Refraction and Total Internal Reflection 1

GCSE C C C A Level P P P

Essential Pre-Uni Physics D8.1

Data:

- Refractive index of crown glass: 1.51
- Refractive index of flint glass: 1.61
- Take the refractive index of air to be 1.00.

Complete the table to show the missing angles.

In some cases, refraction is impossible. In these cases give your answer as `TIR` (Total Internal Reflection).

Light passing from ...		**...to**	
Material	**Angle of incidence / °**	**Material**	**Angle of refraction / °**
Air	30	Crown glass	
Air	30	Flint glass	
Air	13	Flint glass	
Air		Crown glass	30

Refraction and Total Internal Reflection 2

GCSE C C C

A Level P P P

Essential Pre-Uni Physics D8.2

Data:

- Refractive index of crown glass: 1.51
- Refractive index of flint glass: 1.61
- Refractive index of water: 1.34
- Take the refractive index of air to be 1.00.

Complete the table to show the missing angles.

In some cases, refraction is impossible. In these cases give your answer as `TIR` (Total Internal Reflection).

Light passing from ...		...to	
Material	**Angle of incidence / °**	**Material**	**Angle of refraction / °**
Crown glass	50	Air	
Crown glass	40	Water	
Crown glass	50	Flint glass	

Gameboard:

STEM SMART Physics 13 - Refraction & Total Internal Reflection

Refraction and Total Internal Reflection 4

GCSE C C C A Level P P P

Essential Pre-Uni Physics D8.4

Data:

- Refractive index of crown glass: 1.51
- Refractive index of flint glass: 1.61
- Refractive index of water: 1.34
- Refractive index of cubic zirconia: 2.16
- Refractive index of diamond: 2.42
- Take the refractive index of air to be 1.00.

Complete the table to show the missing critical angles.

Boundary between		Critical angle / °
Water	Air	
Crown glass	Air	
Flint glass	Air	
Cubic zirconia	Air	
Diamond	Air	

Gameboard:

STEM SMART Physics 13 - Refraction & Total Internal Reflection

Refraction and Total Internal Reflection 6

GCSE C C C A Level P P P

Essential Pre-Uni Physics D8.6

Physical constants which may be necessary to answer the problems on this page can be found within the hint tabs.

Refractive index of crown glass: 1.51

Refractive index of flint glass: 1.61

Refractive index of water: 1.34

Refractive index of cubic zirconia: 2.16

Refractive index of diamond: 2.42

Take the refractive index of air to be 1.00.

Part A Flint glass

Calculate the speed of light in flint glass.

Part B Diamond

Calculate the speed of light in diamond.

Gameboard:
STEM SMART Physics 13 - Refraction & Total Internal Reflection

Calculating Critical Angles 8

GCSE P P P A Level P P P

Essential GCSE Physics 47.8

A tube of glass of refractive index 1.65 is surrounded by glass of refractive index 1.51.

Calculate the critical angle for light travelling along the tube and incident on the boundary between the glasses.

Gameboard:

STEM SMART Physics 13 - Refraction & Total Internal Reflection

Mirage

GCSE C C C
A Level C C C

A thin layer of calm air immediately above a hot, flat desert is at the same temperature as the desert ground beneath it. Above this layer the temperature of the air abruptly changes to a uniform cooler value. A person with eyes $h = 2.00\,\mathrm{m}$ above the ground has the impression that they are standing at the centre of a circular 'island' of sand, surrounded by a mirror-like surface, reminiscent of water.

Part A Refractive index of warm air

Calculate the refractive index for the warm air if the horizontal distance from the person to the rim of this 'island' is $L = 20.2\,\mathrm{m}$ and the refractive index of the cooler air is 1.05.

Part B Apparent radius

As the day progresses, the bottom layer of air heats up even more, changing the refractive index to 1.02, what is the new radius of the 'island'?

Adapted with permission from UCLES, A Level Physics, June 1967, Paper 2, Question 2

Gameboard:
STEM SMART Physics 13 - Refraction & Total Internal Reflection

Optical Dipstick

GCSE C C C
A Level C C C

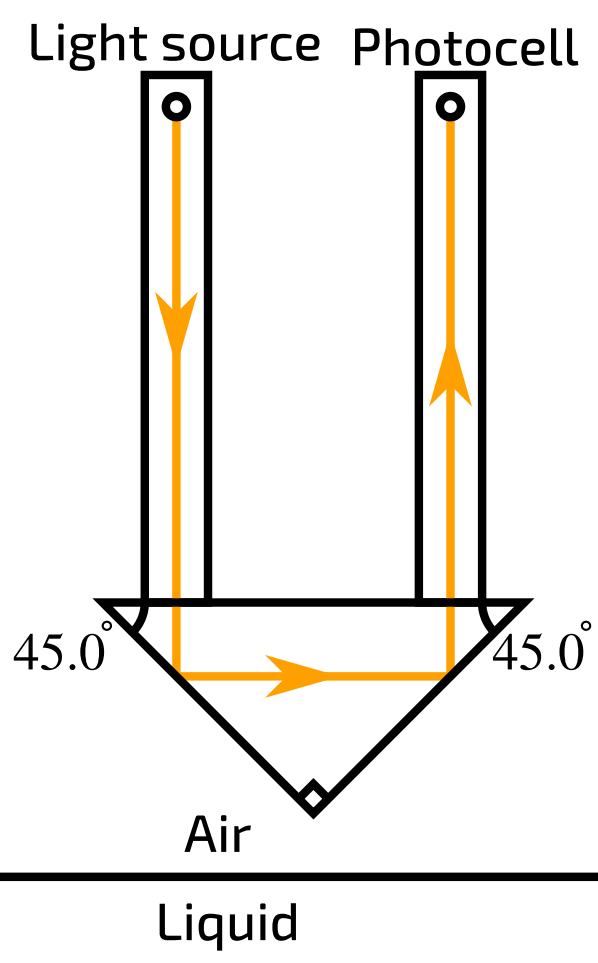

Figure 1: Optical dipstick

The figure shows an optical 'dip-stick' for automatic control of the depth of the liquids in tanks.

Part A Refractive index

If the search prism (drawn above) is in air, above the liquid surface, the light from the lamp is returned to the photocell with little loss as long as the refractive index of the prism exceeds a certain value n. Calculate n. Give your answer to 3 significant figures.

Part B Use as a dipstick

The refractive index of the prism is now $n_1 = 1.90$ and the prism is immersed in a liquid. The liquid is a solution where the concentration changes with depth so that the refractive index varies linearly with depth. The refractive index is 1.33 at the surface and 1.39 at a depth of $12.0\,\mathrm{cm}$. At what depth will the light no longer completely reach the photocell? Give your answer to 3 significant figures.

Adapted with permission from UCLES, A Level Physics, November 1973, Paper 1, Question 2