EXAM PAPERS PRACTICE

Boost your performance and confidence with these topic-based exam questions

Practice questions created by actual examiners and assessment experts

Detailed mark scheme

Suitable for all boards

Designed to test your ability and thoroughly prepare you

Time allowed
82 Minutes

Score /69

Percentage %

Physics

Mark Scheme

AQA
AS & A LEVEL

2. Waves

1 (a)

property (of laser light)	explanation
monochromatic	waves of single frequency/wavelength
collimated	produces an approximately parallel beam
coherent	waves produced are in constant phase
polarised	vibrations in 1 plane only

two correct properties **(1)(1)**

each correct explanation **(1)(1)**
(if explanation contradicts property, no mark for explanation)

4

(b) (i) stepped graph: n = 1.5 A to B **(1)**

n lower and constant between 1.5 and 1.0 B to C **(1)**

n constant at 1.0: C to D **(1)**

(ii) $1.5 = \frac{\sin i}{\sin 10}$ **(1)** i = 15(.1)° **(1)**

(iii) light does not enter the cladding
so cannot pass across from one fibre to a neighbouring fibre **(1)**

fibres without cladding can allow light to pass between fibres when the surface of the fibre becomes scratched or moisture links two adjacent fibres optically **(1)**

personal data (such as bank account information) must be transmitted along fibres from which there is no danger of leakage of light resulting in a breach of security **(1)**

8

[12]

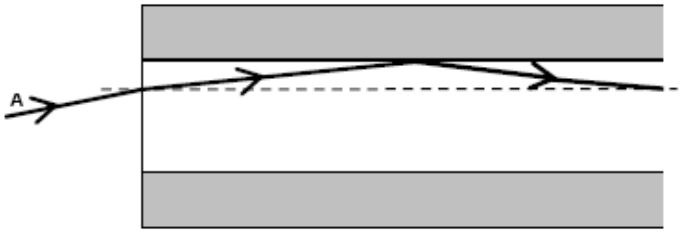
2 (a) decrease ✓

constant ✓

decrease ✓

3

(b)



straight ray (ignore arrow) reflecting to the right ✓

reflected angle = incident angle ✓

(accept correct angle labels if reflected angle is outside tolerance)

2

(c) (i) $(n = \frac{c}{c_s})$ use of 3 $(\times 10^8)$ ✓ $= \frac{300(\times 10^8)}{2.04(\times 10^8)}$ = 1.47 ✓ (1.4706)

(must see 3 sf or more)

2

(ii) $\sin \theta_c = \frac{1.45}{1.47(06)}$ or correct substitution in un-rearranged formula ✓

θ_c = 80.4 ✓ (80.401) (80.3 to 80.54) (≈ 80°) must see 3 sf or more

2

(d) angle of refraction = 180 – 90 – 80.4 = 9.6° ✓

$\sin\theta$ = 147(06) sin 9.6 ✓ = 0.25 ecf from first mark

θ = 14 (= 14.194°) ✓ ecf from first mark

range **13 to 15°** due to use of rounded values

3

(e) (reduced amplitude) due to absorption/energy loss
(within the fibre)/attenuation/scattering (by the medium)
/loss from fibre ✓

(pulse broadening caused by) multi-path (modal) dispersion
/different rays/modes propagating at different angles/non
a ial ray take longer time to travel ame di tance along fibre
as axial rays ✓

2

[14]

3 (a) (i) (using $n_1 \sin \theta_1 = n_2 \sin \theta_2$ or $\sin \theta_c = n_2/n_1$ gives)

correct substitution in either equation (eg $1.55 \sin c = 1.45 (\sin 90)$ or $\sin c = 1.45/1.55$) **(1)**

= 0.9355 (accept less sf) **(1)**
c = 69.3(°) **(1)** (accept 69.4°, 69° **or** 70°)

(ii) the angle (of incidence) is less than the **critical angle** or values quoted **(1)**

(iii) (using $n_1 \sin \theta_1 = n_2 \sin \theta_2$ gives)

$1.55 \sin 60 = 1.45 \sin \theta$ **(1)**

($\sin \theta = 1.55 \sin 60/1.45 =$) 0.9258 or 0.926 or 0.93 **(1)**

θ = 67.8° **(1)** (accept 68° **or** 68.4)

7

(b) any **two** from:

keeps signals secure **(1)**

maintains quality/reduces pulse broadening/smearing (owtte) **(1)**

it keeps (most) light rays in (the core due to total internal reflection at the cladding-core boundary) **(1)**

it prevents scratching **of the core (1)**

(keeps core away from adjacent fibre cores) so helps to prevent crossover of **information/signal/data** to **other** fibres **(1)**

cladding provides (tensile) strength for fibre/prevents breakage **(1)**

given that the core needs to be very thin **(1)**

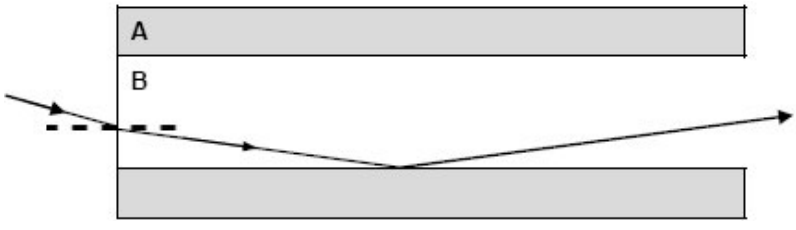
max 2

[9]

4 (a) (i) A: **cladding** + B: **core (1)**

1

(ii)



refraction towards the normal line **(1)**

continuous lines + strikes boundary + TIR correct angles by eye + maximum 2 TIRs **(1)**

2

(b) $\left(\sin\theta_c = \frac{n_2}{n_1}\right)$ or = 0.9865 **(1)**

80.6 or 80.8 or 81 (°) only **(1)**

2

(c) to reduce **multipath** or **multimode dispersion (1)**

(which would cause) light travelling at different angles to arrive at different times/pulse broadening/merging of adjacent pulses/'smearing'/ poor resolution/lower transmission rate/lower bandwidth/less distance between regenerators **(1)**

or to prevent light/data/signal loss (from core or fibre) **(1)**

(which would cause) signal to get weaker/attenuation/crossover/data to be less secure **(1)**

2

(d) correct application **(1)** (endoscope, cytoscope, arthroscope etc, communications etc)

linked significant benefit stated eg improve medical diagnosis/improve transmission of data/high speed internet **(1)**

2

[9]

5 (a) (i) cladding ✓

1

(ii) $\sin \theta_c = 1.41/1.46$ ✓

$\theta_c = 75.0$ (°) (74.96) ✓

2

(b) (i) 65 (degrees) ✓

1

(ii) 1.46 sin 65 = 1.41 sin r **or** sin r = 0.93845 ✓ ecf bi

r = 70 ✓ (degrees) (69.79) ecf bi

2

(c) Two from:

- less light is lost
- better quality signal / less distortion
- increased probability of TIR
- Less change of angle between each reflection
- reflects more times (in a given length of fibre) keeping (incident) angle large(r than critical angle)
- (angle of incidence is) less likely to fall below the critical angle
- less refraction out of the core
- improved data transfer / information / data / signal carried quicker
- less multipath dispersion (smearing / overlap of pulses)

✓ ✓

2

[8]

6 (a) reflects at correct angle by eye (use top of '27' and bottom of '42' as a guide) **or 27**° or **63**° correctly marked **(1)**

refracts away from normal at glass/air **(1)**

symmetrical by eye or refracted angle (42°) correctly marked and at least one normal line added **(1)**

3

(b) $(n_g) = \frac{\sin 42}{\sin 27}$ **(1)** DNA 42/27 = 1.56

= 1.47 (1.474) 3 sf shown **(1)**

2

(c) 63 (°) **(1)**

allow 62 to 62.99 ***with*** *reasoning, allow 'slightly less than 63' without reason given*

1

(d) $\left(\frac{n_l}{n_g} = \frac{\sin 63}{\sin 90}\right) n_l$ = 1.474 sin (c) **(1)** or use of n = 1.5

= 1.3(1) or 1.34 if n = 1.5 used **(1)**

2

[8]

7 (a) $\sin\theta = \frac{1.47 \sin 44}{1.33}$ or $1.33 \sin\theta = 1.47 \sin 44$ or $\sin^{-1} 0.768$ **(1)**

$\theta = 50.15, 50.2, 50.35$ (°) **(1)**

answer seen to > 2 sf

2

(b) refracts towards normal **(1)** 44° shown **(1)**

2

(c) (TIR) only when ray travels from higher *n* to lower *n* **or** (water to glass) is lower *n* to higher *n* **(1)**

do not allow 'density', allow 'optical density', n or refractive index only

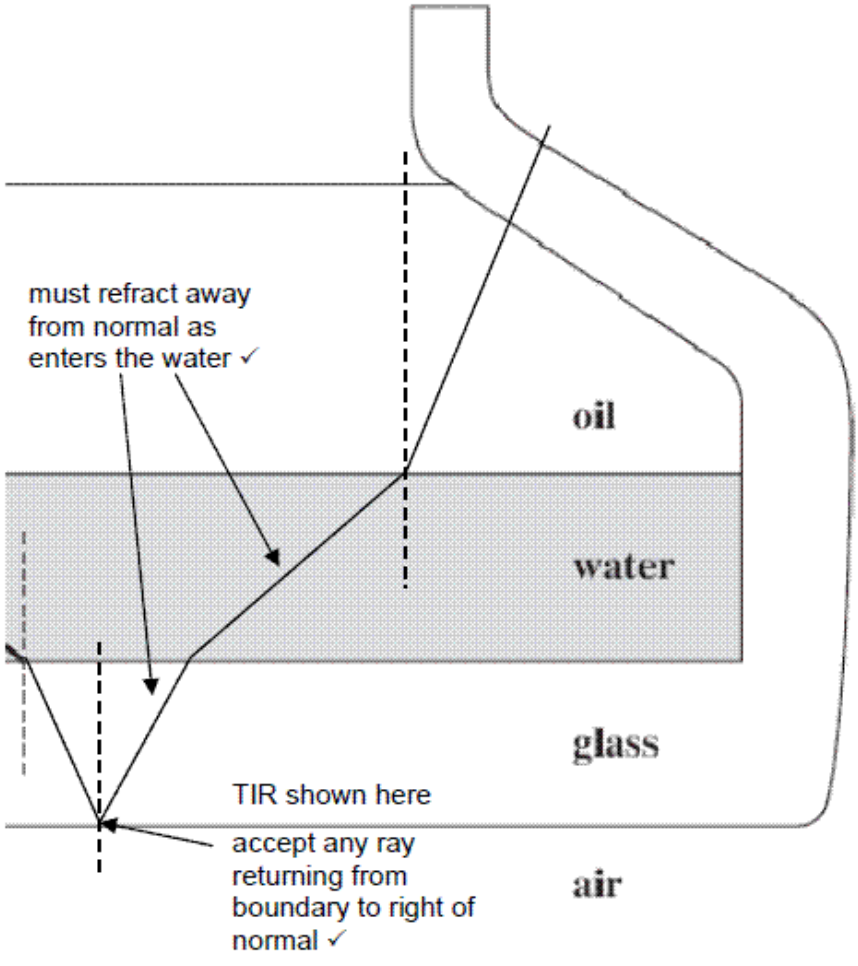
1

(d) $\sin\theta_c = \frac{1}{1.47}$ or $1.47 \sin\theta_c = (1 \times) \sin 90$ **(1)**

$\theta_c = 42.86$ (= 43.0(°)) **(1)**

2

(e)


must refract away from normal as enters the water ✓
oil
water
glass
TIR shown here
accept any ray returning from boundary to right of normal ✓
air

2

[9]