WJEC 2014 Online Exam Review

GCSE Physics Foundation 1322-01

All Candidates' performance across questions

Question Title	N	Mean	S D	Max Mark	F F	Attempt %
1	2822	6.2	2.4	9	68.7	99.8
2	2800	4.6	2.4	8	57	99
3	2811	6.4	2.4	9	71.1	99.4
4	2796	8.9	4.6	14	63.3	98.9
5	2807	6	2	8	74.6	99.3
6	2812	5.9	3.4	11	53.6	99.4
7	2809	6.8	3.2	12	56.8	99.3
8	2781	5.8	2.5	9	64.5	98.3

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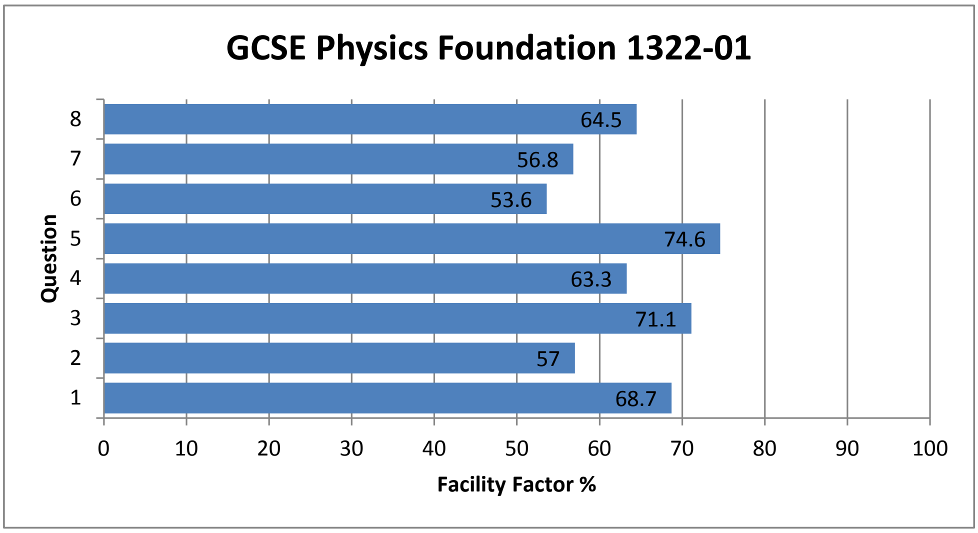
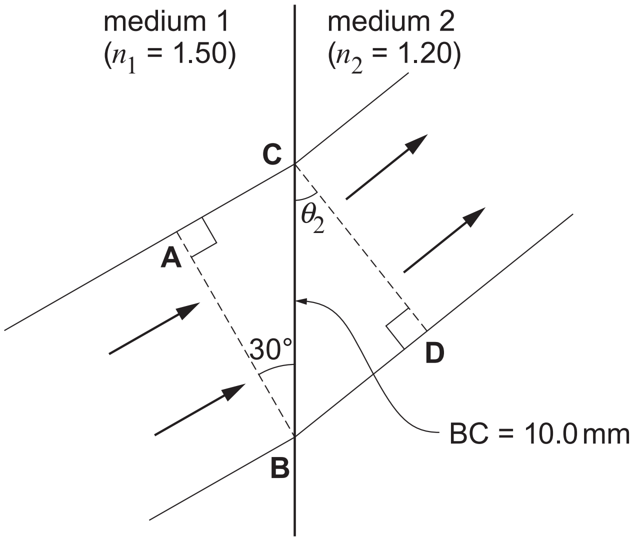


Examiner only

4. *(a)* A beam of light passes from medium 1, of refractive index n_1 = 1.50, into medium 2, of refractive index n_2 = 1.20.



(i) Calculate the speeds of light in the two media. [1]

medium 1 ....

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medium 2 ....

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(ii) Show clearly that the end, **A**, of wavefront **AB** will take 2.5×10^{-11} s to reach the boundary at **C**. [Note that distance BC = 10.0 mm.] [2]

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(iii) While **A** is travelling to **C**, the end, **B**, of wavefront **AB** travels to **D**, through medium **2**. Calculate the distance **BD** and hence the angle θ_2. [2]

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(iv) Check your value of θ_2 using a refraction equation involving n_1 and n_2. [2]

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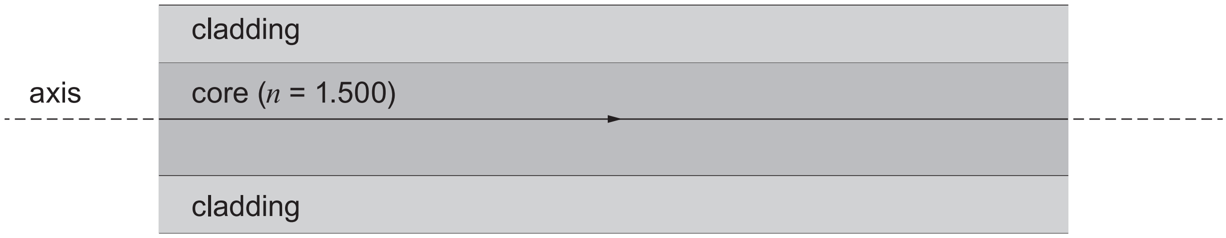
Examiner only

(b) A diagram of an optical fibre is given.



(i) Show clearly that a light pulse travelling along the axis of the fibre takes 8.0 μs to travel through 1.6 km of fibre. [2]

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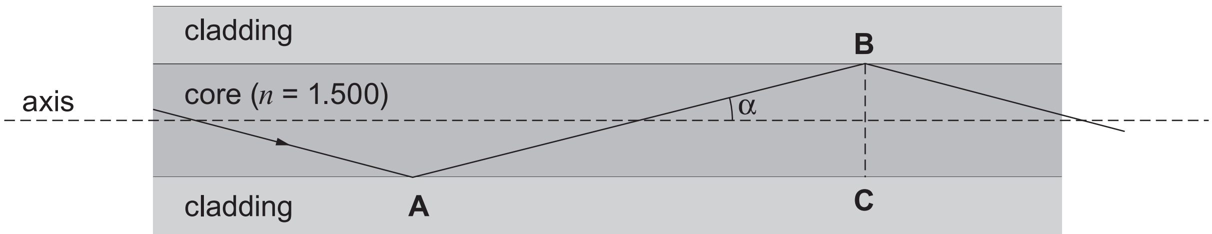
(ii) The greatest angle, α, **to the axis** at which light can travel through the core without escaping is 14°. Calculate the refractive index of the cladding. [3]



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(iii) Calculate the **difference** in times taken for a pulse to travel through 1.6 km of fibre by the routes in *(b)*(i) and *(b)*(ii). [2]

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Examiner only

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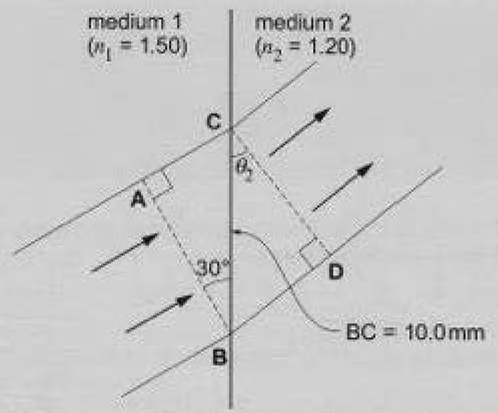

$n_1 V_1 = n_2 V_2$
$1(3\times10^8) = 1.5 V_2$
$\frac{3\times10^8}{1.5} = V_2 = 2\times10^8$

(i) Calculate the speeds of light in the two media. [1]

medium 1 ~~$n_1V_1 = n_2V_2$ $1.5 V_1 = 1.2(3\times10^8)$ $V_1 = \frac{1.2(3\times10^8)}{1.5} = 240\,000\,000$~~

200 000 000 ms^{-1}

$n_1 V_1 = n_2 V_2$
$1(3\times10^8) = 1.2 V_2$
$\frac{1(3\times10^8)}{1.2} = V_2 =$

medium 2 ~~$n_1V_1 = n_2V_2$ $1.5(3\times10^8) = 1.2V_2$ $\frac{1.5(3\times10^8)}{1.2} = V_2 = 375\,000\,000$~~

2.5×10^8 ms^{-1}

(ii) Show clearly that the end, **A**, of wavefront **AB** will take 2.5×10^{-11} s to reach the boundary at **C**. [Note that distance BC = 10.0 mm.] [2]

$\frac{10\times10^{-3}}{\sin 90} = \frac{AC}{\sin 30}$ $AC = \frac{10\times10^{-3}(\sin 30)}{\sin 90} = 5\times10^{-3}$

Speed = $\frac{\text{distance}}{\text{time}}$ time = $\frac{\text{distance}}{\text{speed}}$ time = $\frac{5\times10^{-3}}{2\times10^{8}} = 2.5\times10^{-11}$ s

(iii) While **A** is travelling to **C**, the end, **B**, of wavefront **AB** travels to **D**, through medium **2**. Calculate the distance **BD** and hence the angle θ_2. [2]

$n_1 \sin\theta_1 = n_2 \sin\theta_2$
$1.5 \sin 30 = 1.2 \sin\theta_2$
$\sin^{-1}\left(\frac{1.5\sin 30}{1.2}\right) = \theta_2$ $\theta_2 = 38.68°$

$\frac{BD}{\sin 38.68} = \frac{10\times10^{-3}}{1}$
$BD = 10\times10^{-3}(\sin 38.68)$
$= 6.25$ mm

(iv) Check your value of θ_2 using a refraction equation involving n_1 and n_2. [2]

$n_1 \sin\theta_1 = n_2 \sin\theta_2$
$1.5 \sin 30 = 1.2 \sin\theta_2$
$\sin^{-1}\left(\frac{1.5\sin 30}{1.2}\right) = \theta_2 = 38.68°$ bod

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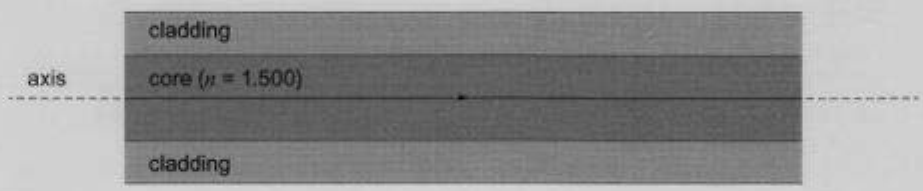
Examiner only

(b) A diagram of an optical fibre is given.

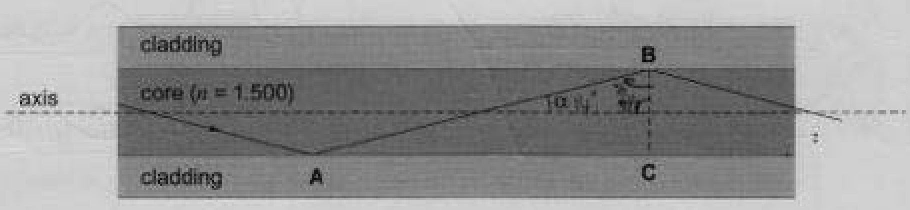


(i) Show clearly that a light pulse travelling along the axis of the fibre takes 8.0 μs to travel through 1.6 km of fibre. [2]

speed = distance / time   time = distance / speed

time = $\frac{1.6 \times 10^3}{2 \times 10^8}$ = 8×10^{-6} = 8 μs

(ii) The greatest angle, α, **to the axis** at which light can travel through the core without escaping is 14°. Calculate the refractive index of the cladding. [3]



$n_1 \sin\theta_1 = n_2 \sin\theta_2$

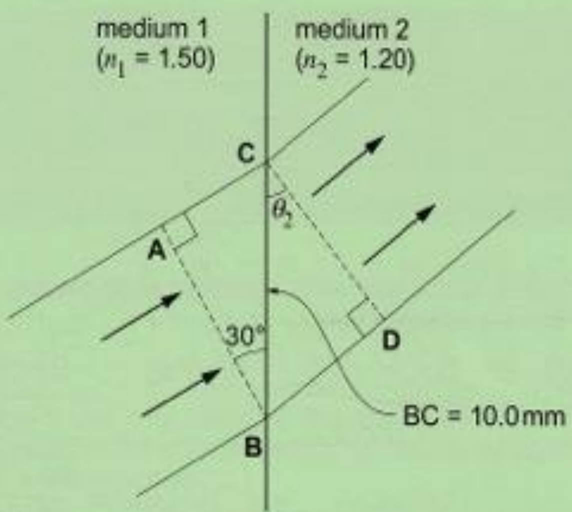
$1.5 \sin 90 = n_2 \sin 14$ ✗✗

$n_2 = \frac{1.5}{\sin 14}$ $n_2 \approx 6.2$

(iii) Calculate the **difference** in times taken for a pulse to travel through 1.6 km of fibre by the routes in *(b)*(i) and *(b)*(ii). [2]

4. *(a)* A beam of light passes from medium 1, of refractive index $n_1 = 1.50$, into medium 2, of refractive index $n_2 = 1.20$.

Examiner only



(i) Calculate the speeds of light in the two media. [1]

medium 1 ....

medium 2 ....

(ii) Show clearly that the end, **A**, of wavefront **AB** will take 2.5×10^{-11} s to reach the boundary at **C**. [Note that distance BC = 10.0 mm.] [2]

(iii) While **A** is travelling to **C**, the end, **B**, of wavefront **AB** travels to **D**, through medium **2**. Calculate the distance **BD** and hence the angle θ_2. [2]

(iv) Check your value of θ_2 using a refraction equation involving n_1 and n_2. [2]

Examiner only

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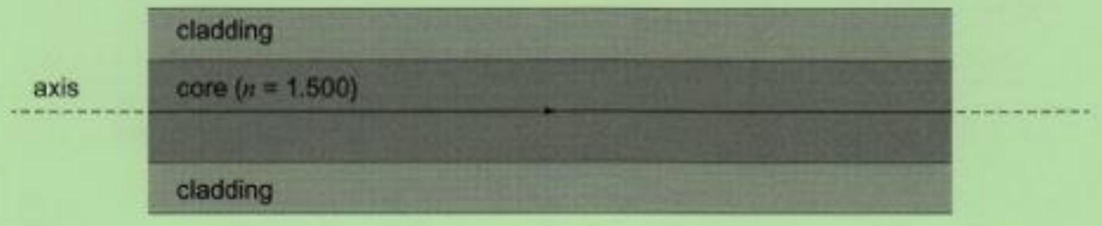

(i) Show clearly that a light pulse travelling along the axis of the fibre takes 8.0 μs to travel through 1.6 km of fibre. [2]

speed = distance / time   time = distance / speed

time = $\frac{1.6 \times 10^3}{2 \times 10^8}$ = 8×10^{-6} = 8 μs

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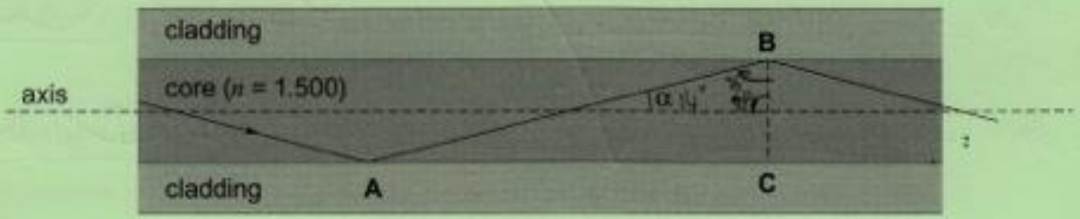
(ii) The greatest angle, α, **to the axis** at which light can travel through the core without escaping is 14°. Calculate the refractive index of the cladding. [3]



$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$1.5 \sin 90 = n_2 \sin 14$

$n_2 = \frac{1.5}{\sin 14}$ $n_2 \approx 6.2$

0

(iii) Calculate the **difference** in times taken for a pulse to travel through 1.6 km of fibre by the routes in *(b)*(i) and *(b)*(ii). [2]

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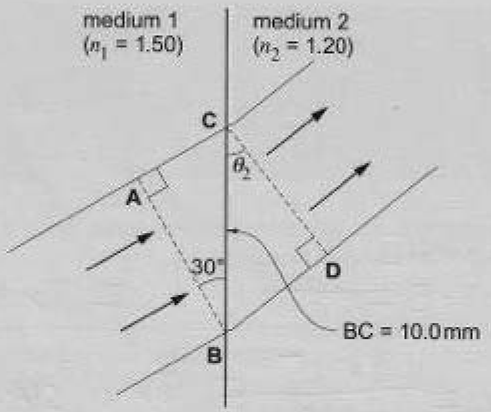
Examiner only

4. *(a)* A beam of light passes from medium 1, of refractive index n_1 = 1.50, into medium 2, of refractive index n_2 = 1.20.



(i) Calculate the speeds of light in the two media. [1]

medium 1 $1.50 = \frac{3\times10^8}{c}$ $c = 2\times10^8\ ms^{-1}$

medium 2 $1.20 = \frac{3\times10^8}{c}$ $c = 2.5\times10^8\ ms^{-1}$

(ii) Show clearly that the end, **A**, of wavefront **AB** will take 2.5×10^{-11} s to reach the boundary at **C**. [Note that distance BC = 10.0 mm.] [2]

$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$ $\frac{5\times10^{11}}{2} = 2.5\times10^{11}$?

$\text{Time} = \frac{10\times10^{-3}}{2\times10^{8}} = 5\times10^{11}$ s

(iii) While **A** is travelling to **C**, the end, **B**, of wavefront **AB** travels to **D**, through medium **2**. Calculate the distance **BD** and hence the angle θ_2. [2]

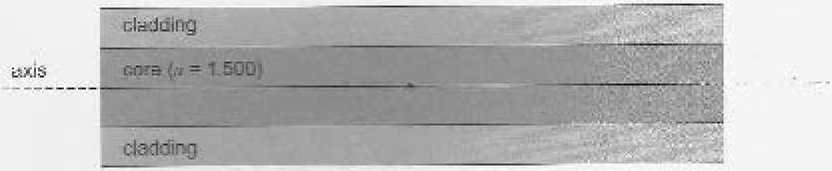
(iv) Check your value of θ_2 using a refraction equation involving n_1 and n_2. [2]

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$(1.50)(\sin 30) = (1.20)(\sin\theta_2)$
$\theta_2 = 38.7°$

Examiner only

(b) A diagram of an optical fibre is given.

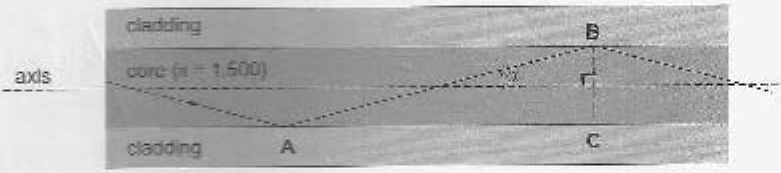


(i) Show clearly that a light pulse travelling along the axis of the fibre takes 8.0 μs to travel through 1.6 km of fibre. [2]

$1.5 = \frac{3\times10^8}{c}$ $c = 2\times10^8$ ms^{-1}

Time $= \frac{1.6\times10^3}{2\times10^8} = 8\times10^{-6}$ s $= 8.0$ μs

(ii) The greatest angle, α, **to the axis** at which light can travel through the core without escaping is 14°. Calculate the refractive index of the cladding. [3]



$n_1 \sin\theta_1 = n_2 \sin\theta_2$

~~$(1.5)(\sin 14) = n_2 \sin 90$~~ $n_2 = 1.550$

$(1.5)(\sin 90) = (n_2)(\sin 76)$

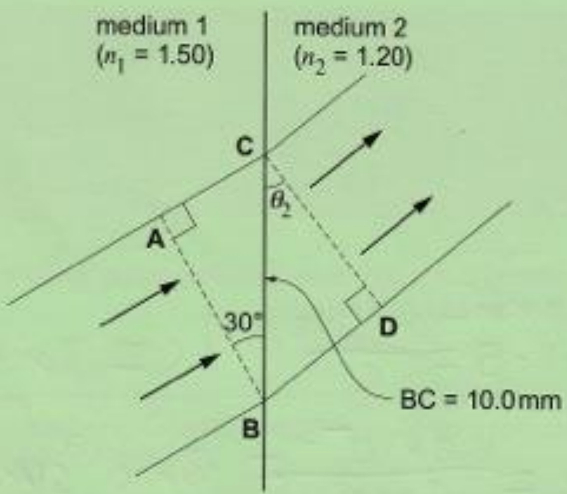
(iii) Calculate the **difference** in times taken for a pulse to travel through 1.6 km of fibre by the routes in (b)(i) and (b)(ii). [2]

Time $= \frac{1.6\times10^3}{1.94\times10^8} = 8.25$ μs

Difference $= 0.25$ μs

Examiner only

4. *(a)* A beam of light passes from medium 1, of refractive index n_1 = 1.50, into medium 2, of refractive index n_2 = 1.20.



(i) Calculate the speeds of light in the two media. [1]

medium 1 $1.50 = \frac{3 \times 10^8}{c}$ $c = 2 \times 10^8 \text{ ms}^{-1}$

medium 2 $1.20 = \frac{3 \times 10^8}{c}$ $c = 2.5 \times 10^8 \text{ ms}^{-1}$ ✓

(ii) Show clearly that the end, **A**, of wavefront **AB** will take 2.5 × 10⁻¹¹ s to reach the boundary at **C**. [Note that distance BC = 10.0mm.] [2]

$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$ $\frac{5 \times 10^{11}}{2} = 2.5 \times 10^{11}$?

$\text{Time} = \frac{10 \times 10^{-3}}{2 \times 10^8} = 5 \times 10^{11} \text{ s}$ ✗

(iii) While **A** is travelling to **C**, the end, **B**, of wavefront **AB** travels to **D**, through medium **2**. Calculate the distance **BD** and hence the angle θ_2. [2]

(iv) Check your value of θ_2 using a refraction equation involving n_1 and n_2. [2]

$n_1 \sin \theta_1 = n_2 \sin \theta_2$

$(1.50)(\sin 30) = (1.20)(\sin \theta_2)$

$\theta_2 = 38.7°$ ✓✓

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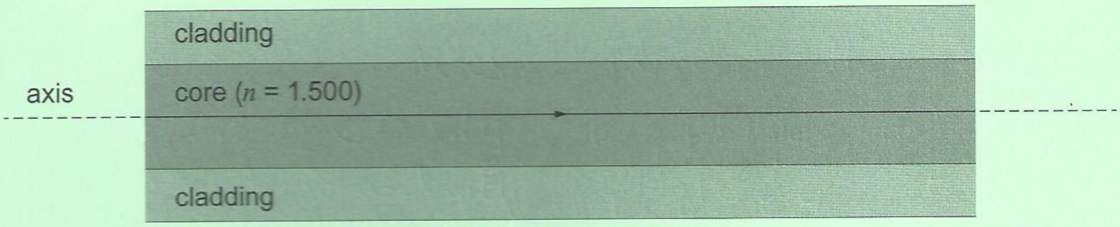
Examiner only

(b) A diagram of an optical fibre is given.



(i) Show clearly that a light pulse travelling along the axis of the fibre takes 8.0 μs to travel through 1.6 km of fibre. [2]

$1.5 = \frac{3\times10^8}{c}$ $c = 2\times10^8\ ms^{-1}$ ✓✓

$\text{Time} = \frac{1.6\times10^3}{2\times10^8} = 8\times10^{-6}\,s = 8.0\ \mu s$

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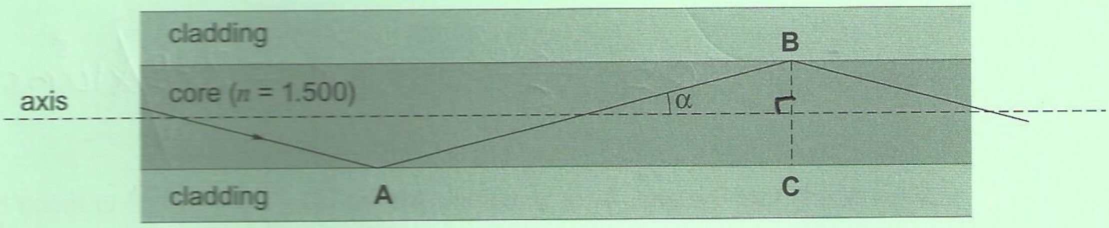
(ii) The greatest angle, α, **to the axis** at which light can travel through the core without escaping is 14°. Calculate the refractive index of the cladding. [3]



$n_1 \sin\theta_1 = n_2 \sin\theta_2$

~~$(1.5)(\sin 14) = n_2 \sin 90$~~ ✓ $n_2 = 1.550$ ✗

$(1.5)(\sin 90) = (n_2)(\sin 76)$ ✗

1

(iii) Calculate the **difference** in times taken for a pulse to travel through 1.6 km of fibre by the routes in *(b)*(i) and *(b)*(ii). [2]

$\text{Time} = \frac{1.6\times10^3}{1.94\times10^8} = 8.25\ \mu s$ ✓✓

Difference $= 0.25\ \mu s$

~~0~~ 2

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Examiner only

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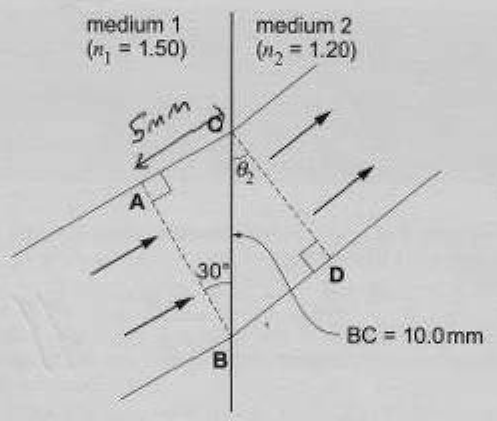
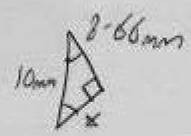




(i) Calculate the speeds of light in the two media. [1]

medium 1 $\frac{3\times10^8}{1\cdot5} = 2\times10^8\ ms^{-1}$

medium 2 $\frac{3\times10^8}{1\cdot2} = 2\cdot5\times10^8\ ms^{-1}$

(ii) Show clearly that the end, **A**, of wavefront **AB** will take 2.5×10^{-11} s to reach the boundary at **C**. [Note that distance BC = 10.0 mm.] [2]

$\frac{a}{\sin A} = \frac{b}{\sin B}$ $s = \frac{d}{t}$ $t = \frac{d}{s}$

$\frac{AQ}{\sin 30} = \frac{0\cdot01}{\sin 90}$ $t = \frac{0\cdot05}{2\times10^8}$

$AQ = 5\times10^{-3}m$
$= 5mm$

$t = 2\cdot5\times10^{-11}s$

(iii) While **A** is travelling to **C**, the end, **B**, of wavefront **AB** travels to **D**, through medium **2**. Calculate the distance **BD** and hence the angle θ_2. [2]

~~$a^2 = b^2 + c^2 + 2bc\cos A$~~
~~$a^2 = 10^2 + 75 + 2(18\cdot66)\cos 90$~~
~~$a = 13\cdot23$~~

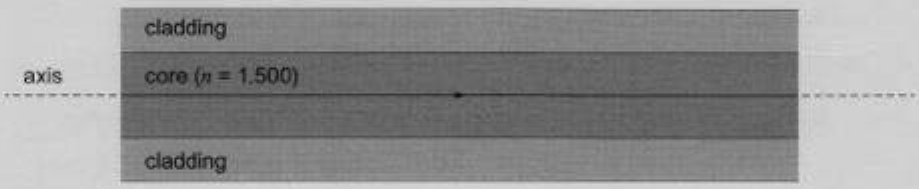
$BD = 14\cdot3\ mm$

(iv) Check your value of θ_2 using a refraction equation involving n_1 and n_2. [2]

$n_1 \sin\theta_1 = n_2 \sin\theta_2$
$1\cdot5\sin 30 = 1\cdot2\sin\theta$
$0\cdot75 = 1\cdot2\sin\theta$ $\theta = 38\cdot7°$

Examiner only

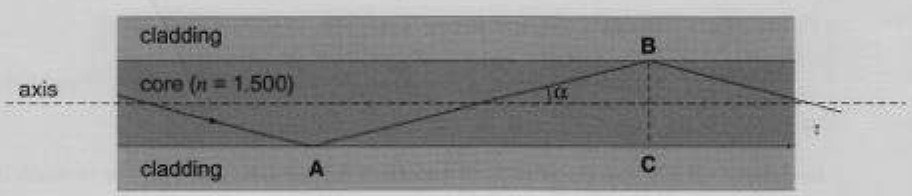
(b) A diagram of an optical fibre is given.



(i) Show clearly that a light pulse travelling along the axis of the fibre takes 8.0 μs to travel through 1.6 km of fibre. [2]

$s = \frac{d}{t}$ $t = \frac{d}{s} = \frac{1.6 \times 10^3}{2 \times 10^8} = 8 \times 10^{-6}$ s or 8 μs

(ii) The greatest angle α, **to the axis** at which light can travel through the core without escaping is 14°. Calculate the refractive index of the cladding. [3]



$\frac{n_2}{n_1} = \sin\theta$ $\frac{n_2}{1.5} = \sin 14$

$n_2 = 0.36$

(iii) Calculate the **difference** in times taken for a pulse to travel through 1.6 km of fibre by the routes in *(b)*(i) and *(b)*(ii). [2]

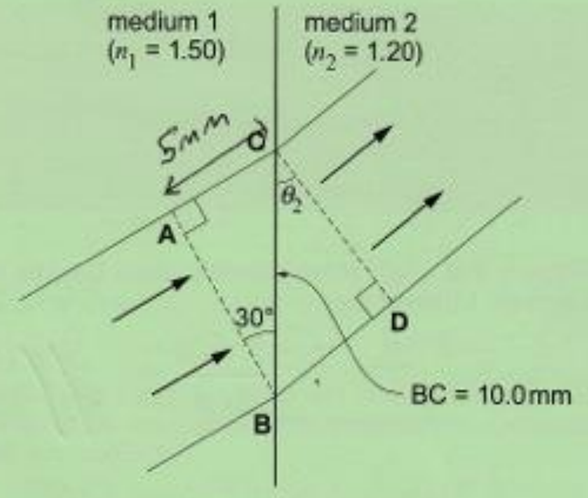
$t = \frac{d}{s} = \frac{1.55 \times 10^3}{2 \times 10^8} = 7.76 \times 10^{-6}$

$8 - 7.76 = 2.4 \times 10^{-7}$ s

$8 \times 10^{-6} - 7.76 \times 10^{-6}$

Examiner only

4. *(a)* A beam of light passes from medium 1, of refractive index n_1 = 1.50, into medium 2, of refractive index n_2 = 1.20.



(i) Calculate the speeds of light in the two media. [1]

medium 1 $\frac{3\times10^8}{1.5} = 2\times10^8\ ms^{-1}$

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(ii) Show clearly that the end, **A**, of wavefront **AB** will take 2.5×10^{-11} s to reach the boundary at **C**. [Note that distance BC = 10.0 mm.] [2]

$\frac{a}{\sin A} = \frac{b}{\sin B}$ $s = \frac{d}{t}$ $t = \frac{d}{s}$

$AQ = 5\times10^{-3}$ m $= 5$ mm $\frac{AQ}{\sin 30} = \frac{0.01}{\sin 90}$ $t = \frac{0.05}{2\times10^8}$

$t = 2.5\times10^{-11}$ s

(iii) While **A** is travelling to **C**, the end, **B**, of wavefront **AB** travels to **D**, through medium **2**. Calculate the distance **BD** and hence the angle θ_2. [2]

BD = 14.3 mm

(iv) Check your value of θ_2 using a refraction equation involving n_1 and n_2. [2]

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$1.5 \sin 30 = 1.2 \sin\theta$

$0.75 = 1.2 \sin\theta$ $\theta = 38.7°$

Examiner only

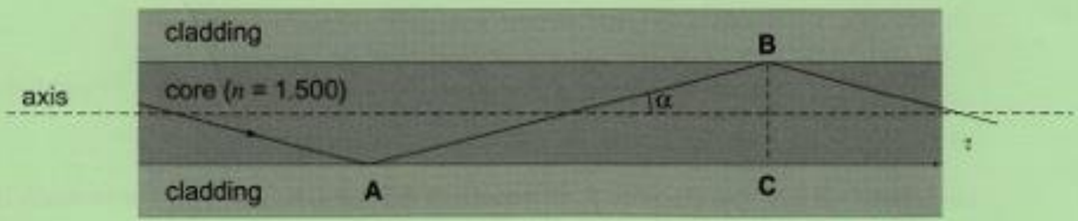
(b) A diagram of an optical fibre is given.

(i) Show clearly that a light pulse travelling along the axis of the fibre takes 8.0 μs to travel through 1.6 km of fibre. [2]

$s = \frac{d}{t}$ $t = \frac{d}{s} = \frac{1.6\times10^3}{2\times10^8} = 8\times10^{-6}$ s or 8 μs ✓✓

2

(ii) The greatest angle, α, **to the axis** at which light can travel through the core without escaping is 14°. Calculate the refractive index of the cladding. [3]



$\frac{n_2}{n_1} = \sin\theta$ $\frac{n_2}{1.5} = \sin 14$ ✓

$n_2 = 0.36$

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(iii) Calculate the **difference** in times taken for a pulse to travel through 1.6 km of fibre by the routes in *(b)*(i) and *(b)*(ii). [2]

$t = \frac{d}{s} = \frac{1.55\times10^3}{2\times10^8} = 7.76\times10^{-6}$ ✗

$8 - 7.76 = 2.4\times10^{-7}$ s

$8\times10^{-6} - 7.76\times10^{-6}$

0

7

Examiner only

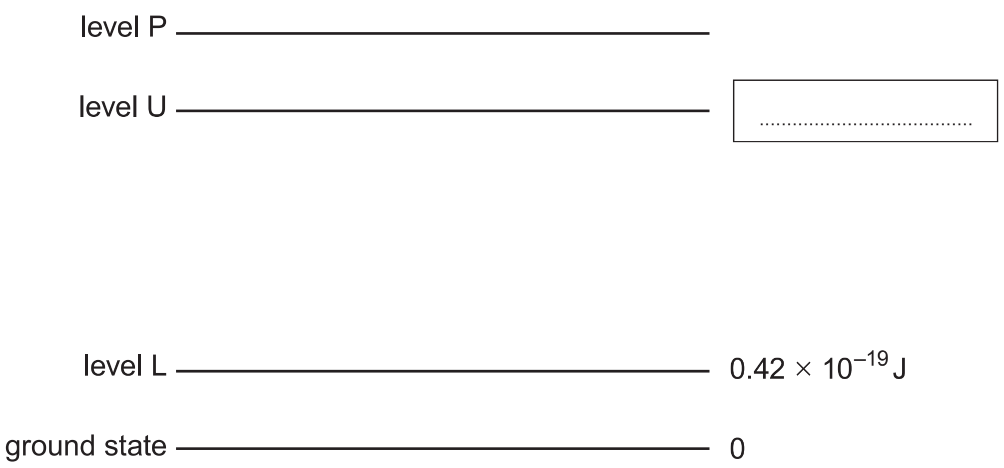
6. *(a)* A laser emits 25 W of coherent infra-red radiation of wavelength 1 064 nm.

(i) Explain what 'coherent' means in this sentence. [2]

(ii) Calculate the photon energy. [2]

(iii) Calculate the number of these photons leaving the laser per second. [1]

(iv) A simplified energy level diagram for this (four level) laser is given.



(I) **Show, with an arrow,** on the diagram the transition associated with emission of the infra-red radiation. [1]

(II) In the box provided in the diagram above, **write** the energy of level U. [1]

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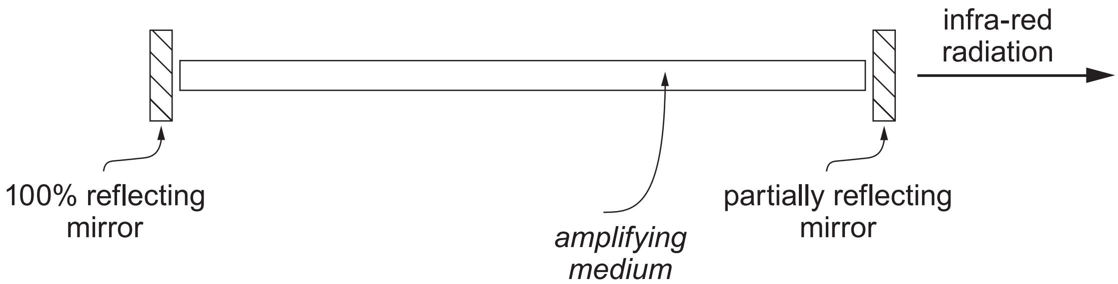
(b) 'Light' amplification occurs as the radiation passes through the amplifying medium in the laser cavity.



Explain how light amplification occurs. Start by explaining what is meant by *stimulated emission,* referring to the diagram in *(a)*(iv). [4]

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Examiner only

6. *(a)* A laser emits 25 W of coherent infra-red radiation of wavelength 1 064 nm.

(i) Explain what 'coherent' means in this sentence. [2]

In phase - with the same amplitude, frequency and wavelength

(ii) Calculate the photon energy. [2]

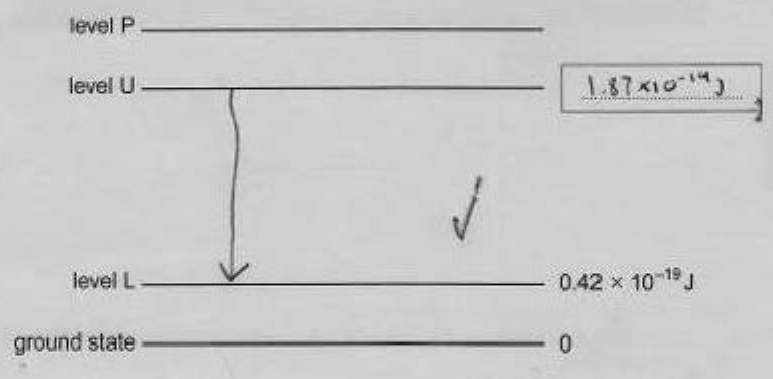
$c = f\lambda$ $3\times10^8 = f(1064\ldots)$ $f = 2.8\times10^{14}$

$(6.63\times10^{-34})(2.8\times10^{14}) = 1.87\times10^{-19}$ J

(iii) Calculate the number of these photons leaving the laser per second. [1]

25 W = 25 J/s $25 / 1.87\times10^{-19} = 1.34\times10^{20}$

(iv) A simplified energy level diagram for this (four level) laser is given.

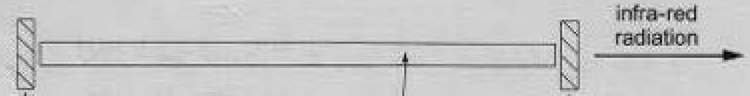


(I) **Show, with an arrow,** on the diagram the transition associated with emission of the infra-red radiation. [1]

(II) In the box provided in the diagram above, **write** the energy of level U. [1]

Examiner only

(b) 'Light' amplification occurs as the radiation passes through the amplifying medium in the laser cavity.



Explain how light amplification occurs. Start by explaining what is meant by *stimulated emission*, referring to the diagram in *(a)*(iv). [4]

Stimulated emission is where an incident photon causes an electron to fall from a population that has undergone population inversion, this means more photons are emitted than absorbed. When the photons hit the mirrors they reflect and cause more stimulated emission. Some of this light escapes the front mirror and most is reflected, causing more emission and thus amplification

Examiner only

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(i) Explain what 'coherent' means in this sentence. [2] 1

In phase ? with the same amplitude, frequency and wavelength

(ii) Calculate the photon energy. [2] 2

$c = f\lambda$ $3\times10^8 = f(1064..)$ $f = 2.8\times10^{14}$

$(6.63\times10^{-34})(2.8\times10^{14}) = 1.87\times10^{-19}$ J

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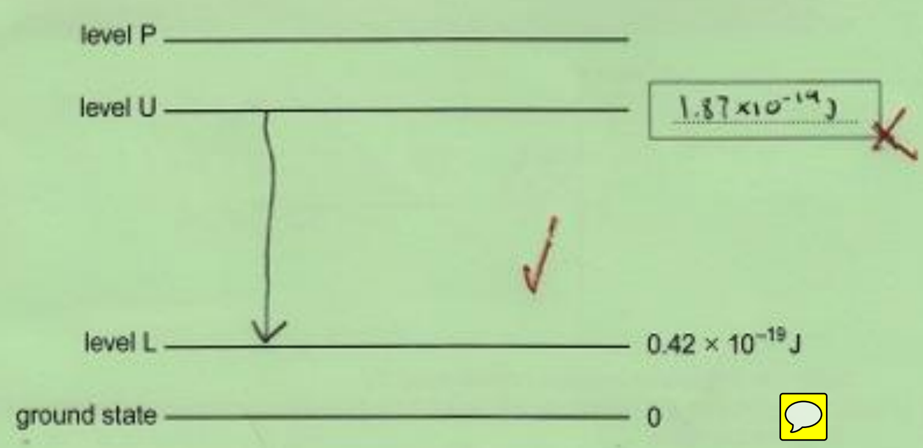

(I) **Show, with an arrow,** on the diagram the transition associated with emission of the infra-red radiation. [1] 1

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Examiner only

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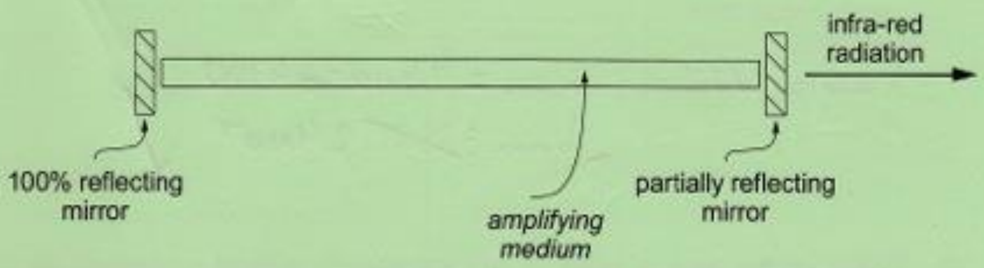

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1

6

Examiner only

6. *(a)* A laser emits 25 W of coherent infra-red radiation of wavelength 1064 nm.

(i) Explain what 'coherent' means in this sentence. [2]

coherent is a wave with:
↳ same frequency
↳ constant phase different ?

(ii) Calculate the photon energy. [2]

$E_{photon} = \frac{hc}{\lambda}$

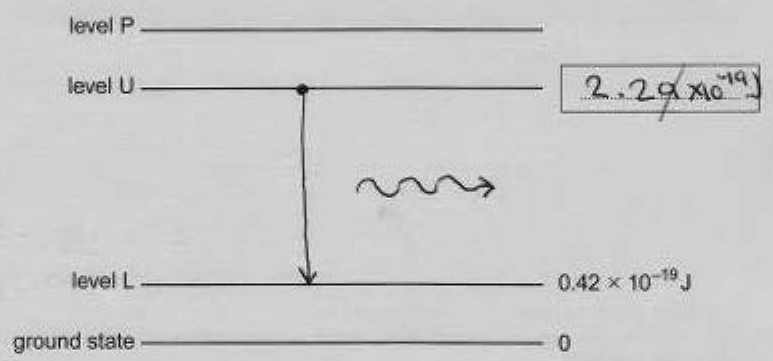
$= \frac{(6.63 \times 10^{-34})(3 \times 10^{8})}{1064 \times 10^{-9}} = 1.87 \times 10^{-19} J$

(iii) Calculate the number of these photons leaving the laser per second. [1]

$\frac{25}{1.87 \times 10^{-19}} \simeq 1.34 \times 10^{20}$ electrons per second

$\simeq 1.34 \times 10^{20}\ s^{-1}$

(iv) A simplified energy level diagram for this (four level) laser is given.



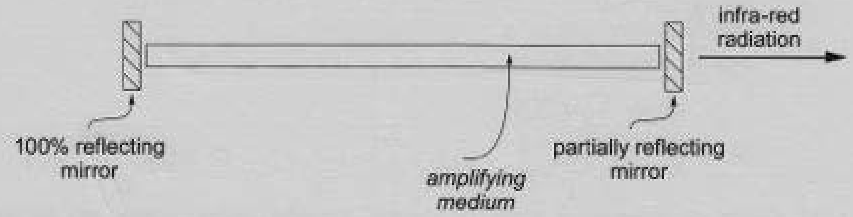
(I) **Show, with an arrow,** on the diagram the transition associated with emission of the infra-red radiation. [1]

(II) In the box provided in the diagram above, **write** the energy of level U. [1]

$0.42 \times 10^{-19} + 1.87 \times 10^{-19}$

Examiner only

(b) 'Light' amplification occurs as the radiation passes through the amplifying medium in the laser cavity.



Explain how light amplification occurs. Start by explaining what is meant by *stimulated emission*, referring to the diagram in *(a)*(iv). [4]

stimulated emission

↳ when a incident photon (with energy of LU − LL) passes, electron in LU drops down a level releasing a photon with the same (except) frequency as the incident photon (in phase and coherent)

Light Amplification occurs when a photon is reflected back causing stimulated emission, the 2 photons are then reflected back so 4 photons are now produced and so on.

Examiner only

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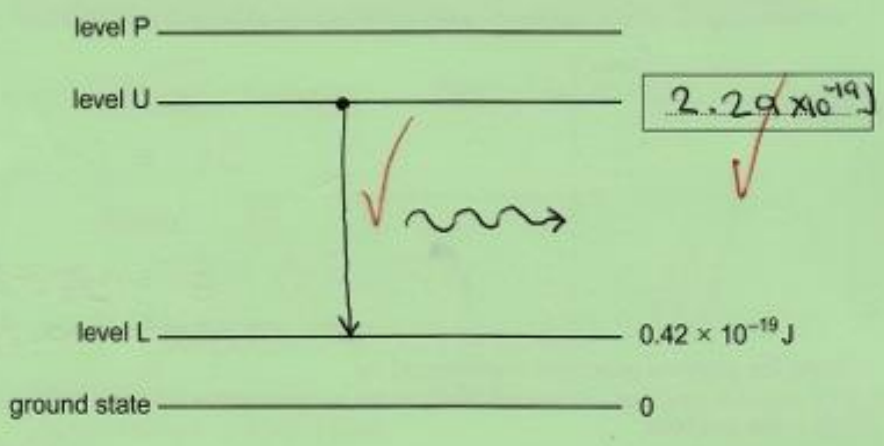

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Examiner only

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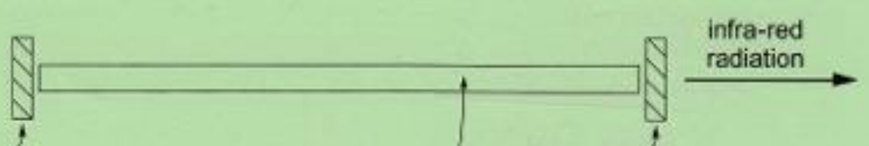

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stimulated emission
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4

10

Examiner only

6. *(a)* A laser emits 25 W of coherent infra-red radiation of wavelength 1064 nm.

(i) Explain what 'coherent' means in this sentence. [2]

The light is in a fixed phase relationship ? and has the same amplitude.

(ii) Calculate the photon energy. [2]

$E = hf$

$E = hf \doteq (6.63\times10^{-34})(2.82\times10^{14})$

answer → ≈ 1.87×10^{-19} J.

$c = f\lambda$

$f = \frac{c}{\lambda}$

$= \frac{3\times10^{8}}{1064\times10^{-9}}$

$= 2.82\times10^{14}$ Hz.

(iii) Calculate the number of these photons leaving the laser per second. [1]

$P = \frac{\Delta E}{t}$ $E = 25$

$\Delta E = Pt$

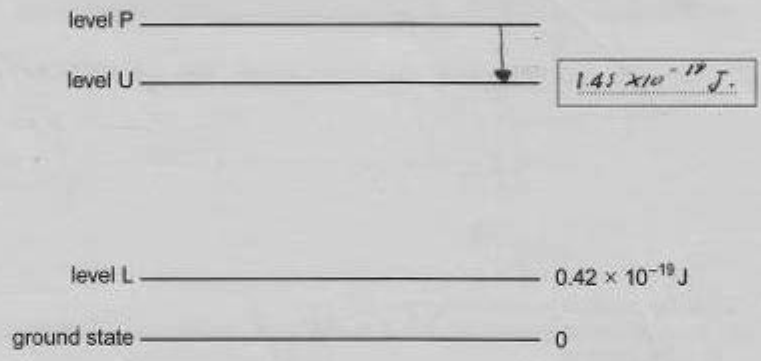
$= 25(1)$

$n = \frac{25}{1.87\times10^{-19}}$

$n = 1.34\times10^{20}$ / photons

≈ 1×10^{20} photons

(iv) A simplified energy level diagram for this (four level) laser is given.



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Examiner only

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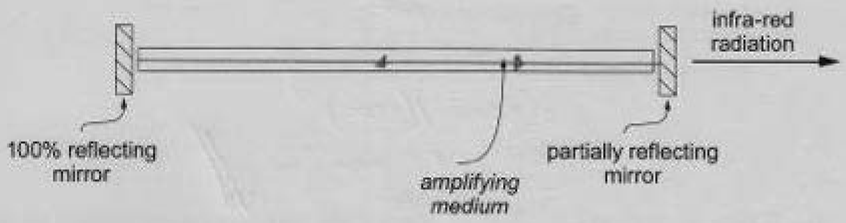

Explain how light amplification occurs. Start by explaining what is meant by *stimulated emission*, referring to the diagram in *(a)*(iv). [4]

Stimulated emission is where a passing photon of the right energy causes electrons to move from an excited state back down to ground state emitting an identical photon to the original in the process, this photon can be seen as infra red. In this case photons flowing through the medium are reflected back along it by the mirrors if the distance between the mirrors is $n\lambda$ then a standing wave is created, at the right hand side of the diagram the partially reflecting mirror lets some of these photons through creating the laser beam of infra red radiation. As photons pass backwards and forwards along the medium more and more electrons are stimulated to fall providing population inversion is in process and more electrons are in an excited state than in the ground state.

Examiner only

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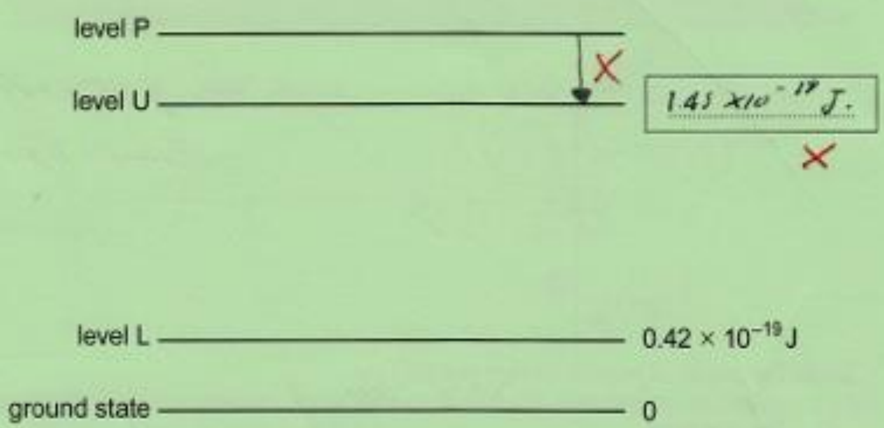

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Examiner only

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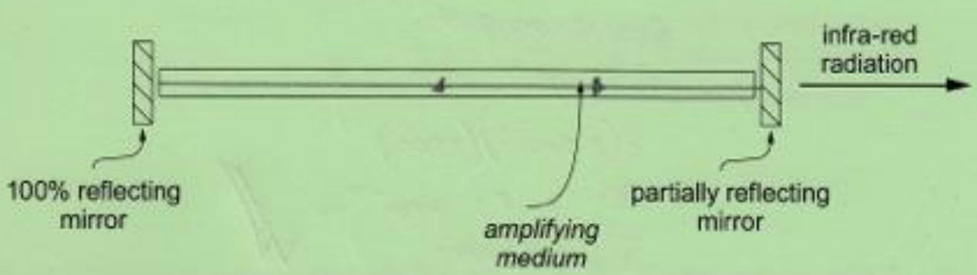

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3

6

Examiner only

7. The star Sirius A has a surface temperature of 9900 K and a luminosity (total power output of electromagnetic radiation) of 1.00×10^{28} W.

(a) (i) Calculate the star's wavelength of peak spectral intensity. [2]

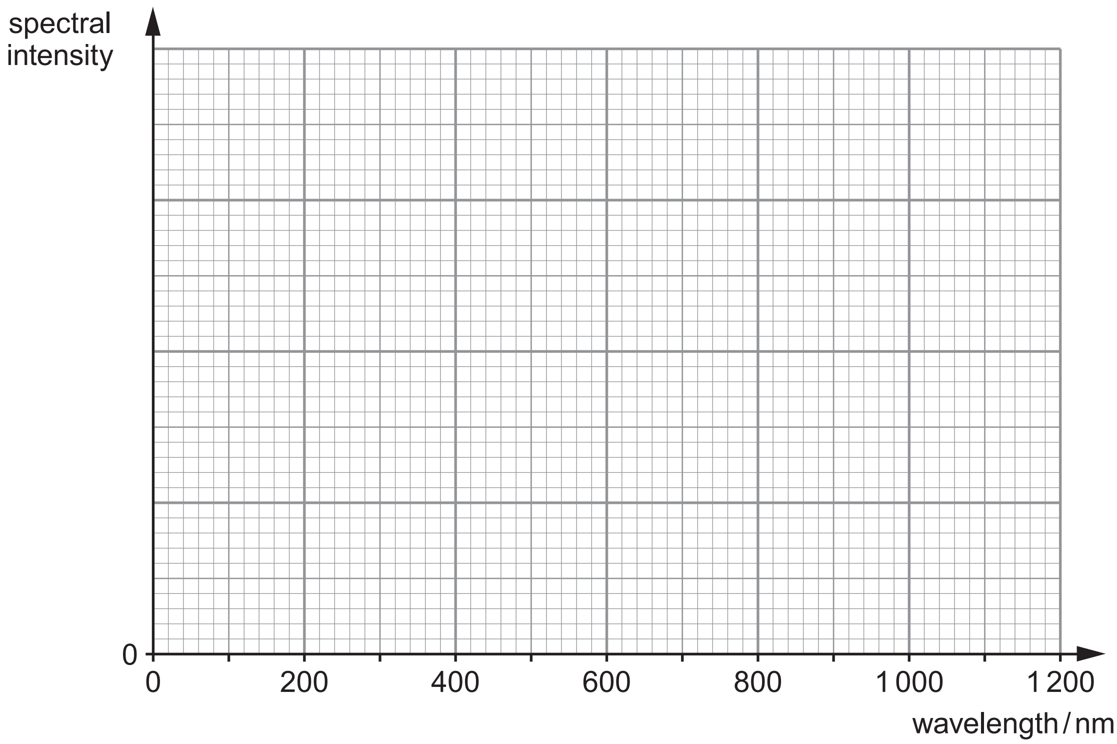
....

....

....

....

(ii) Sketch on the axes a graph of spectral intensity against wavelength for the continuous spectrum of Sirius A. *(Note: make the peak spectral intensity three or four large squares above the wavelength axis.)* [2]



(iii) What colour would you expect Sirius A to be? [1]

....

(b) Use Stefan's Law to calculate the diameter of Sirius A. [3]

....

....

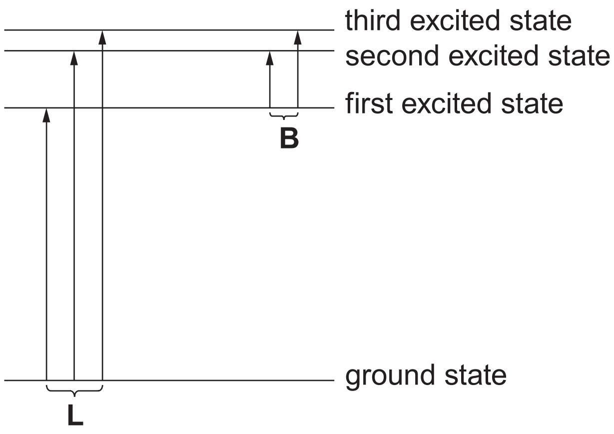
....

....

....

Examiner only

(c) The diagram shows the lowest energy levels of a hydrogen atom, and five possible transitions between these levels.



(i) Name the process (involving photons) which is responsible for the transitions. [1]

....

(ii) Briefly describe the observed feature of the spectrum of a star which this process explains. [1]

....

....

(iii) All the transitions shown in the diagram take place in the atmosphere of Sirius A. State which group of transitions, **L** or **B**, is almost completely absent in a much cooler star, giving a reason for your answer. [2]

....

....

....

TURN OVER FOR QUESTION 8

Examiner only

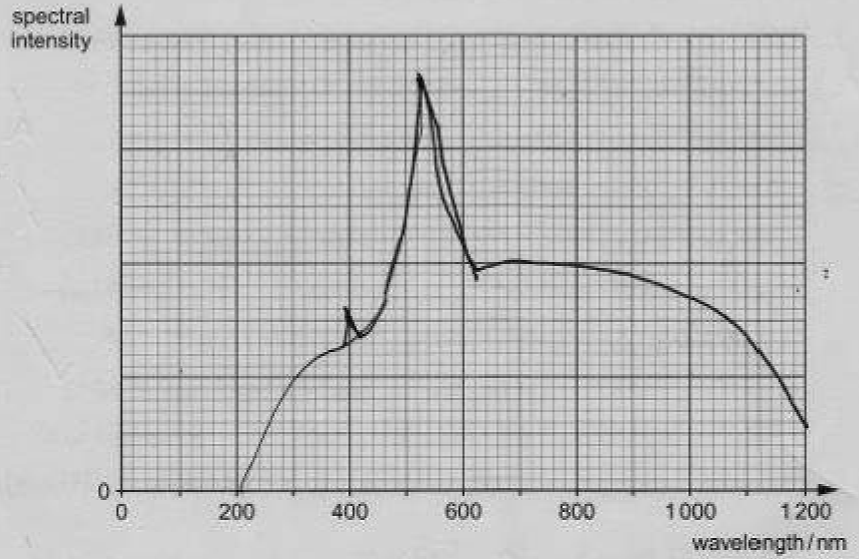
7. The star Sirius A has a surface temperature of 9900 K and a luminosity (total power output of electromagnetic radiation) of 1.00×10^{28} W.

(a) (i) Calculate the star's wavelength of peak spectral intensity. [2]

~~$\lambda T = \frac{W}{T} = \frac{1 \times 10^{28}}{9900} = 1.01 \times 10^{24}$~~

$\lambda = \frac{W}{9900} = \frac{2.90 \times 10^{-3}}{9900} = 2.93 \times 10^{-7}$

(ii) Sketch on the axes a graph of spectral intensity against wavelength for the continuous spectrum of Sirius A. *(Note: make the peak spectral intensity three or four large squares above the wavelength axis.)* [2]



(iii) What colour would you expect Sirius A to be? [1]

~~a~~ blue

(b) Use Stefan's Law to calculate the diameter of Sirius A. [3]

$P = A\sigma T^4$

$1 \times 10^{28} = A\sigma(9900)^4$

$A = \frac{1 \times 10^{28}}{9900^4 \times 5.67 \times 10^{-8}} = 1.836 \times 10^{19}$

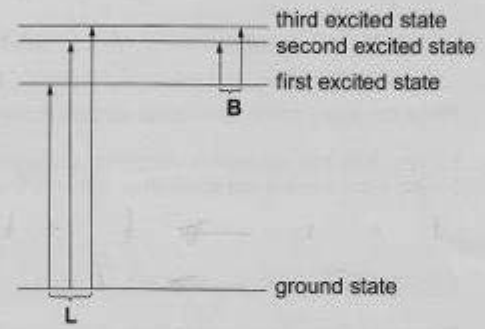
$A = 4\pi r^2$

$r^2 =$ ~~[crossed out]~~ 1208700000×2

$= 2.4 \times 10^{10}$

Examiner only

(c) The diagram shows the lowest energy levels of a hydrogen atom, and five possible transitions between these levels.



(i) Name the process (involving photons) which is responsible for the transitions. [1]

pumping.

(ii) Briefly describe the observed feature of the spectrum of a star which this process explains. [1]

black bond spectrum

(iii) All the transitions shown in the diagram take place in the atmosphere of Sirius A. State which group of transitions, **L** or **B**, is almost completely absent in a much cooler star, giving a reason for your answer. [2]

B is absent because a cooler star has less energy so cannot pump electrons and the electrons

TURN OVER FOR QUESTION 8

Turn over.

Examiner only

7. The star Sirius A has a surface temperature of 9 900 K and a luminosity (total power output of electromagnetic radiation) of 1.00×10^{28} W.

(a) (i) Calculate the star's wavelength of peak spectral intensity. [2]

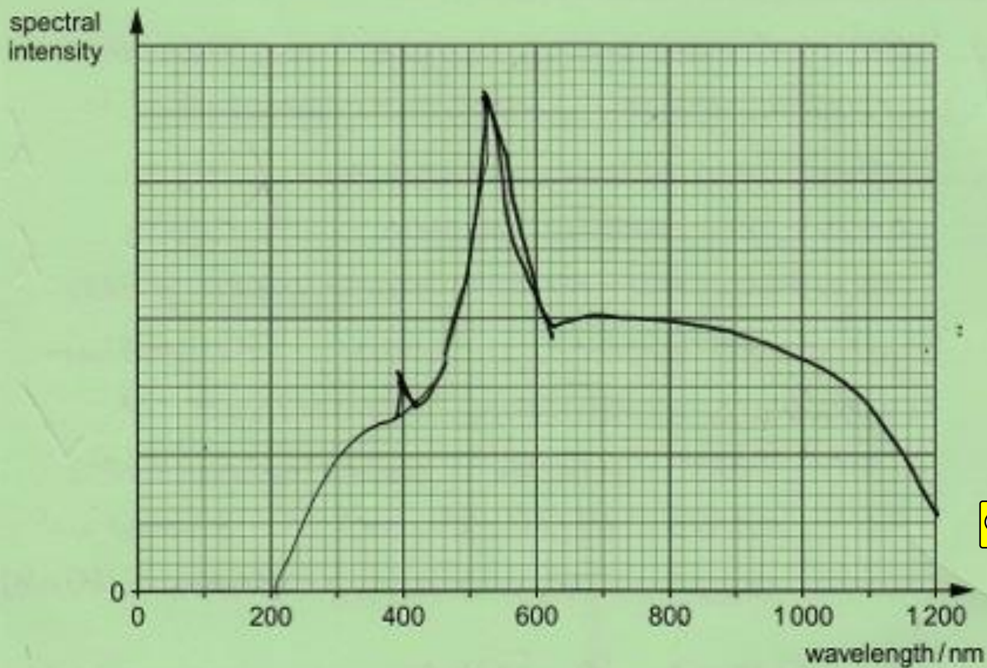
~~$\lambda = \frac{W}{T} = \frac{1 \times 10^{28}}{9900} = 1.01 \times 10^{24}$~~

$\lambda = \frac{W}{9900} = \frac{2.90 \times 10^{-3}}{9900} = 2.93 \times 10^{-7}$ ✓

12

(ii) Sketch on the axes a graph of spectral intensity against wavelength for the continuous spectrum of Sirius A. *(Note: make the peak spectral intensity three or four large squares above the wavelength axis.)* [2]

0



(iii) What colour would you expect Sirius A to be? [1]

blue ✓

1

(b) Use Stefan's Law to calculate the diameter of Sirius A. [3]

2

$P = A \sigma T^4$

$1 \times 10^{28} = A \sigma (9900)^4$

$A = \frac{1 \times 10^{28}}{9900^4 \times 5.67 \times 10^{-8}} = 1.836 \times 10^{19}$

$A = 4 \pi r^2$

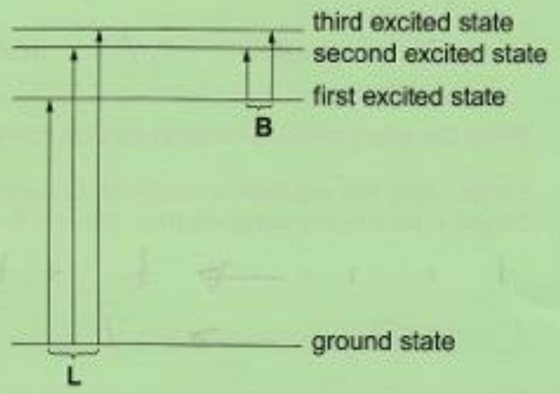
✓✓

$r^2 =$ ~~[crossed out]~~ 1208700000×2

$= 2.4 \times 10^{10}$

Examiner only

(c) The diagram shows the lowest energy levels of a hydrogen atom, and five possible transitions between these levels.



(i) Name the process (involving photons) which is responsible for the transitions. [1]

pumping.

(ii) Briefly describe the observed feature of the spectrum of a star which this process explains. [1]

black band spectrum

(iii) All the transitions shown in the diagram take place in the atmosphere of Sirius A. State which group of transitions, **L** or **B**, is almost completely absent in a much cooler star, giving a reason for your answer. [2]

B is absent because a cooler star has less energy so cannot pump electrons, and the electrons

TURN OVER FOR QUESTION 8

Examiner only

7. The star Sirius A has a surface temperature of 9900 K and a luminosity (total power output of electromagnetic radiation) of 1.00×10^{28} W.

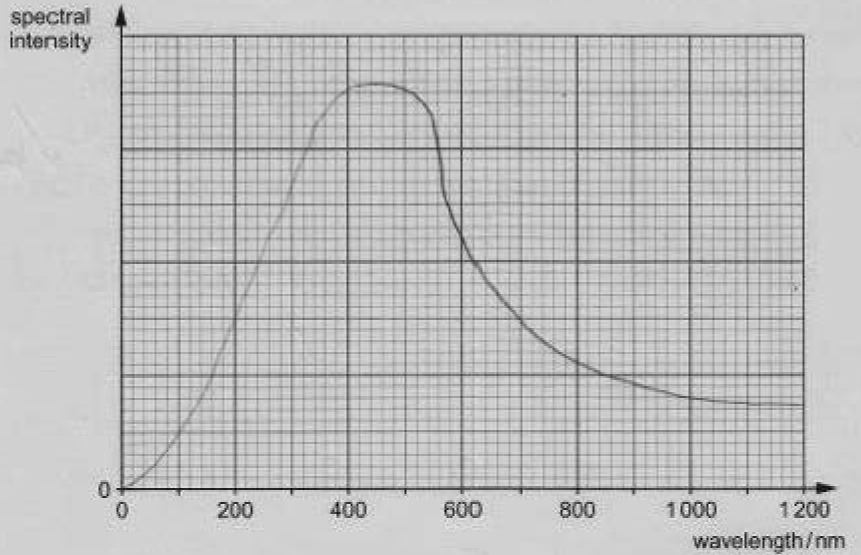
(a) (i) Calculate the star's wavelength of peak spectral intensity. [2]

$\lambda_{max} = W T^{-1}$

$= (1 \times 10^{28})(1/9900)$

$= 1.01 \times 10^{24}$

(ii) Sketch on the axes a graph of spectral intensity against wavelength for the continuous spectrum of Sirius A. *(Note: make the peak spectral intensity three or four large squares above the wavelength axis.)* [2]



(iii) What colour would you expect Sirius A to be? [1]

violet

(b) Use Stefan's Law to calculate the diameter of Sirius A. [3]

$P = A \sigma T^4$

$1 \times 10^{28} = A(5.67 \times 10^{-8})(9900)^4$

$A = 1.84 \times 10^{-19}$

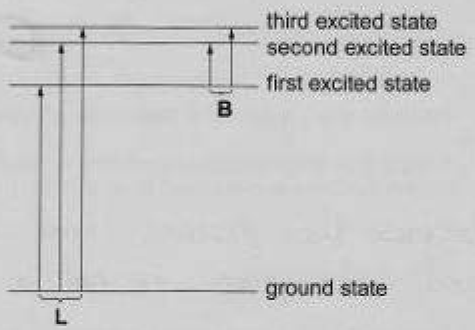
$4\pi r^2 = 1.84 \times 10^{-19}$

$r^2 = 5.84 \times 10^{18}$ $r = 2417481421$

diameter = 4834962841 m

Examiner only

(c) The diagram shows the lowest energy levels of a hydrogen atom, and five possible transitions between these levels.



(i) Name the process (involving photons) which is responsible for the transitions. [1]

stimulated emmission

(ii) Briefly describe the observed feature of the spectrum of a star which this process explains. [1]

The colour of the star

(iii) All the transitions shown in the diagram take place in the atmosphere of Sirius A. State which group of transitions, **L** or **B**, is almost completely absent in a much cooler star, giving a reason for your answer. [2]

B, because in a cooler stair there is less energy to get up to first excited state.

TURN OVER FOR QUESTION 8

Examiner only

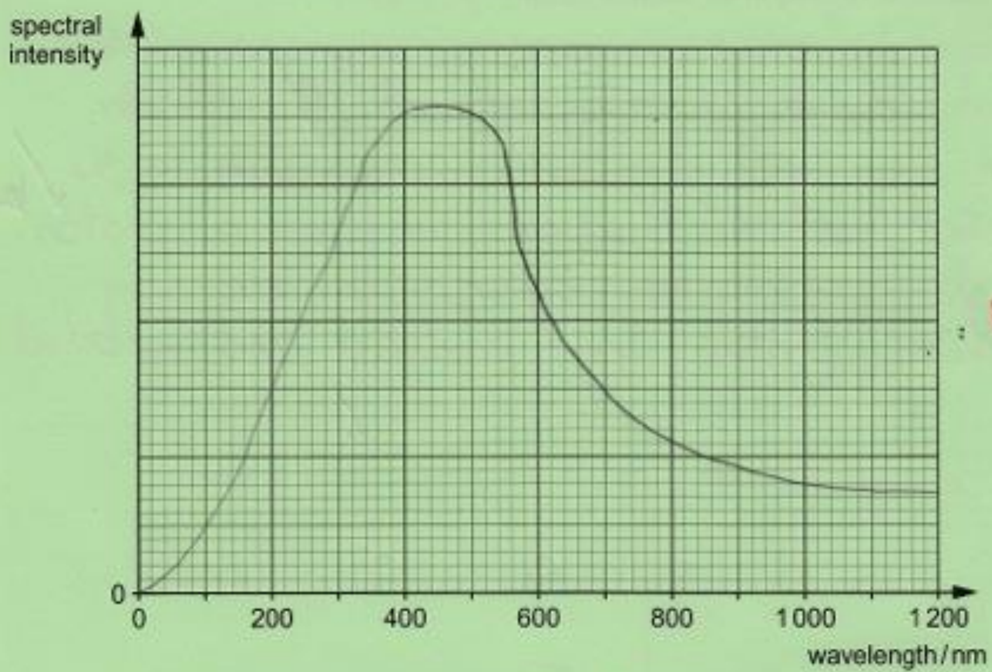
7. The star Sirius A has a surface temperature of 9 900 K and a luminosity (total power output of electromagnetic radiation) of 1.00×10^{28} W.

(a) (i) Calculate the star's wavelength of peak spectral intensity. [2]

$\lambda_{max} = W T^{-1}$
$= (1 \times 10^{28})(1/9900)$
$= 1.01 \times 10^{24}$

0

(ii) Sketch on the axes a graph of spectral intensity against wavelength for the continuous spectrum of Sirius A. *(Note: make the peak spectral intensity three or four large squares above the wavelength axis.)* [2]



1

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violet

1

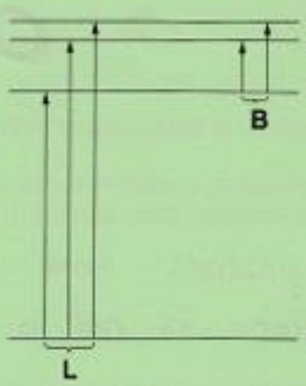
(b) Use Stefan's Law to calculate the diameter of Sirius A. [3]

$P = A \sigma T^4$
$1 \times 10^{28} = A(5.67 \times 10^{-8})(9900)^4$
$A = 1.84 \times 10^{-19}$
$4\pi r^2 = 1.84 \times 10^{-19}$
$r^2 = 5.84 \times 10^{18}$ r = 2417481421
~~diameter = 4834962842~~
diameter = 4834962841 m

2

Examiner only

(c) The diagram shows the lowest energy levels of a hydrogen atom, and five possible transitions between these levels.



(i) Name the process (involving photons) which is responsible for the transitions. [1]

~~stimul~~ ~~Pumping~~ stimulated emmission

0

(ii) Briefly describe the observed feature of the spectrum of a star which this process explains. [1]

The colour of the star ~~[illegible]~~
~~[illegible]~~

0

(iii) All the transitions shown in the diagram take place in the atmosphere of Sirius A. State which group of transitions, **L** or **B**, is almost completely absent in a much cooler star, giving a reason for your answer. [2]

B, because in a cooler stair there is less energy to get up to first excited state. ✓

1

5

TURN OVER FOR QUESTION 8

Examiner only

7. The star Sirius A has a surface temperature of 9900 K and a luminosity (total power output of electromagnetic radiation) of 1.00×10^{28} W.

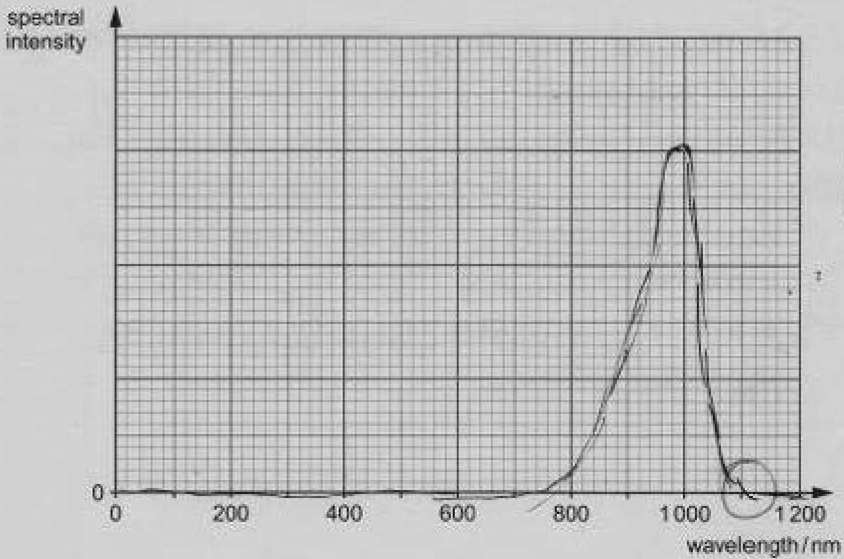
(a) (i) Calculate the star's wavelength of peak spectral intensity. [2]

$\lambda_{max} = WT^{-1}$

$\lambda_{max} = (990)(1 \times 10^{28})$

$\lambda_{max} = 9.99 \times 10^{30}$ nm

(ii) Sketch on the axes a graph of spectral intensity against wavelength for the continuous spectrum of Sirius A. *(Note: make the peak spectral intensity three or four large squares above the wavelength axis.)* [2]



not ecf

(iii) What colour would you expect Sirius A to be? [1]

Blue/Violet

(b) Use Stefan's Law to calculate the diameter of Sirius A. [3]

$P = A\sigma T^4 \rightarrow P = (\pi r^2)\sigma T^4$

$\frac{P}{\sigma T^4} = \pi r^2$

$\frac{P}{\sigma T^4} = A$

$\frac{1 \times 10^{28}}{(5.67 \times 10^{-8})(9.6 \times 10^{15})} = \pi r^2$

$1.837 \times 10^{19} = \pi r^2$

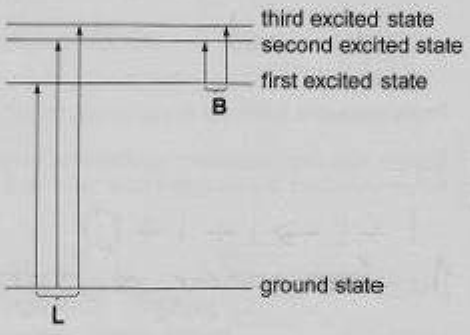
$4286023798 = \pi r$

r = 1364283747

diameter = 2728567495 m

Examiner only

(c) The diagram shows the lowest energy levels of a hydrogen atom, and five possible transitions between these levels.



(i) Name the process (involving photons) which is responsible for the transitions. [1]

Absorption .

(ii) Briefly describe the observed feature of the spectrum of a star which this process explains. [1]

Black body radiation, this is where the body emits/absorbs ~~[illegible]~~ radiation.

(iii) All the transitions shown in the diagram take place in the atmosphere of Sirius A. State which group of transitions, **L** or **B**, is almost completely absent in a much cooler star, giving a reason for your answer. [2]

B, because in a cooler star there isnt as much energy changes and there will be no ground state.

TURN OVER FOR QUESTION 8

Examiner only

7. The star Sirius A has a surface temperature of 9900 K and a luminosity (total power output of electromagnetic radiation) of 1.00×10^{28} W.

(a) (i) Calculate the star's wavelength of peak spectral intensity. [2]

$\lambda_{max} = WT^{-1}$

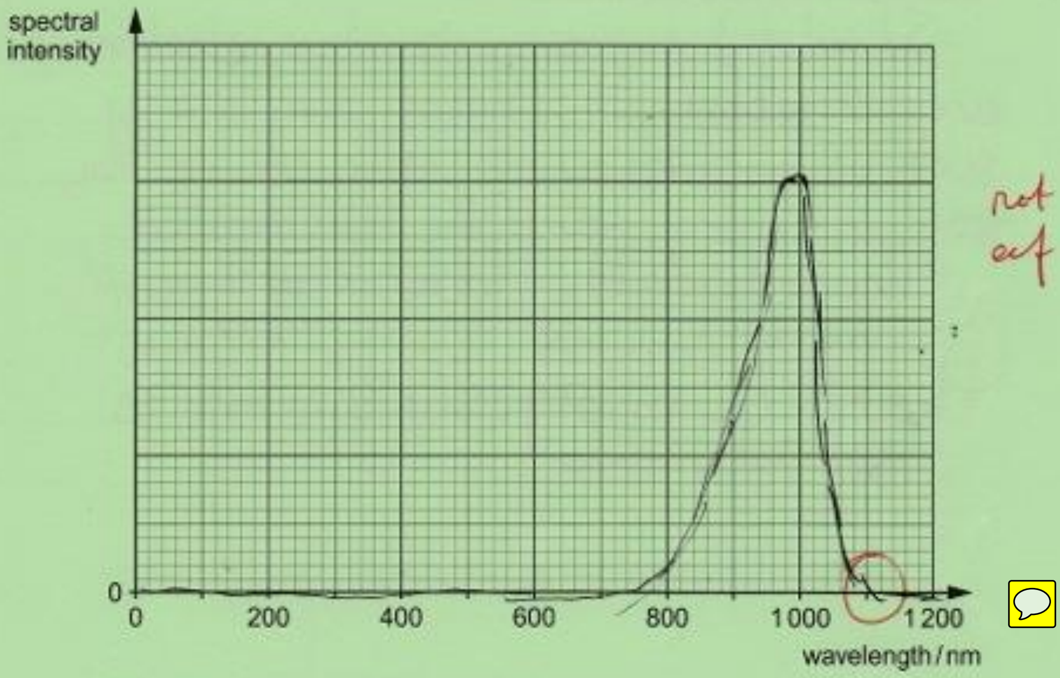
$\lambda_{max} = (9900)(1 \times 10^{28})$

$\lambda_{max} = 9.99 \times 10^{30}$ nm

0

(ii) Sketch on the axes a graph of spectral intensity against wavelength for the continuous spectrum of Sirius A. *(Note: make the peak spectral intensity three or four large squares above the wavelength axis.)* [2]

0



(iii) What colour would you expect Sirius A to be? [1]

Blue/Violet ✓

1

(b) Use Stefan's Law to calculate the diameter of Sirius A. [3]

$P = A\sigma T^4 \rightarrow P = (\pi r^2)\sigma T^4$

$\frac{P}{\sigma T^4} = \pi r^2$

$\frac{P}{\sigma T^4} = A$

$\frac{1 \times 10^{28}}{(5.67 \times 10^{-8})(9.6 \times 10^{15})} = \pi r^2$ ✓ ✗

$1.837 \times 10^{19} = \pi r^2$

$4286023798 = \pi r$ ✗

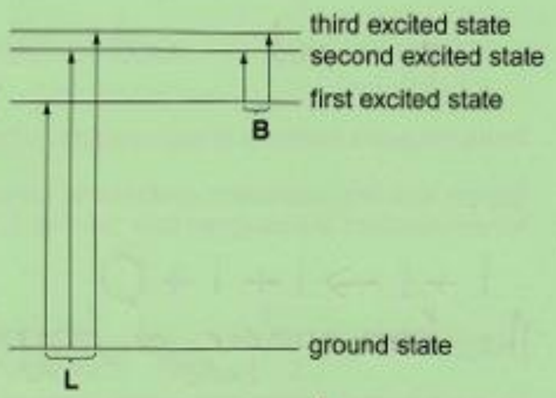
$r = 1364283747$

diameter = 2728567495 m

1

Examiner only

(c) The diagram shows the lowest energy levels of a hydrogen atom, and five possible transitions between these levels.



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TURN OVER FOR QUESTION 8