

- 1 (a) (i) light of a single wavelength / frequency ignore 'one colour' B1
- (ii) $n = \sin i / \sin r$ OR $1.52 = \sin 50 / \sin r$ OR $\sin r = \sin 50 / 1.52$ C1
 30.26° at least 2 s.f. A1
- (iii) ray closer to normal in block B1
ray parallel to incident ray emerging from block B1
- (b) (i) $n = v_A / v_G$ OR $n = 1.54 / v_G$ OR $v_G = 3 \times 10^8 / 1.54$ C1
 $1.948 \times 10^8 \text{ m/s}$
- (ii) ray with smaller angle of refraction than red in block i.e. violet ray under red ray B1
emerging ray parallel to incident ray B1 [9]
- 2 (a) incident ray correct at 59° B1 [1]
- (b) use of $n = \sin i / \sin r$ C1
 $(r = \sin^{-1}(\sin 59 / 1.33)) = 40.1^\circ$ condone no unit
only accept 40° if working shown e.g. $\sin 59 / 1.33$ A1 [2]
- (ii) ray from A to B AND angle of refraction = 40° B1 [1]
- (c) reflected ray at B, correct by eye B1 [1]
- (d) emerging ray refracted away from normal B1 [1]

- 3 (a) single frequency / wavelength IGNORE single colour / chromatic B1
- (b) $\sin i / \sin r$ OR $\sin 45 / \sin 26$ IGNORE $\sin r / \sin i$ C1
1.613 A1
- (c) 45° B1
- (d) less / slower / smaller B1
more / faster / greater B1 [6]
- 4 (a) single wavelength/frequency accept single colour B1
- (b) refraction B1
- (c) 29° unit needed B1
- (d) $n = \sin i / \sin r$ in any form OR $n = \sin r / \sin i$ in any form OR $\sin i / \sin r$ C1
 $\sin 45 / \sin 29$ OR $\sin 29 / \sin 45$ e.c.f.from (c) C1
- 1.458524649 to at least 2 sig figs c.a.o.
accept incorrect rounding of answer to more than 3 S.F.
e.g. do not accept 1.4 or 1.45 do accept 1.46 or 1.5 or 1.4 A1
- (e) (at B) greater than critical angle OR ray is totally internally reflected B1
less than critical angle at C B1
- (f) AB continued straight by eye, to RH glass surface, drawn with ruler B1
refracted up at RH surface C1
horizontal A1 [11]