

Accept answer that rounds to 5.3°

The identification of their angles can be inferred from their working or diagram. Simply writing $90^\circ - 41.5^\circ = 48.5^\circ$ does not get a mark on its own.

4

(e) Using 60° prism (Fig 3) does not work because:

- light would not leave the prism at the original angle ✓
- idea that light will escape from second reflection ✓

A smaller n (Fig 4) does not work because:

- larger critical angle ✓
- which would reduce the value of θ ✓

Suggestion that the design would work limits the mark to Max 1 for that design.

Alternative for MP2

Light would no longer be totally internally reflected at second reflection

OR

angle of incidence at second reflection is now less than the critical angle

4

[14]