

PHYSICS



EXAM QUESTION PACK

P5.3 WAVE INTERACTION

SCORE

/77

PERCENTAGE

%

STEMUP

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Gateway Physics A (9-1)

Wave interaction

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:

Additional resources may be supplied with this paper.

Other materials required:

- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate forename		Candidate surname	
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Centre number						Candidate number				
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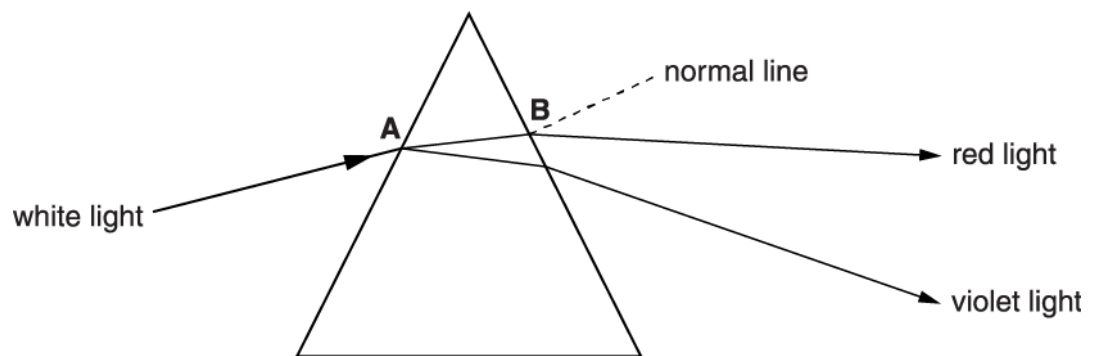
INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **77**.
- The total number of marks may take into account some 'either/or' question choices.

- 1 Look at the diagram. It shows white light entering a glass prism at A.



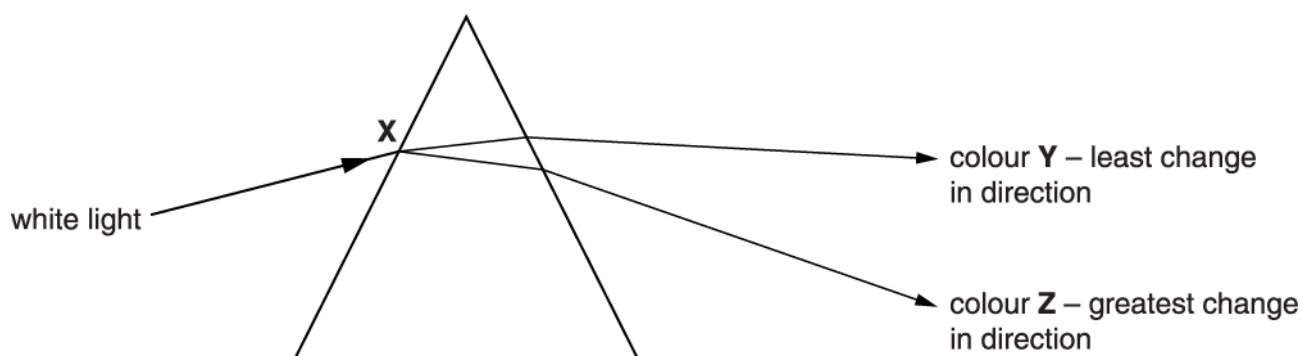
The red light refracts away from the normal at B.

Violet light refracts **more** than red light.

Explain why.

----- [2]

2 Look at the diagram. It shows white light entering a glass prism.



Dispersion happens and different colours are produced.

Complete the sentences.

Choose from:

diffracts
reflects
shortest

longest
refracts
violet

red
same
white

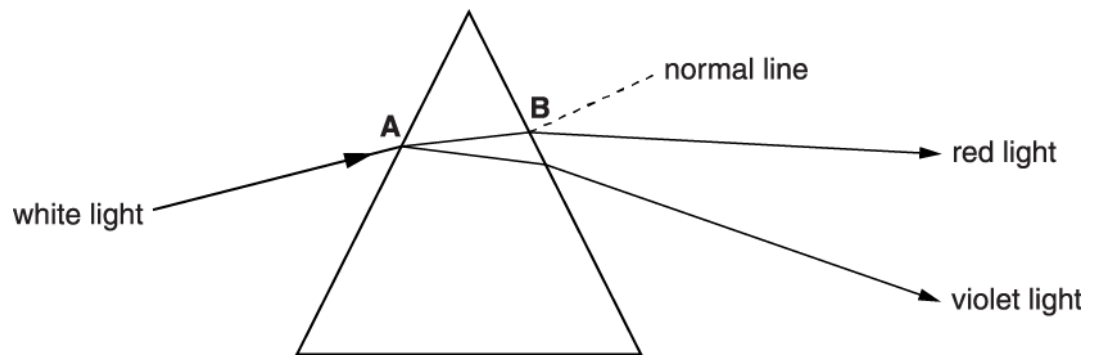
When the light enters the prism at X, it _____

Colour Z is _____

Colour Z has the greatest change in direction because it has the _____ wavelength.

[3]

3 Look at the diagram. It shows white light entering a glass prism at A.



The red light refracts away from the normal at B.

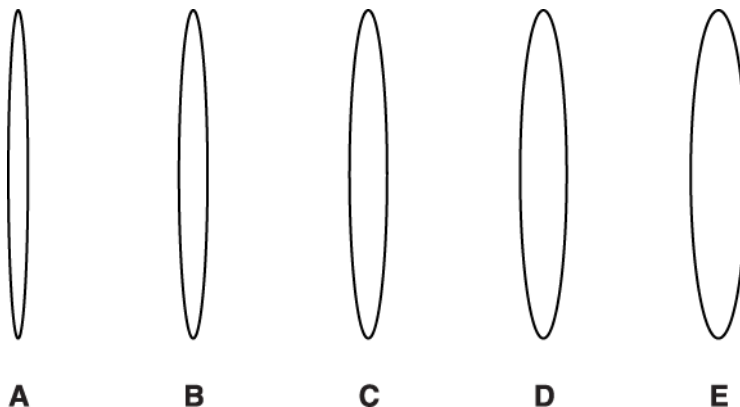
Use ideas about waves to explain why this happens.

----- [2]

4 Sam wants to measure the focal length of some convex (converging) lenses.

He has some equipment.

- A metre rule measuring in cm
- A small ruler measuring in mm
- A sheet of white card
- A tree outside which he can use as a distant object
- 5 lenses of different thicknesses.



Explain what is meant by focal length and describe an experiment that Sam could do to investigate how the thickness of a lens affects its focal length.



The quality of written communication will be assessed in your answer to this question.

[6]

5(a) She sends a laser beam through an optical fibre.

The laser beam is totally internally reflected as it moves along the fibre.

Describe one other use of total internal reflection.

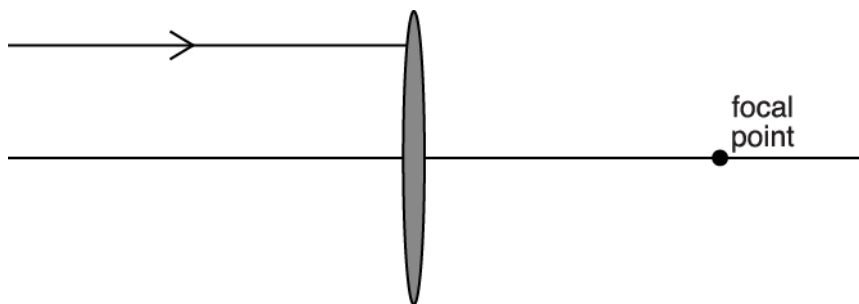
----- [1]

(b) Chantal experiments with converging lenses.

(i) Write down another name for a converging lens.

----- [1]

(ii) Complete the path of the light ray after it goes through the converging lens.



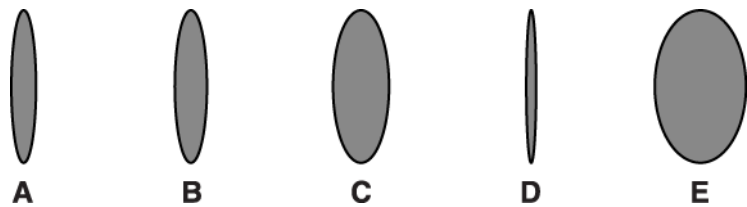
[1]

(c) Converging lenses are used in cameras to produce images.

Describe the **type** of image and **where** it is produced in a camera.

----- [2]

(d) Chantal has some converging lenses with different thicknesses.



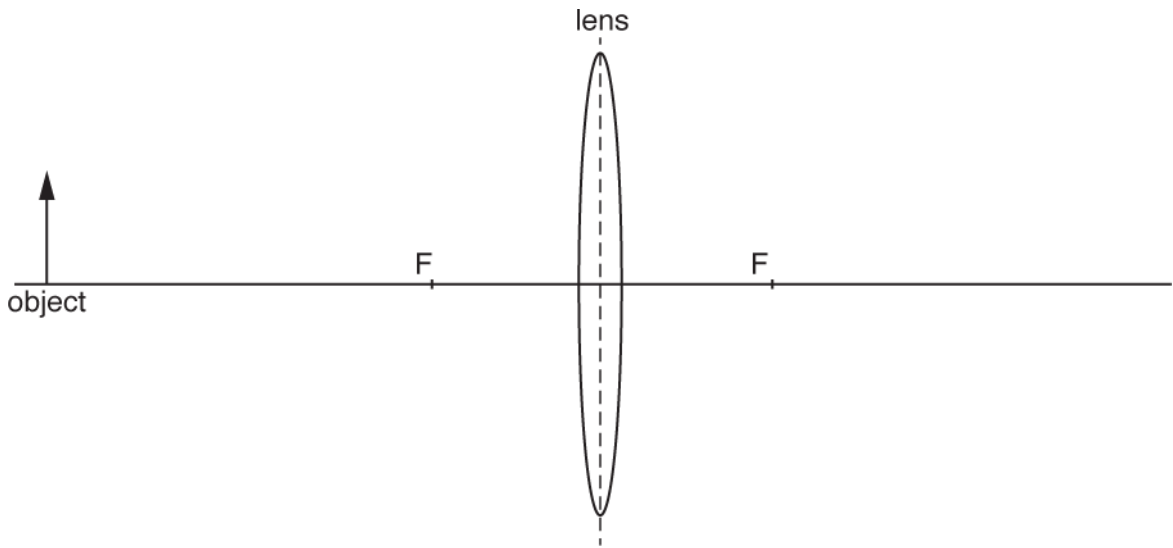
She wants to arrange the lenses in the order of their focal lengths.

Put the lenses in the correct order. Complete the table. One has been done for you.

Focal length in cm	Lens
5	
10	
15	B
20	
25	

[2]

6 Anya starts drawing a ray diagram for a convex lens.



The magnification of the lens is 0.5 and the object height is 1.5 cm.

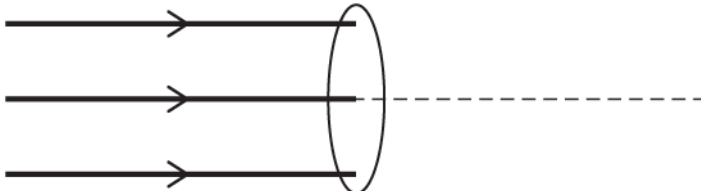
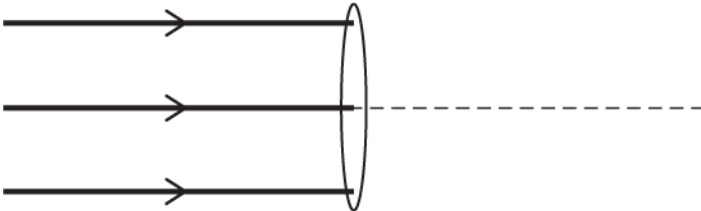
Complete the ray diagram to show the size and position of the image. Calculate the size of the image and use your diagram to explain refraction by a convex lens.



The quality of written communication will be assessed in your answer to this question.

[6]

7



The light rays pass through the lenses.

Label and complete the ray diagrams to show the path the rays take.

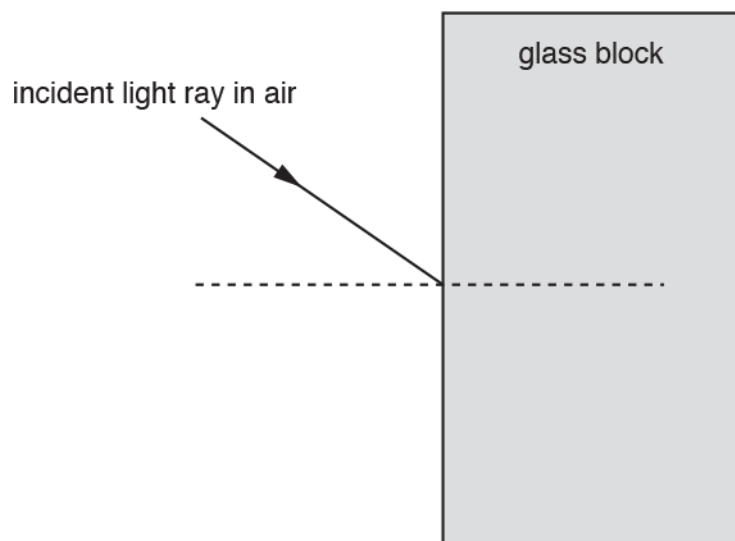
Use your completed diagrams to describe how convex lenses produce a real image.



The quality of written communication will be assessed in your answer to this question.

[6]

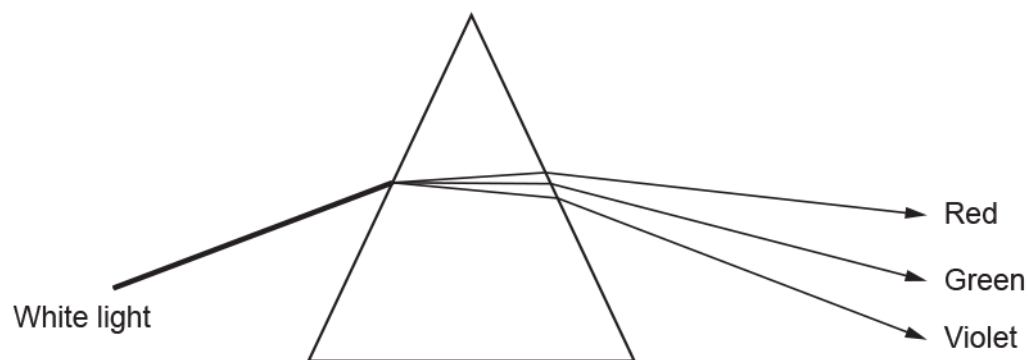
- 8 A light ray passes from air through a glass block.



Complete the ray diagram for this light ray as it travels into **and** out of the glass block.

[3]

- 9 Look at the diagram of white light as it passes through a prism.



A spectrum of colours is seen. It ranges from red to violet.

Why does the **violet** light refract **more** than the red light?

- A Violet light changes frequency more than red light.
- B Violet light has the largest change in speed.
- C Violet light has the smallest change in speed.
- D Violet light increases its speed in the glass prism.

Your answer

[1]

10(a) A student investigates reflection and refraction of light rays.

The student sends a ray of red light into a glass prism.

Fig. 18.1 shows the light ray as it leaves the glass prism.

On Fig. 18.1 complete the ray of light as it travels towards and through the glass prism.

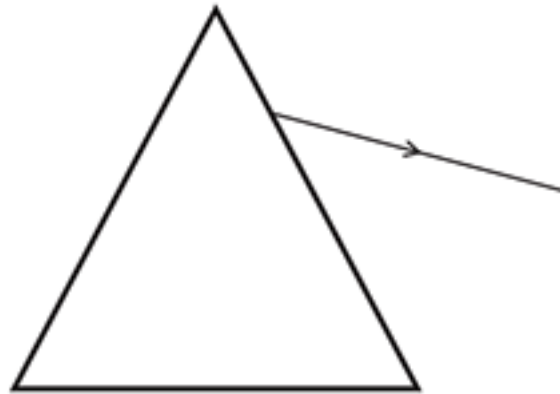


Fig. 18.1

[2]

(b) Fig. 18.2 shows two mirrors placed at 90° to each other.

A light ray hits one of the mirrors at 45° .

On Fig. 18.2 complete the ray of light as it reflects from both mirrors.

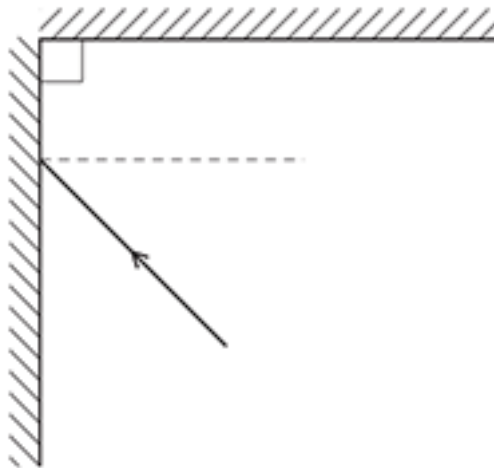


Fig. 18.2

[2]

(c) White light is made of different colours.

White light passes through a transparent filter X.

Filter X absorbs green, blue, indigo and violet light.

The light then passes through another transparent filter, Y, as shown in Fig. 18.3.

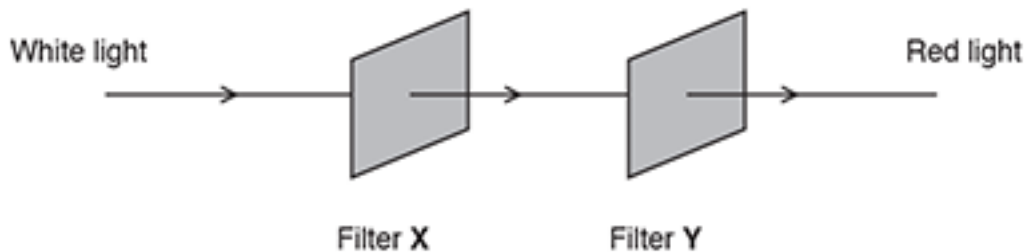


Fig. 18.3

The light that leaves filter Y is red.

(i) What colours are transmitted by filter X?

----- [1]

(ii) What colours are absorbed by filter Y?

----- [1]

(d) A wall is painted red.

When some coloured lights shine on it, the wall appears black.

(i) Explain why.

----- [1]

(ii) Suggest **two** different colours of light that would cause the wall to appear black.

----- and -----

[1]

(e) An optician uses red and green light to test vision.

Fig. 18.4 is a ray diagram showing **red light** passing through a lens.

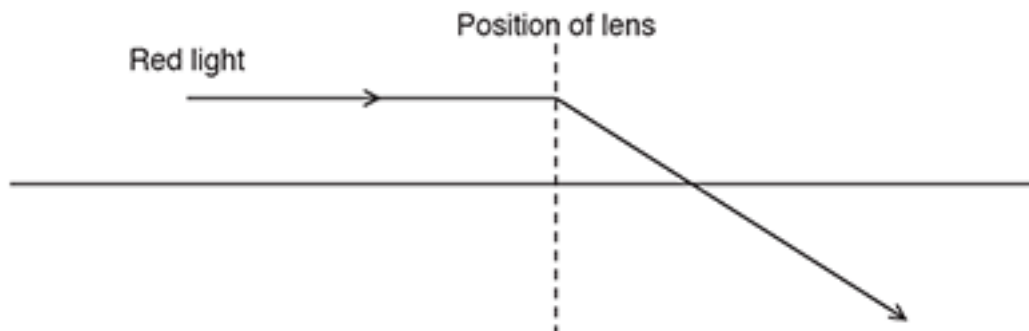


Fig. 18.4

- (i) Green light passes through the same lens as in Fig. 18.4.

Complete the ray diagram in Fig. 18.5 for **green light**. The focal point for red light F_R is shown.

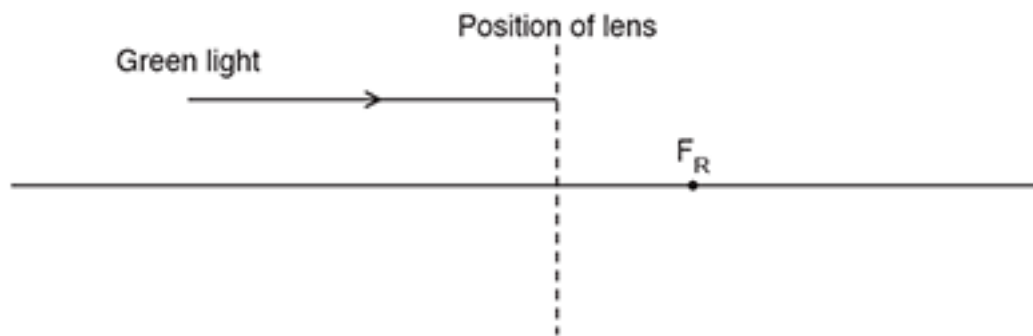


Fig. 18.5

[1]

- (ii) Explain your answer to (i).

----- [1]

- (iii) Is the lens in Fig. 18.4 and 18.5 suitable for correcting long-sight or short-sight?

Tick (✓) **one** box.

Long-sight

☐

Short-sight

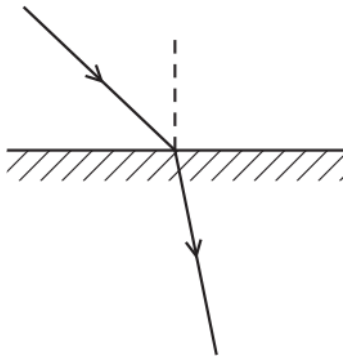
☐

Explain your answer.

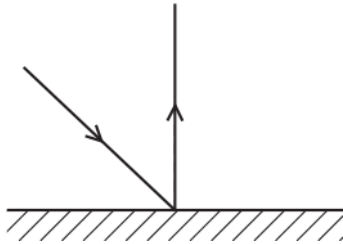
----- [2]

- 11 Which diagram shows reflection of a light ray using a plane mirror?

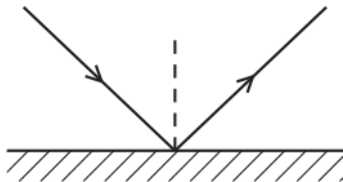
A



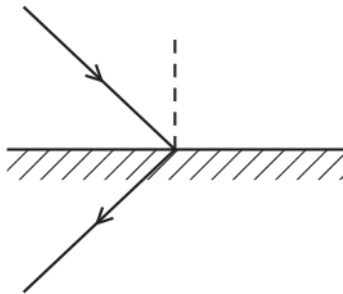
B



C



D



Your answer

[1]

12(a) Lenses can be used to help people see clearly.

Fig. 18.1 is a diagram of a convex lens.



Fig. 18.1

- (i) A student models the lens using two glass **prisms** and a glass **block**.

Complete the ray diagram Fig. 18.2 to show how light rays travel through the model lens (glass prism and glass block).

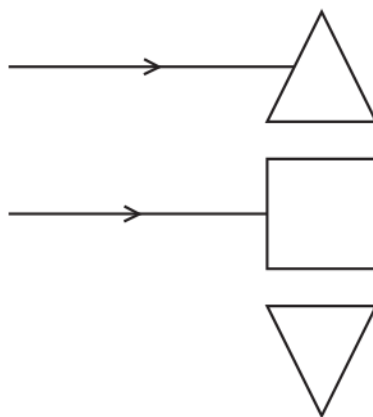


Fig. 18.2

[2]

- (ii) Explain how a convex lens can correct long-sighted vision.

Use the model in Fig. 18.2 to help you.

[2]

(b) A student looks at coloured paper in different coloured light.

Fig. 18.3 is a diagram of her experiment.

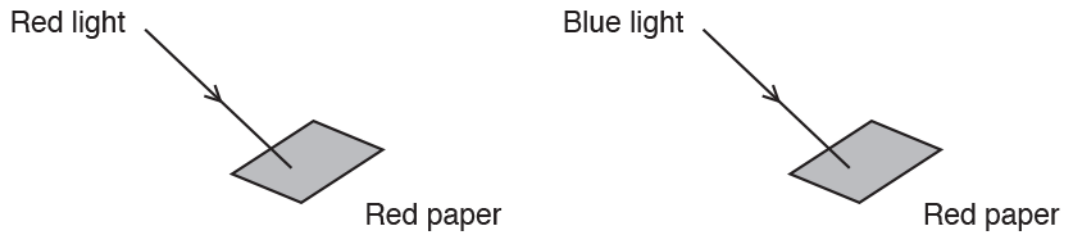


Fig. 18.3

She looks at red paper with red light. The paper appears red.

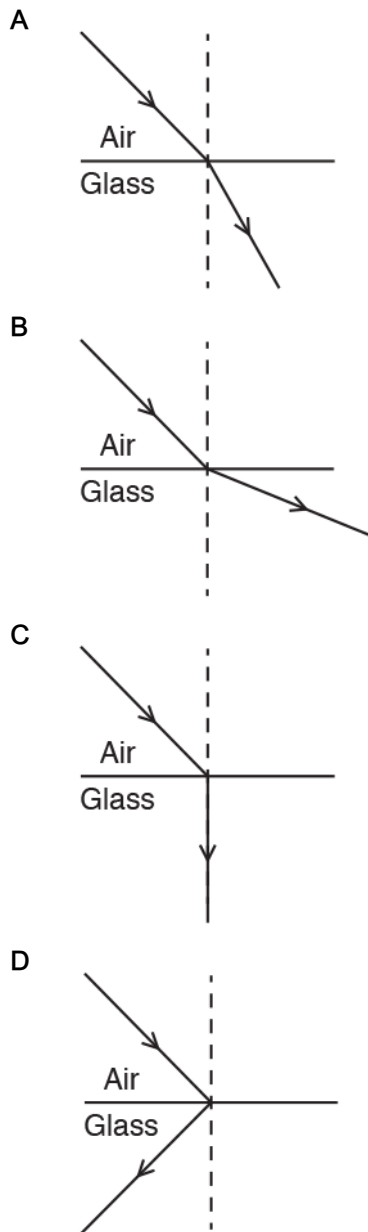
What colour does the red paper appear in blue light?

Explain your answer.

[2]

13 A light ray passes from air into glass.

Which diagram shows the **refraction** of this light ray?



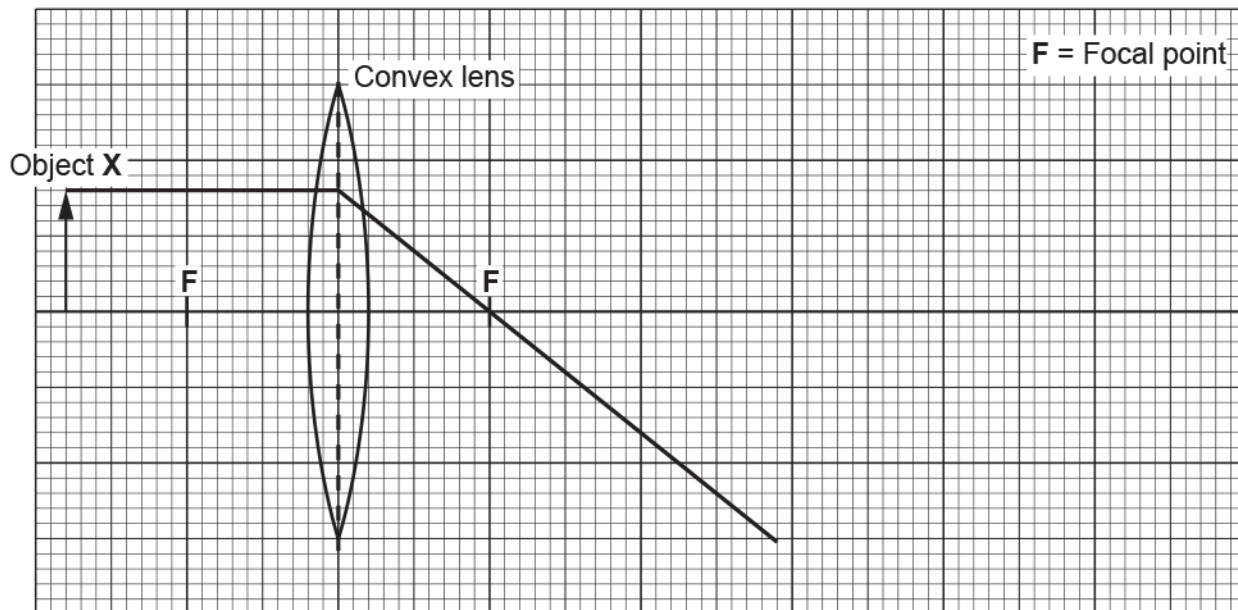
Your answer

[1]

14(a) A projector is used to create a larger image of an object.

The diagram shows one light ray as it passes through the convex lens.

Draw **one** more ray on the diagram to show where the image is formed. Label the image Y.



[2]

(b) The projector contains a white light source.

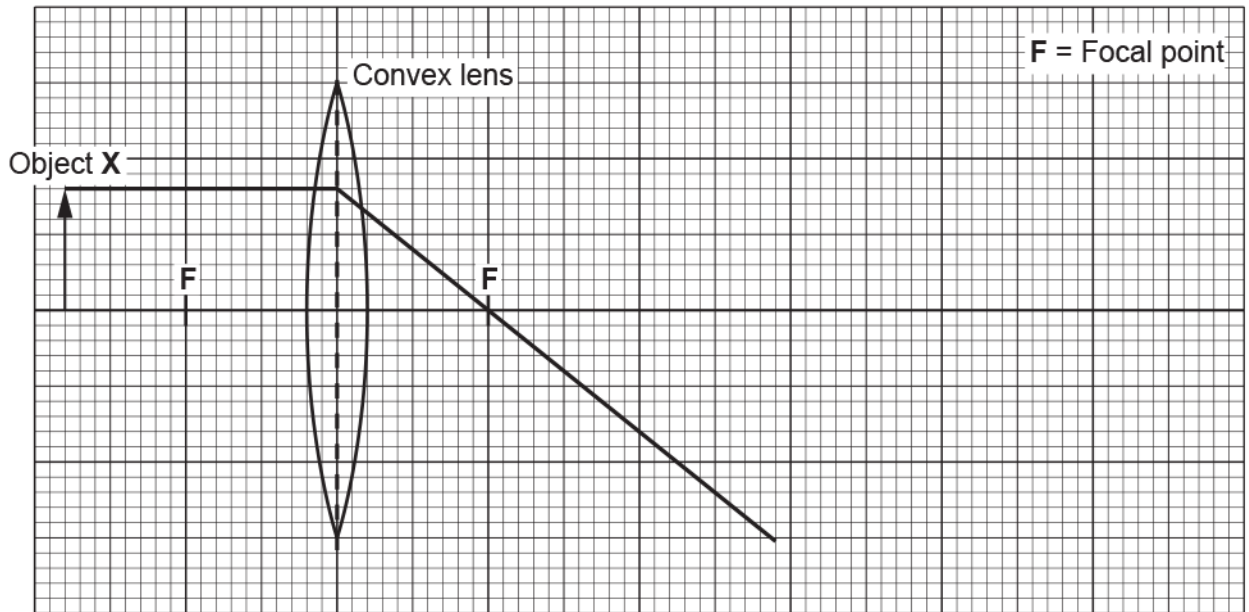
Explain how this white light source can be used to get **red** light.

[2]

15 A projector is used to create a larger image of an object.

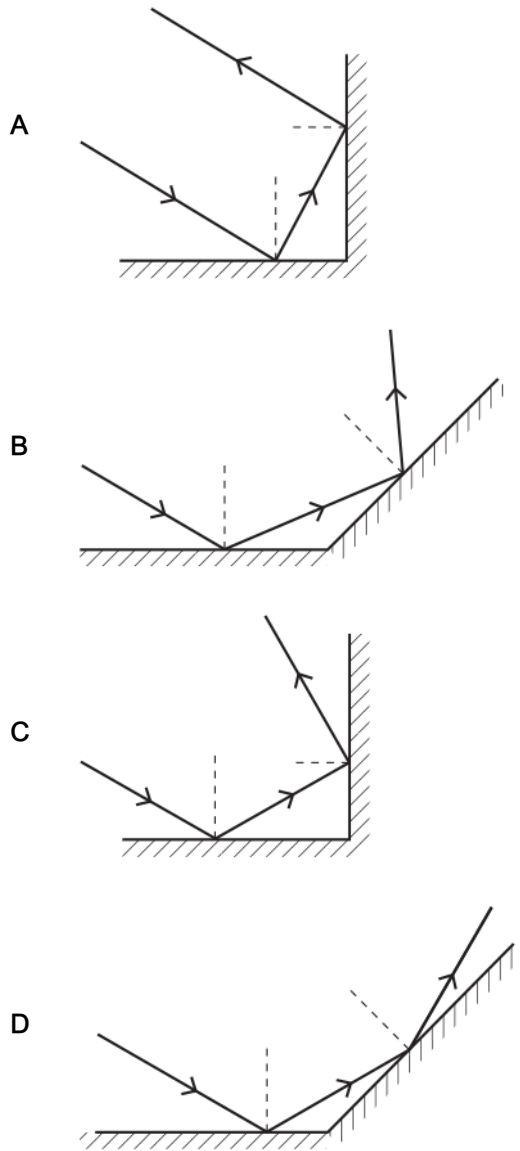
The diagram shows one light ray as it passes through the convex lens.

Draw **one** more ray on the diagram to show where the image is formed. Label the image Y.



[2]

16 Look at the diagrams of a light ray reflecting from two identical surfaces.



Which diagram is correct?

Your answer

[1]

17 A projector is used to create a larger image of an object.

The projector contains a white light source.

Explain how this white light source can be used to get red light.

[2]

18(a) The graph in Fig. 19.1 shows how displacement of an ultrasound wave varies with distance.

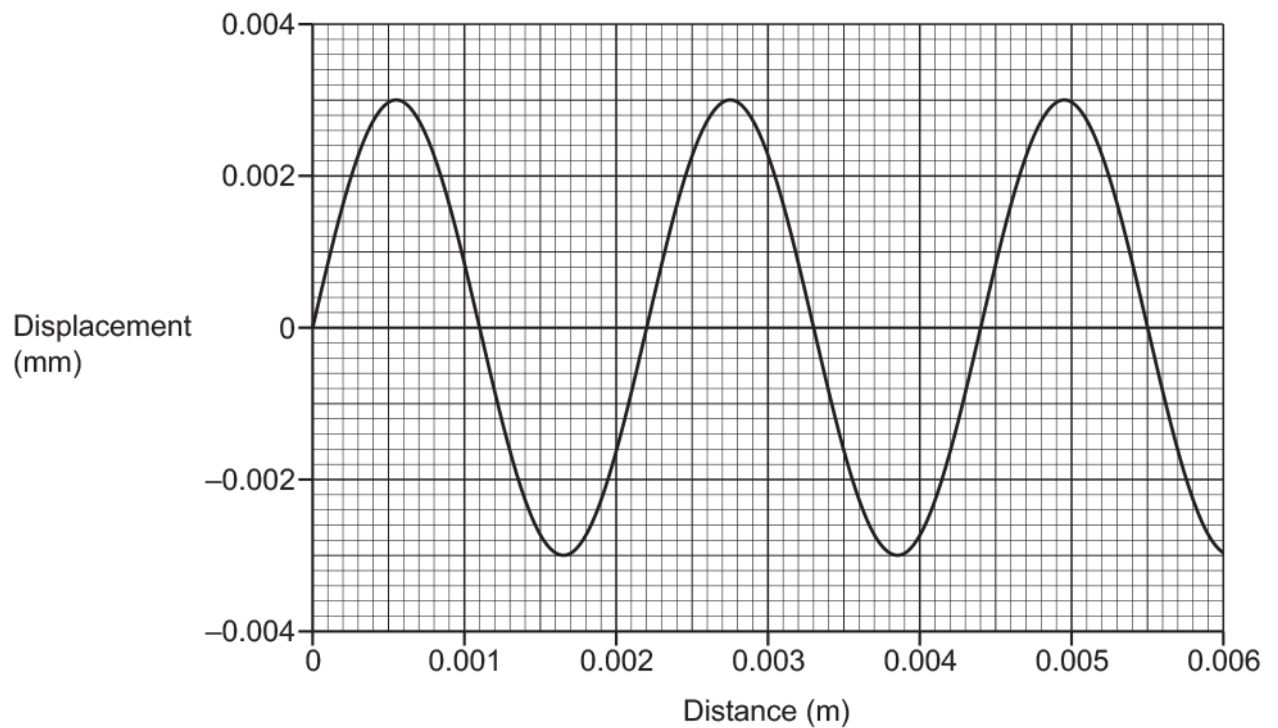


Fig. 19.1

(i) Use the graph in Fig. 19.1 to determine the wavelength of an ultrasound wave.

Wavelength = ... m [1]

(ii) The speed of ultrasound waves in (i) is 4500 m / s.

Calculate the frequency of the ultrasound wave in Fig. 19.1.

Use the equation: wave speed = frequency $\times$ wavelength

Give your answer in **standard form** and to 2 significant figures.

Frequency = ... Hz [4]

(b) Doctors can use an ultrasound scan to measure the size of a person's kidney.

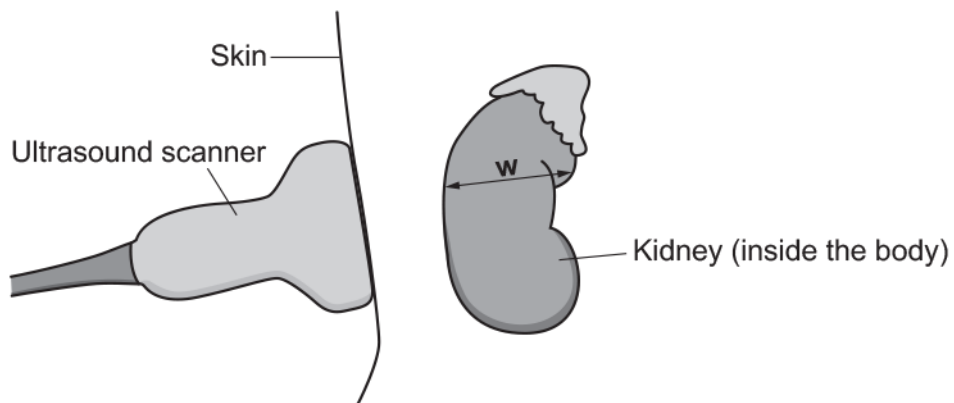


Fig. 19.2

Complete the sentences using the words below.

Each word may be used once, more than once, or not at all.

Increases Decreases Stays the same

The ultrasound scanner is made from a solid ceramic material.

As the wave enters the body, the speed

As the wave enters the body, the frequency

[2]

(c)

(i) Explain what happens to the ultrasound wave when it reaches the kidney.

----- [2]

(ii) Fig. 19.2 shows the thickness of the kidney, w .

Explain how ultrasound waves are used to measure w .

----- [2]

(d) A doctor uses an ultrasound scan instead of X-rays to measure the kidneys.

Explain why.

----- [1]

END OF QUESTION PAPER

Mark Scheme

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	

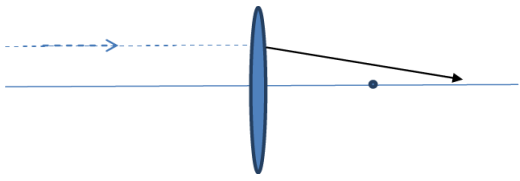
Mark Scheme

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	

Mark Scheme

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	

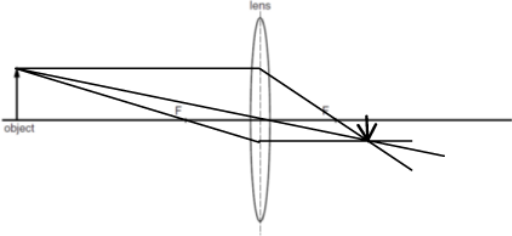
Mark Scheme

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 <u>Examiner's Comments</u> ??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) <u>Examiner's Comments</u> 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 <u>Examiner's Comments</u> ??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 <u>Examiner's Comments</u> 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.

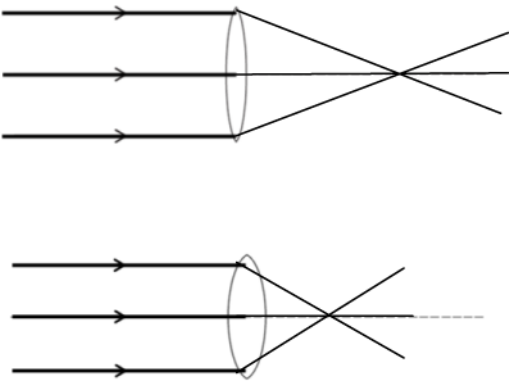
Mark Scheme

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) <u>Examiner's Comments</u> ?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	

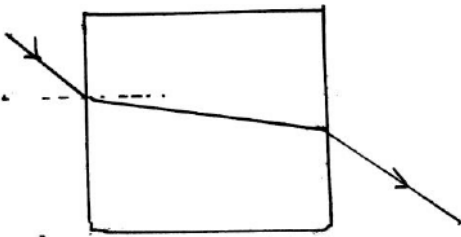
Mark Scheme

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

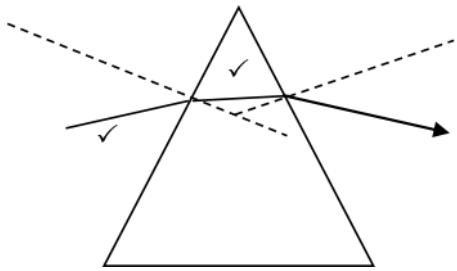
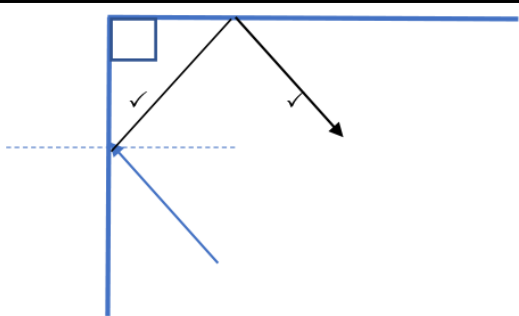
Mark Scheme

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	

Mark Scheme

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	

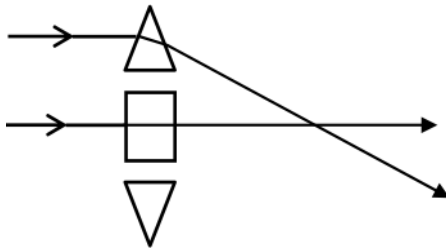
Mark Scheme

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 entry 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 2x1.2)	One mark for each correct reflection of about 90° 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.

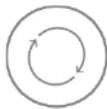
Mark Scheme

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 <u>Examiner's Comments</u> 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 F_R 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 <u>Examiner's Comments</u> 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)	<u>Examiner's Comments</u> This question was answered correctly by the majority of the candidates. A small number of candidates opted for D
			Total	1	

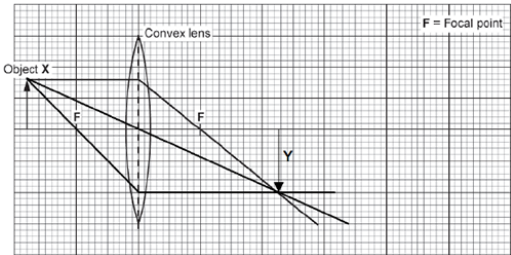
Mark Scheme

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  <u>Examiner's Comments</u> 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 <u>behind</u> retina / eye (ball) / AW ✓ Convex lens refracts light inwards / focuses light on the retina / AW ✓	2 (AO 2x1.1)	ALLOW near object focussed <u>behind</u> the retina / eye (ball) or eye (ball) is too short ALLOW converges / meet for focuses <u>Examiner's Comments</u> 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.

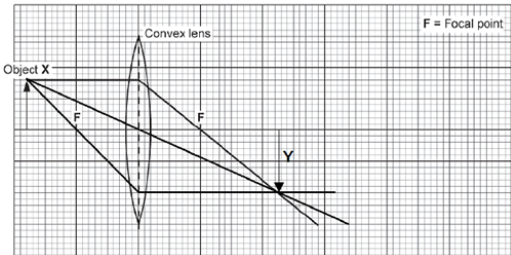
Mark Scheme

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 <u>Examiner's Comments</u> 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	

Mark Scheme

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 <u>only</u> / <u>only</u> lets red (light/frequency/wavelength) through
			Total	4	

Mark Scheme

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	

Mark Scheme

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 x 2.1)	
	c	i	(Partial) reflection/absorption at the front of the kidney ✓ (Partial) reflection at the back of the kidney ✓	2 (AO2 x 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 = $\frac{1}{2} \times \text{speed} \times \text{time}$ (to find the size) ✓	2 (AO2 x 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	