OCR GCSE GATEWAY PHYSICS A · J249

PHYSICS



MARK SCHEME

P5.3 WAVE INTERACTION

SCORE	PERCENTAGE
/77	%

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Question			Answer/Indicative content	Marks	Guidance
1			Violet light has a greater change in speed (from glass to air) / ora scores [1] **BUT** Violet speeds up **more** (from glass to air) / ora [2] red and violet have a different refractive index scores [1] **BUT** refractive index is larger for violet / ora [2]	2	**Assume** answer refers to violet compared to red unless indicated otherwise **Assume** light goes from glass to air unless indicated otherwise **But** violet slows down more than red / ora [1] **Ignore** merely 'violet is faster ' / ora **allow** violet light has shorter wavelength / higher frequency (than red light) / ora [1] **Examiner's Comments** Weaker answers did not refer to the change of speed of the violet light. They sometimes picked up a mark for shorter wavelength though. 'Speeds up more' and larger refractive index was stated equally by higher grade candidates [2]. Many thought incorrectly that violet had a longer wavelength than red light. Some contradicted themselves by writing that violet had a shorter wavelength and lower frequency.
			Total	2	
2			**refracts** [1] **violet** [1] **shortest** [1]	3	**Examiner's Comments** This question on the behaviour of light was not well answered Most scored at least 1 mark (usually for refraction) but few scored 2 marks (frequently not recognising that violet light has the greatest change in direction).
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
3			change in wave speed / refractive index [1] **but** (in air) wave speed increases / lower refractive index / ora [2]	2	one side of wave (front) / ray changes speed before the other [1] one side of wave (front) / ray speeds up before the other [2] **allow** if **no** other marks scored that air is less dense (than glass) / ora [1] **Examiner's Comments** Weaker answers only referred to refraction with respect to the normal. Often there was reference to the speed change but it was the wrong way around [1]. Many did say however that the speed increased [2] although fewer mentioned refractive index. Density differences were referred to quite rarely but when correct gained [1] mark.
			Total	2	

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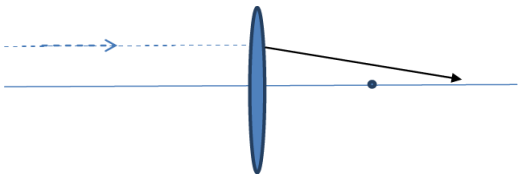
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Question			Answer/Indicative content	Marks	Guidance
4			[Level 3] Describes measurement of image distance AND at least 1 other feature of experiment AND explains focal length. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) [Level 2] Describes at least two features of experiment OR explains focal length. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) [Level 1] Describes one feature of experiment Quality of written communication impedes communication of the science at this level. (1 – 2 marks) [Level 0] (0 marks) Insufficient or irrelevant science. Answer not worthy of credit.	6	This question is targeted up grade E To reach Level 3 image must be formed on a screen Indicative scientific points may include: Focal length • focal length is distance between lens and image (of a distant object) or distance between lens and focal point Features of experiment: • measures thickness of all lenses (with the mm ruler) • produce an image (of the tree on the card) • measure image distance • try all lenses Allow for level 1 correct comparison of focal lengths of lenses Use the L1, L2, L3 annotations in Scoris; do not use ticks. Examiner's Comments This 6 mark level of response question on an investigation to determine the focal length of different thicknesses of convex lenses was targeted at low demand up to grade E. In general the quality of response across the whole range was poor. It was clear that few candidates had undertaken the practical investigation into creating a real image from a distant object by a convex lens on a screen. Better candidates could describe focal length and some candidates achieved a Level 1 by describing how the focal length varies with thickness. This was clearly more familiar as it has been assessed in written papers in the previous Specification.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
5	a		Any one from : reflective clothing / cat's eyes / reflector on the road / binoculars / periscopes / (some) cameras / (some LCD) projectors / optical fibres for communications (1)	1	**allow** named application of TIR e.g. endoscope (1) **allow** (fibre optic) Christmas trees Examiner's Comments ??It was surprising that less than half could describe a use correctly of total internal reflection. This year the most common answer was usage in super-fast communications with far fewer references to endoscopes than in previous years.
	b	i	convex (1)	1	**allow** biconvex (1) Examiner's Comments Only higher scoring candidates regularly recalled convex as the name of a converging lens. A significant number did not attempt this question.
		ii	straight ray drawn from the original ray or lens to (or through) the focal point (1)	1	 (1) ignore continuation of ray after focal point Examiner's Comments ??Most candidates accurately completed the ray diagram.
	c		real image (1) on a screen or sensor or film (1)	2	**allow** upside down or diminished (1) **allow** on back of camera Examiner's Comments As in 2014 very few could describe the type and location of the image formed by a convex lens. Around a quarter of all candidates did not attempt this question.

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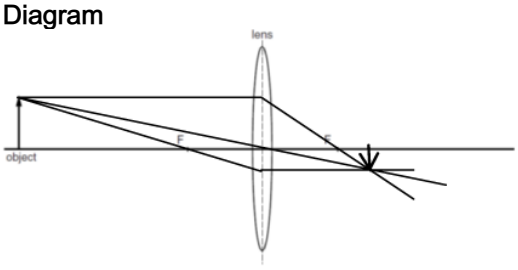
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Question			Answer/Indicative content	Marks	Guidance
	d		E C both in correct order and above (B) (1) (B) A D both in correct order and below (B) (1)	2	Allow both correct lenses above B and below B but in wrong order (1) ie C E (B) D A (1) Examiner's Comments ?Almost all candidates attempted this question but the vast majority could not correctly sequence focal length of convex lenses by linking with lens thickness.
			Total	7	

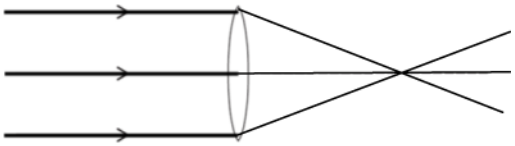
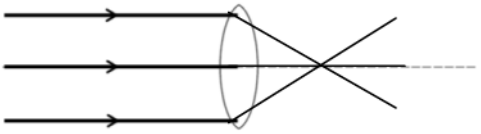
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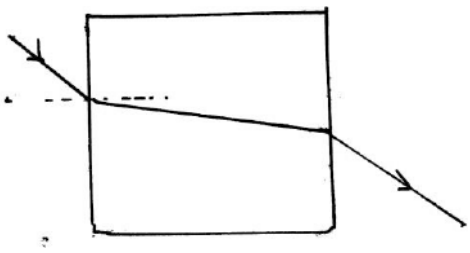
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Question			Answer/Indicative content	Marks	Guidance
6			**Level 3: (5–6 marks)** **Ray diagram with image completed** **AND** **image height or size calculated / measured from diagram** **AND** **refraction explained using TWO ideas.** Quality of written communication does not impede communication of science at this level. **Level 2: (3–4 marks)** **Any two from:** **Ray diagram completed** **OR** **image height or size calculated / measured from diagram** **OR** **refraction explained using TWO ideas.** Quality of written communication partly impedes communication of science at this level. **Level 1: (1–2 marks)** **Ray diagram completed** **OR** **image height or size calculated / measured from diagram** **OR** **refraction explained simply using ONE idea.** Quality of written communication impedes the communication of science at this level	6	This question is targeted up to grade A* Indicative scientific points may include (but are not limited to) the following: **Diagram**  two of the rays drawn as shown in diagram • ray parallel to principal axis is refracted to focal point • ray is not refracted when it passes through optical centre of lens • ray through focal point (before it reaches lens) is refracted parallel to principal axis **explanation** • refraction occurs at boundary between two different mediums • speed of light in air is faster than in glass • refractive index of glass is higher than air • light bends towards normal when entering lens / ORA • lens causes light rays to converge • light rays parallel to the principal axis meet at the focal point • image is inverted / image is real / image is after F **image height or size** • image calculated as 0.75 (cm) or partly calculated as

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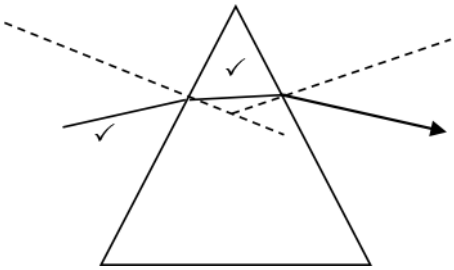
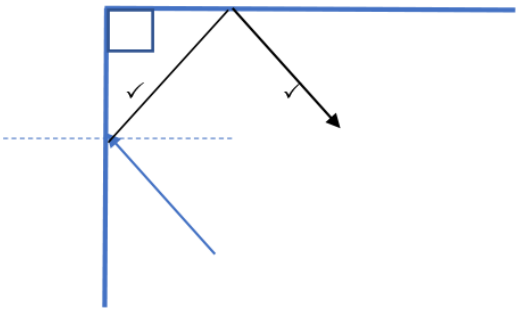
Question			Answer/Indicative content	Marks	Guidance
			Level 0: (0 marks) Insufficient or irrelevant science. Not worthy of credit.		$0.5 = \frac{\text{image size}}{1.5}$ • image correctly measured on the diagram accepting a range of 0.5 to 0.8 cm
			Total	**6**	
7			**Level 3: (5–6 marks)** **Labels the diagram** **AND** **both diagrams completed** **AND** **description of convex lens producing a real image.** Quality of written communication does not impede communication of science at this level. **Level 2: (3–4 marks)** **Labels the diagram** **OR** **both diagrams completed** **AND** **simple description of convex lens producing a real image.** Quality of written communication partly impedes communication of science at this level. **Level 1: (1–2 marks)** **Simple labels on the diagram** **OR** **one diagram completed** **OR** **simple description of convex lens producing a real image.** Quality of written communication impedes the communication of science at this level **Level 0: (0 marks)** Insufficient or irrelevant science. Not worthy of credit.	6	This question is targeted up to grade C Indicative scientific points may include (but are not limited to) the following: **labels** • (convex) lens / optical centre of lens • (incident light) ray • principal axis • focal point / focal length **diagram**   **description** • light refracted • light goes through the lens • focused at focal point • real image can be projected onto a screen or film
			Total	**6**	

Question			Answer/Indicative content	Marks	Guidance
8			ray bends towards the normal within the block (up to the normal is acceptable but not past the normal) (1) ray bends away from the normal as it leaves the block (1) ray leaving the block is parallel to the ray entering the block – by sight (1)	3	 **If no other mark scored allow** (1) for ray bending away from normal within the block
			Total	3	
9			B ✓	1 (AO1.2)	<u>Examiner's Comments</u> Higher ability candidates were able to correctly apply their knowledge of refraction through a prism (option B). Most lower ability candidates chose one of the distractors and were unable to explain why violet light is refracted more than red light.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
10	a		Diagram showing correct refractions 	2 (AO 2x1.2)	If diagram is incorrect, maximum of one mark from: any rising line in air before the prism ✓ a line in the prism close to horizontal by eye and joining the exit ray ✓ IGNORE any arrows on rays <u>Examiner's Comments</u> This question proved very difficult for most candidates. Although some candidates could accurately draw the ray of light as it travelled through the glass prism, only the more able gained 2 marks.
	b			2 (AO 2×1.2)	One mark for each correct reflection of about 90o by eye IGNORE any arrows on rays
	c	i	(Filter X lets through) red, orange and yellow ✓	1 (AO 3.2b)	DO NOT ALLOW any extra colours
		ii	(Filter Y absorbs) orange and yellow ✓	1 (AO 3.2b)	DO NOT ALLOW any extra colours
	d	i	**Any one from:** Red (wall) absorbs all colours (in the light except red) ✓ (The wall) only reflects red light ✓	1 (AO 2.1)	ALLOW there is no red in the coloured light to reflect / AW ALLOW (wall) cannot reflect other colours (of light) <u>Examiner's Comments</u> Over half of the candidates were able to answer this question correctly. Incorrect answers involved misconceptions about the 'coloured lights mixing' to give black or the lights being transmitted by the wall.

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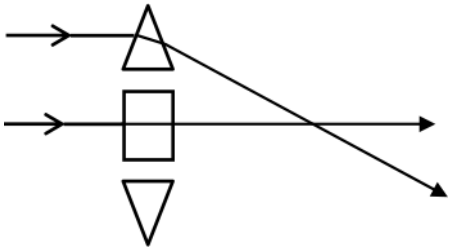
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Question			Answer/Indicative content	Marks	Guidance
		ii	**Any two from:** green ✓ blue ✓ indigo ✓ violet ✓ cyan ✓	1 (AO 2.1)	**DO NOT ALLOW** orange / yellow / magenta
	e	i	Ray of green light focused between lens and F_R ✓	1 (AO 1.2)	
		ii	green has shorter wavelength or higher frequency (than red) / shorter wavelengths refract more / show a larger change in speed / green light slows down more (than red light) / AW / ORA ✓	1 (AO 2.1)	**IGNORE** green (light) refracts more **IGNORE** just green (light) slows down Examiner's Comments Question 18e assessed candidates' knowledge of the refraction of different colours of light through a convex lens. It was evident that the majority of candidates did not know that green light would focus between the lens and FR because it has a shorter wavelength and therefore refracts more.
		iii	long sighted ✓ (Because lens is) convex/focusing/converging ✓	2 (AO 3.1a) (AO 3.2b)	Mark independently Examiner's Comments This question discriminated well. Most candidates successfully identified that the lens was suitable for correcting long-sight and the more able could also explain that it was because the lens was convex.
			Total	**12**	
11			**C** ✓	1 (AO1.2)	Examiner's Comments This question was answered correctly by the majority of the candidates. A small number of candidates opted for D
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
12	a	i	Ray from prism: straight line (by eye) towards focal point ✓ Ray from block: continues straight ✓	2 (AO 2x1.2)	IGNORE ray in prism IGNORE other rays  Examiner's Comments This question required candidates to use a ruler to draw straight lines. A number of candidates did not have a continuous straight line passing through the centre of the block. Candidates should be encouraged to read the question carefully. In this case there was no need to draw rays for the lower triangular block.
		ii	(in long sight) rays focused behind retina / eye (ball) / AW ✓ Convex lens refracts light inwards / focuses light on the retina / AW ✓	2 (AO 2x1.1)	ALLOW near object focussed behind the retina / eye (ball) or eye (ball) is too short ALLOW converges / meet for focuses Examiner's Comments The explanations written by candidates were often vague. Candidates were expected to explain the meaning of long-sighted vision and then explain how the use of convex lens would focus the image on the retina.

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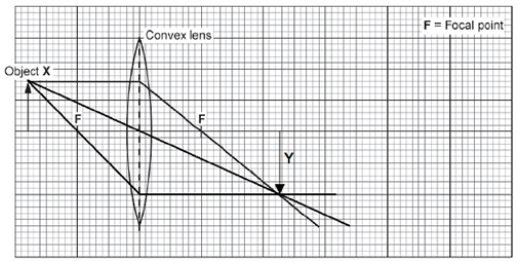
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Question			Answer/Indicative content	Marks	Guidance
	b		Black ✓ AND Any one from: Black because blue light absorbed by red paper ✓ Black because red paper only reflects red light ✓ Black because red paper absorbs all colours except red ✓ Black because no light reflected from paper ✓	2 (AO2×2.2)	ALLOW dark without any colour Examiner's Comments Few candidates realised that the red paper would appear black in blue light. Candidates often thought that the red paper would look purple. Candidates that did state that the red paper appeared black and often reasoned that the red paper would absorb all the other colours. AfL Candidates should be encouraged to understand the adding and subtraction of colours and be able to explain light being absorbed at surfaces.
			Total	6	
13			A ✓	1 (AO2.2)	
			Total	1	

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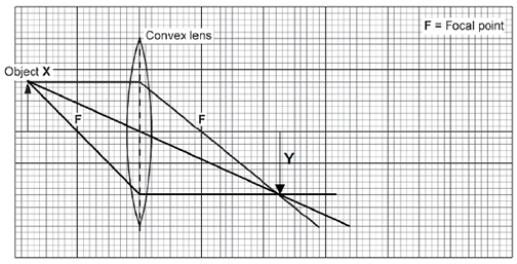
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Question			Answer/Indicative content	Marks	Guidance
14	a		**Either** ray (centre ray or focal ray) drawn as indicated below ✓  Image upside down **AND** in the correct place ✓	2 (AO2 × 2.2)	**ALLOW** just one ray drawn If no rays drawn (or incorrect) but image is inverted, slightly larger and roughly in the correct place then award this mark **IGNORE** position of Y (if arrow is in the correct place) **ALLOW** tolerance of +/- 2 squares for image position
	b		A (red) filter is needed ✓ (The red filter) absorbs all colours/frequencies/wavelengths except red (light) ✓	2 (AO2 × 2.1)	**ALLOW** The red filter absorbs blue and green (light/frequency/wavelength) (but not red) **ALLOW** the filter transmits red light only / only lets red (light/frequency/wavelength) through
			Total	**4**	

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Question			Answer/Indicative content	Marks	Guidance
15			**Either** ray (centre ray or focal ray) drawn as indicated below ✓  Image upside down **AND** in the correct place ✓	2 (AO2 × 2.2)	**ALLOW** just one ray drawn If no rays drawn (or incorrect) but image is inverted, slightly larger and roughly in the correct place then award this mark **IGNORE** position of Y (if arrow is in the correct place) **ALLOW** tolerance of +/- 2 squares for image position
			Total	**2**	
16			**D** ✓	1 (AO2.2)	
			Total	**1**	
17			A (red) filter is needed ✓ (The red filter) absorbs all colours/frequencies/wavelengths except red (light) ✓	2 (AO2 × 2.1)	**ALLOW** The red filter absorbs blue and green (light/frequency/wavelength) (but not red) **ALLOW** the filter transmits red light <u>only</u> / <u>only</u> lets red (light/frequency/wavelength) through
			Total	**2**	

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Question			Answer/Indicative content	Marks	Guidance
18	a	i	0.0022 (m) ✓	1 (AO2.2)	
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.0×10^6 (Hz) award 4 marks (Rearrange: frequency =) speed / wavelength OR (f =) 4500 / 0.0022 ✓ (f =) 2 045 455 (Hz) ✓ (f =) 2 000 000 (Hz) ✓ (f =) 2.0×10^6 (Hz) ✓	4 (AO1.2) (AO2 x 2.1) (AO1.2)	ALLOW ecf from (i) ALLOW three marks for 2.0 MHz ALLOW a mark for their answer to 2 significant figures ALLOW a mark for their answer in standard form
	b		Decreases ✓ Stays the same ✓	2 (AO2 × 2.1)	
	c	i	(Partial) reflection/absorption at the front of the kidney ✓ (Partial) reflection at the back of the kidney ✓	2 (AO2 × 2.1)	Both of the marking points can be awarded by a suitably clear diagram (or additional drawings on the given diagram) ALLOW 1 mark maximum for just reflection/bounces back
		ii	Measure the <u>time</u> between reflections ✓ Use distance = ½ x speed x time (to find the size) ✓	2 (AO2 × 2.2)	ALLOW distance = speed x time and mention of time halve
	d		There is no (known) risk associated with ultrasound / ultrasounds are safer than X-rays / X-rays pass through soft tissue (so would not detect the kidney) / X-rays are ionising (radiation) ✓	1 (AO1.1)	ALLOW X-rays used to detect bones/pass through kidney ALLOW ultrasound detects soft tissue/organs
			Total	12	

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