Higher

GCSE

Physics A Gateway

J249/04: Paper 4 (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for June 2024

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

MARKING INSTRUCTIONS

PREPARATION FOR MARKING

RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Online Training*; *OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are available in RM Assessor.
3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **required number** of standardisation responses.

MARKING

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the RM Assessor messaging system.

5. **Crossed Out Responses**

Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

Rubric Error Responses – Optional Questions

Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

Multiple Choice Question Responses

When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).
When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses

When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only one mark per response)

Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

Short Answer Questions (requiring a more developed response, worth two or more marks)
If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

Longer Answer Questions (requiring a developed response)
Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add the annotation SEEN to confirm that the work has been seen.

7. Award No Response (NR) if:

- there is nothing written in the answer space

Award Zero '0' if:

- anything is written in the answer space and is not worthy of credit (this includes text and symbols).

Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

8. The RM Assessor **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**

If you have any questions or comments for your Team Leader, use the phone, the RM Assessor messaging system, or email.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. For answers marked by levels of response:

Read through the whole answer from start to finish, using the Level descriptors to help you decide whether it is a strong or weak answer. The indicative scientific content in the Guidance column indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the skills and science content evidenced within the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.

Once the level is located, award the higher or lower mark:

The higher mark should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.

The lower mark should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.

In summary:

The skills and science content determines the level.

The communication statement determines the mark within a level.

Level of response question on this paper is **21c**.

11. Annotations available in RM Assessor

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
BOD	Benefit of doubt given
CON	Contradiction
RE	Rounding error
SF	Error in number of significant figures
ECF	Error carried forward
L1	Level 1
L2	Level 2
L3	Level 3
NBOD	Benefit of doubt not given
SEEN	Noted but no credit given
I	Ignore

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
I	alternative and acceptable answers for the same marking point
✓	Separates marking points
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

12. **Subject-specific Marking Instructions**

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

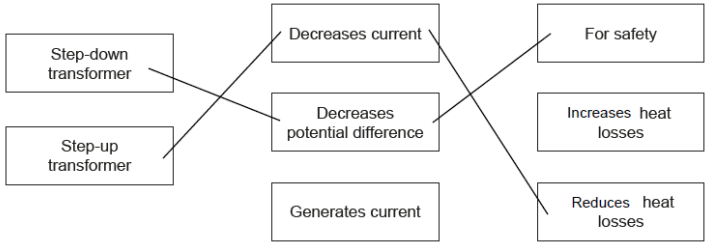
Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

The breakdown of Assessment Objectives for GCSE (9-1) in Physics A:

	Assessment Objective
AO1	**Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.**
AO1.1	Demonstrate knowledge and understanding of scientific ideas.
AO1.2	Demonstrate knowledge and understanding of scientific techniques and procedures.
AO2	**Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.**
AO2.1	Apply knowledge and understanding of scientific ideas.
AO2.2	Apply knowledge and understanding of scientific enquiry, techniques and procedures.
AO3	**Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.**
AO3.1	Analyse information and ideas to interpret and evaluate.
AO3.1a	Analyse information and ideas to interpret.
AO3.1b	Analyse information and ideas to evaluate.
AO3.2	Analyse information and ideas to make judgements and draw conclusions.
AO3.2a	Analyse information and ideas to make judgements.
AO3.2b	Analyse information and ideas to draw conclusions.
AO3.3	Analyse information and ideas to develop and improve experimental procedures.
AO3.3a	Analyse information and ideas to develop experimental procedures.
AO3.3b	Analyse information and ideas to improve experimental procedures.

For answers to Section A if an answer box is blank ALLOW correct indication of answer e.g. circled or underlined.

Question	Answer	Marks	AO element	Guidance
1	C	1	2.1	
2	D	1	2.1	
3	C	1	1.1	
4	A	1	1.1	
5	B	1	1.2	
6	D	1	1.1	
7	C	1	2.1	
8	B	1	1.2	
9	A	1	2.1	
10	C	1	1.2	
11	A	1	2.1	
12	A	1	2.1	
13	C	1	2.1	
14	A	1	2.2	
15	B	1	2.2	

Question			Answer	Marks	AO element	Guidance
16	(a)		 ✓✓	2	2 × 1.1	Mark independently Correct matching of both transformers to what they do Correct matching of what they do to reason If no other marks scored: **ALLOW** 1 mark for step-down transformer → decreases pd → for safety **OR** step-up transformer → decreases current → reduces heat losses
	(b)		**First check the answer on the answer line** **If answer = 450 (A) award 2 marks** 132 000 × I_p = 1800 × 33 000 ✓ **OR** (I_p =) 1800 × 33 000 ÷ 132 000 ✓ (I_p =) 450 (A) ✓	2	2 × 2.1	**ALLOW** substitution into any correct rearrangement of the equation **ALLOW** equation in letters/words rearranged (I_p =) V_s I_s ÷ V_p

	(c)		Alternating (current) / a.c. ✓ p.d./voltage/current/it changes direction / becomes + and – / changes polarity ✓	**2**	**1 x 1.1** **1x3.2b**	 **ALLOW** p.d./voltage/current/it/oscilloscope trace/charge flow goes in both directions or both ways or two ways or different ways **ALLOW** oscillates/fluctuates across the centre/zero **IGNORE** just changes or switches / goes up and down / alternates **IGNORE** charge changes from positive to negative

Question			Answer	Marks	AO element	Guidance
17	(a)		Contaminated because radioactive material touched the workers / was breathed in ✓ Irradiated because workers were exposed to radiation (from outside of the body) ✓	2	2 × 1.1	**ALLOW** it is in contact with (workers) / went on/inside them **DO NOT ALLOW** answers which also include ideas about irradiation e.g. radiation touches the workers/is inhaled **ALLOW i**n presence of radiation/radiation passes into body **DO NOT ALLOW** answers which also include ideas about contamination
	(b)		Nuclear ✓→Thermal ✓→ Kinetic ✓	3	3 × 2.1	**IGNORE** heat
	(c)	(i)	(It takes) 30 years / (average) time taken for number of (un-decayed or unstable) nuclei to halve / for activity to halve / for count rate to halve / for mass of undecayed nuclei to halve ✓	1	1.1	**ALLOW** atoms for nuclei **ALLOW** mass (of it/caesium) to halve / half of it/substance to decay **IGNORE** reactivity / time taken for a nucleus to halve
		(ii)	Radioactive decay is a random process. ✓ When a nucleus decays, it splits in half. ☐ With large numbers, it is easier to count half of the nuclei. ☐ ✓	1	1.1	
		(iii)	**First check the answer on the answer line** **If answer = 3.5 (kg) award 2 marks** (idea that 90 years =) 3 (half-lives) ✓ (mass = 28 × (½)^3 =) 3.5 (kg) ✓	2	2 × 2.2	**ALLOW** evidence of 3 half-lives e.g. 28→14→7→3.5

	(d)		$^{238}_{94}Pu \rightarrow {}^{234}_{92}U + {}^{4}_{2}He$ $^{9}_{4}Be + {}^{4}_{2}He \rightarrow {}^{12}_{6}C + {}^{1}_{0}n$ Correct mass for U ✓ Correct atomic number for U ✓ Correct mass and atomic number for n ✓	**3**	**3 × 2.2**	

Question			Answer	Marks	AO element	Guidance
18	(a)		Angle of incidence not equal to angle of reflection (at mirror B/second reflection) / **AW** ✓ Normal line is not at 90° (to surface of mirror B) / **AW** ✓	**2**	**2 × 1.1**	**IGNORE** not at correct angle **If no other marks scored:** **ALLOW** (second**)** reflected ray should be parallel to original ray for 1 mark
	(b)		dust on it/retroreflector ✓	**1**	**3.2a**	**ALLOW** it is dirty/dull/scratched/not smooth
	(c)		**First check the answer on the answer line** **If answer = 61.6 (J) award 3 marks** Select: (gravitational potential energy =) mass × gravitational field strength x height / (E =) mgh ✓ (E =) 77 × 0.5 × 1.6 ✓ (E =) 61.6 (J) ✓	**3**	**1.2** **2 × 2.1**	**ALLOW** 62 (J) **ALLOW** equation in any form

	(d)		**First check the answer on the answer line** **If answer = 5.6 × 10^{14} (Hz) award 4 marks** Select and rearrange: (frequency =) wave speed ÷ wavelength / f = v ÷ λ ✓ (f =) 3 x 10^{8} ÷ 5.32 x 10^{-7} ✓ (f =) 5.639… × 10^{14} ✓ (f =) 5.6 × 10^{14} (Hz) (2 s.f.) ✓	**4** **1.2** **2.1** **2.1** **1.2**		**ALLOW** correct substitution into unrearranged equation for 1 mark **ALLOW** 5.639…x 10^{n} for 2 marks **ALLOW** 5.6 x 10^{n} for 3 marks **ALLOW** this mark for clear evidence of an incorrect answer (correctly rounded) to two significant figures (not a bald answer to 2 s.f.)
	(e)		Eyes can only detect a limited range of (electromagnetic) waves / wavelength is too large (to be seen) / frequency is too small (to be seen) ✓	**1**	**1.1**	**ALLOW (**frequency/wavelength of) IR is outside of the range of EM waves that is detectable to the eye / eye is not able to see that frequency/wavelength of wave **ALLOW** eyes can <u>only</u> detect (visible) light **BUT IGNORE** IR is not visible to the eye / eyes cannot see/detect IR
	(f)	**(i)**	Visible light has a larger frequency (than infrared) / **ORA** ✓ Visible light has shorter wavelength (than infrared) / **ORA** ✓	**2**	**2 × 1.1**	**IGNORE** longer/shorter frequency

		(ii)	**Any two from:** Count number of waves (passing a point) ✓ Measure time (for these waves with a stopwatch) ✓ Divide number of waves (passing a point) by the time (for these waves) ✓ **Alternative method** (idea of) measure time period / time for 1 wave ✓ Use frequency = 1 ÷ time period ✓	**2**	**2 × 2.2**	 **ALLOW** count how many times an object e.g. cork bobs up and down **IGNORE** time it takes waves to travel a certain distance **ALLOW** count number of waves in a certain time for 2 marks **If no other marks scored:** (idea that) frequency is the number of waves per second for 1 mark

Question			Answer	Marks	AO element	Guidance
19	(a)		**First check the answer on the answer line** **If answer = 7 (%) award 2 marks** (% system margin =) (64.2 – 60.0) ÷ 60.0 × 100 ✓ (% system margin =) 7 (%) ✓	**2**	**2 × 2.1**	
	(b)	**(i)**	**Any two from:** (Idea that) demand may change ✓ (Idea that) supply (capacity) may change ✓ Weather may change / may be warmer or colder than expected ✓	**2**	**2 x 3.2a**	**ALLOW** don't know the exact demand / customers may use more or less electricity/heating (than predicted) **ALLOW** don't know the exact supply (capacity) **ALLOW** wind speed will change **IGNORE** seasons change
		(ii)	**First check the answer on the answer line** **If answer = 35 (%) award 2 marks** (% uncertainty =) 0.5 × (6.2 – 3.0) ÷ 4.6 × 100 ✓ (% uncertainty =) 35 (%) ✓	**2**	**2 × 3.3b**	 **ALLOW** answers that round to 35 (%)
	(c)	**(i)**	(Idea that) demand may be greater than supply / possibility of power cuts / may not be able to supply enough electricity (to customers) / **AW** ✓	**1**	**3.2b**	
		(ii)	**First check the answer on the answer line** **If answer = 5.68 award 2 marks** 4.5 × 0.04 **OR** 0.18 **OR** 4.5 x 1.04 **OR** 4.68 ✓ 5.68 ✓	**2**	**2 × 2.2**	**ALLOW** 5.7

Question			Answer	Marks	AO element	Guidance
20	(a)		**First check the answer on the answer line** **If answer = 15 (m / s) award 3 marks** Evidence for use of area under line / distance = area under (v-t) graph ✓ 30 = ½ × u × 4 **OR** u = 2 × 30 ÷ 4 ✓ (u =) 15 (m / s) ✓	**3**	**3 × 2.2**	 **ALLOW** e.g. 5u ÷ 2 **OR** 0.5xbxh **ALLOW** evidence seen on graph **ALLOW** use of higher level answers using SUVAT equations of motion e.g. s = (u + v)t ÷ 2
	(b)	(i)	**First check the answer on the answer line** **If answer = 27 (m) award 3 marks** Select and rearrange: (distance =) final velocity^2 – initial velocity^2 ÷ 2 x acceleration **OR** (s =) $v^2 – u^2 ÷ 2$ x a ✓ Substitution: (s =) $–18^2 ÷ –12$ **OR** $18^2 ÷ 12$ **OR** 324 ÷ 12 ✓ (s =) 27 (m) ✓	**3**	 **1.2** **2 × 2.1**	 **ALLOW** correct substitution into unrearranged equation for 1 mark e.g. $0 – 18^2 = 2 × –6 × s$ **OR** $18^2 – 0 = 2 × 6 × s$ **ALLOW** d for s **ALLOW** -27 (m) **ALLOW** other correct use of SUVAT equations of motion

Question			Answer	Marks	AO element	Guidance
		(ii)	**First check the answer on the answer line** **If answer = 2400 – 21 000 (N) award 3 marks** Estimation of mass of car = 1500 (kg) ✓ (F =) 1500 × 6 ✓ (F =) 9000 (N) ✓	**3**	 **1.1** **2 × 2.1**	**ALLOW** 2 marks for force correctly calculated if mass is outside of range **ALLOW** 400 - 3500 (kg) **ALLOW** candidate's mass estimate x 6 for 1 mark **ALLOW** candidate's mass estimate x 6 correctly calculated for 2 marks
		(iii)	**Any two from:** Skid mark may not have clear start or end ✓ Skid mark may be curved / difficult to measure ✓ (Idea that) car may not have produced a skid for whole of braking (distance) / **AW** ✓ (Idea that) skid mark only occurs when the wheels stop turning ✓	**2**	**2 × 3.2a**	 **ALLOW** skid marks don't appear as soon as braking starts / deceleration is not always large enough to produce skids marks

Question			Answer	Marks	AO element	Guidance
21	(a)		The Earth is accelerating ✓	1	1.1	
	(b)		**Any two from:** Star **A** has higher (maximum) intensity than star **B** / Star **B** has lower (maximum) intensity than star **A** ✓ Star **A** graph intensity peaks at shorter wavelength than star **B** / Star **B** graph intensity peaks at longer wavelength than star **A** ✓	2	2 × 3.1a	**IGNORE** stronger/more radiation **If no other marks are scored:** **ALLOW** star **A** is hotter than star **B** / **ORA**

Question			Answer	Marks	AO element	Guidance
Maximum of 3 marks if only explanation of radiation absorbed/emitted or effect of Earth's atmosphere is mentioned.						
21	*	(c)	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** **A detailed explanation of the radiation absorbed and emitted by the Earth AND a detailed explanation of the effect of the Earth's atmosphere.** *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** **A clear explanation of the radiation absorbed and emitted by the Earth AND a clear explanation of the effect of the Earth's atmosphere.** **OR** **A detailed explanation of the radiation absorbed and emitted by the Earth AND a basic explanation of the effect of the Earth's atmosphere.** **OR** **A detailed explanation of the effect of the Earth's atmosphere AND a basic explanation of the radiation absorbed and emitted by the Earth.** *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*	6	3 × 1.1 3 × 3.1b	**AO1.1– Demonstrate knowledge and understanding of scientific ideas to explain the radiation absorbed and emitted by the Earth.** • The Earth radiates (infrared) radiation back into space • The Earth emits less radiation than it absorbs. • If energy/radiation absorbed = energy/radiation emitted by the Earth, the temperature of the Earth stays constant • If energy/radiation absorbed > energy/radiation emitted by the Earth, the temperature of the Earth increases • The Earth absorbs UV/light/shorter wavelength (infrared) radiation • The Earth emits longer wavelength (infrared) radiation **AO3.1b - Analyse information and ideas to explain the effect of the Earth's atmosphere on the actual temperature of the Earth.** • Atmosphere/greenhouse gases trap/reflect (infrared) radiation • Amount of greenhouse gases is increasing • Greenhouse effect is increasing • Without atmospheric/greenhouse gases, temperature of the Earth would be very cold • Greenhouse gases/CO_2 in atmosphere absorb some of the Earth's emitted (infrared) radiation

			Level 1 (1–2 marks) **A basic explanation of the radiation absorbed and emitted by the Earth** **OR** **a basic explanation of the effect of the Earth's atmosphere.** *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant***.** **0 marks** *No response or no response worthy of credit.*			• Greenhouse gases/CO_2 in atmosphere emit (infrared) radiation • Some of the (infrared) radiation emitted by the Earth is radiated/reflected back towards the Earth's surface • Some of the (infrared) radiation emitted by the Earth is radiated/reflected by the atmosphere/ (greenhouse) gases/CO_2

Question			Answer	Marks	AO element	Guidance
22	(a)		Refraction ray drawn with angle of refraction smaller than angle of incidence ✓	1	1.2	Judge by eye **IGNORE** direction of arrow and length of ray
	(b)		Glass is more (optically) dense than air ✓ The speed of light is lower in glass ✓	2	2 × 1.1	**ALLOW** glass has a different (optical) density (to air) **DO NOT ALLOW** glass is less (optically) dense **ALLOW** glass has a different refractive index (to air) **ALLOW** (the light) slows down **DO NOT ALLOW** the speed of light is higher in glass **IGNORE** ideas about wavelength and frequency **If no other mark scored:** **ALLOW** light changes speed (in glass)

22	**(c)**	**(i)**	Measure angles with a protractor ✓ Angle (of incidence and angle of refraction) measured between ray and normal ✓ **And any two from:** Draw normal (where ray enters block) ✓ Trace along light rays (with a pencil) ✓ Detail on tracing rays e.g., draw crosses along rays first then remove block and join them up ✓ Change the angle of incidence (to measure different angles of refraction) ✓ Plot a graph to show relationship between angle of incidence and angle of refraction ✓	**4**	**2 × 1.2** **2 × 3.3a**	**ALLOW** can be shown on Fig 22.1 **ALLOW** draw line at 90^{o} (where ray enters block) **ALLOW** draw a line entering block and shine laser along it **ALLOW** use of pins on rays to trace where the light rays are
	(c)	**(ii)**	Calculate a constant from one pair of data values ✓ Calculate a constant from a different pair of angles and compare ✓	**2**	**2 × 3.2a**	e.g., 22/14 = 1.57 34/22 = 1.55 48/30 = 1.60 55/33 = 1.67 62/36 = 1.72 **ALLOW** use of vertical ratios e.g., 48/34 = 1.41 30/22 = 1.36 etc **ALLOW** use of calculated constant from one pair of data values to show that it does not work with another pair of data values e.g., 22/14 = 1.57 and 48 ÷ 1.57 ≠ 30 **ALLOW** use of vertical ratios e.g., 48/34 = 1.4 but 30/22 = 1.36 etc

	(d)		(Green and red light have) different wavelengths/frequencies ✓ (Idea that) the amount the speed changes (in glass) is different for each colour ✓	**2**	**2 × 1.1**	**ALLOW** red light has longer wavelength/smaller frequency / **ORA** **DO NOT ALLOW** red light has shorter wavelength/larger frequency / **ORA** **ALLOW** red light slows down the least (in glass) / **ORA** **ALLOW** speed of red light in glass is larger (than speed of green light) **ALLOW** speed in glass is different for each colour **DO NOT ALLOW** speed of red light in glass is smaller (than speed of green light) / **ORA**
	(e)		Both rays drawn as straight lines and refract towards principal axis ✓ The green ray crosses the principal axis closer to the lens than the red ray ✓	**2**	**1.2** **1.1**	

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