Rewarding Learning

ADVANCED
General Certificate of Education
2023

Life and Health Sciences

Assessment Unit A2 4

Sound and Light

[AZ041]

WEDNESDAY 21 JUNE, MORNING

MARK SCHEME

Foreword

Introduction

Mark Schemes are published to assist teachers and students in the preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of 16–18-year-old students in schools and colleges. The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes therefore are regarded as a part of an integral process which begins with the setting of questions and ends with the marking of the examination.

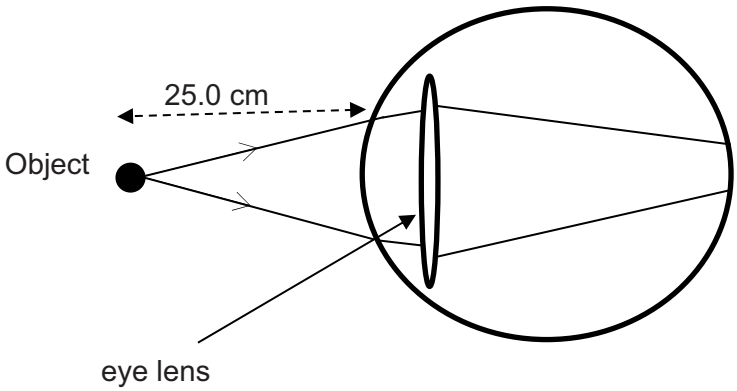
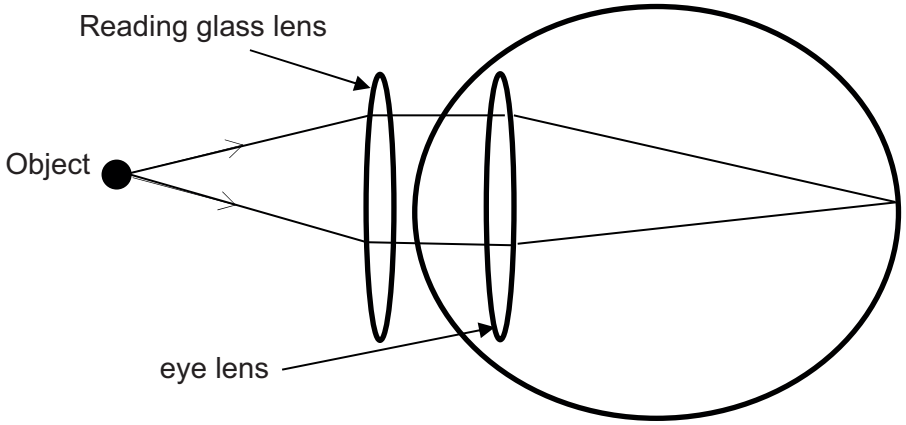
The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

The Council hopes that the mark schemes will be viewed and used in a constructive way as a further support to the teaching and learning processes.

					AVAILABLE MARKS
1	**(a)**	The cornea	[1]		
		Biggest difference in density (between air/cornea boundary)	[1]	[2]	
	(b)	There are more rods than cones	[1]		
		Several rods are connected to one nerve cell	[1]	[2]	
		Deduct [1] for each box ticked in excess of two (to max of 2 marks)			
	(c)	The ability to focus on close up and far away objects	[1]		
		Achieved by changing the shape of the lens	[1]		
		This is done using ciliary muscles	[1]		
		Close up objects lens is thicker/far away objects lens is thinner	[1]	[4]	
	(d)	Any **one** from: Smaller range of vision Loss of stereoscopic vision/loss of depth perception Loss of 3D vision/only see in 2D		[1]	9
2	**(a)**	**(i)** 3 – 4 kHz	[1]		
		Resonance in the auditory canal	[1]	[2]	
		(ii) The amount of energy per second per m^2 or Power per unit area		[1]	
		(iii) 1 pWm^{-2}		[1]	
	(b)	Any **four** from: Using a signal generator connected to a loud speaker/earphones Set the frequency to maximum sensitivity Increase the loudness until the sound is just audible Use a decibel meter (to record the decibel level) Very quiet room (4 × [1])		[4]	8
3	**(a)**	**(i)** Any **one** from: • vibrations from (tympanic membrane) not translated (to ossicles) • tympanic membrane too tight to vibrate/vibrations too small		[1]	
		(ii) Eustachian tube	[1]		
		(Allows fluid to drain) into throat	[1]	[2]	
		(iii) Cochlea		[1]	
		Inner ear	[1]	[2]	
		(iv) Listening to loud sounds		[1]	
	(b)	**(i)** Produces larger vibrations (at the tympanic membrane)/ amplifies sound		[1]	
		(ii) Any **one** from: If too much nerve loss then hearing aid ineffective All sounds are amplified not just the ones you wish to hear Doesn't pick up all frequencies		[2]	9

					AVAILABLE MARKS
4	**(a)**	Human hearing covers a wide range of intensities	[1]		
	(b) **(i)**	$I = I_o \times 10^{(dB/10)}$	[1]		
		$I = 1 \times 10^{-12} \times 10^{(102/10)}$	[1]		
		$I = 0.0158\ Wm^{-2}$	[1]	[3]	
	(ii)	$I_{total} = 0.0221$ ecf	[1]		
		dB level = 10 log $\frac{I}{I_0}$	[1]		
		dB level = 10 log $\frac{0.0221}{1 \times 10^{-12}}$ ecf	[1]		
		dB level = 103 dB	[1]	[4]	
	(c) **(i)**	It is dependent on the listener		[1]	
	(ii)	Frequency generator/signal generator and speaker		[1]	
	(iii)	Set the frequency at 1000 Hz [1] Increase loudness until the power tools and the frequency Generator sound equally loud [1] Read the dB meter this is the loudness in phons [1]		[3]	13
5	**(i)**	1/f = 1/u + 1/v	[1]		
		Subs .. 1 each			
		1/f = 1/25.8 + 1/44.2 (= 0.06138)	[2]		
		f = 16.3 cm ecf	[1]	[4]	
	(ii)	P = 1/f or subs	[1]		
		P = 6.13 (or 6.14)(D) ecf	[1]	[2]	
	(iii)	5 cm is less than a focal length distance from the lens	[1]		
		virtual image formed/rays won't meet or diverging	[1]	[2]	8

						AVAILABLE MARKS
6	(a)	(i)	Closest point that an object can be placed in front of the eye and still be in focus (without strain)		[1]	
		(ii)	P(or 1/f) = 1/0.25 – 1/0.69 [1] each for subs	[2]		
			P = 4 – 1.449			
			P = 2.55 D	[1]	[3]	
		(iii)	25 cm to 39 cm ecf ([1] for each)		[2]	
	(b)	(i)	Retina at the back of the eyeball			
			Cornea at the front		[1]	
		(ii)			[1]	
		(iii)				
			Refraction inwards at reading glass lens	[1]		
			Rays meet at retina	[1]	[2]	10

						AVAILABLE MARKS
7	**(a)**	**(i)**	Can both travel in a vacuum/both transverse waves/polarised [1] Have different wavelengths/frequencies [1]		[2]	
		(ii)	A (changing/alternating) voltage across/current through the wire [1] makes the electrons in the wire vibrate/accelerate [1]		[2]	
	(b)	**(i)**	$v = f\lambda$ [1] $f = 3 \times 10^8/0.5$ [1] $f = 6 \times 10^8$ Hz [1]		[3]	
		(ii)	dist = speed × time [1] dist = $3 \times 10^8 \times 4.03 \times 10^{-6}$ [1] = 1209 [1] Height = 604.5 m [1]		[4]	
	(c)		• radio waves sent out from emitter and reflect (echo) off storm [1] • they return to detector [1] • if the returning waves have higher frequency the storm is moving towards the observer [1] • lower frequency means it is moving away [1] • the bigger the change in frequency the greater the speed/faster the storm [1]		[5]	16
8	**(a)**	**(i)**	The wave shown could be either transverse or longitudinal (third box)		[1]	
		(ii)	T = 1/f or sub 1/50 [1] T = 0.02 s [1]		[2]	
		(iii)	30		[1]	
		(iv)	0.05 m		[1]	
	(b)	**(i)**	E		[1]	
		(ii)	Both A and E only		[1]	
		(iii)	Half way between D and E/C and D/0 and A		[1]	8

AVAILABLE MARKS

9 (a) Indicative content:

- Draw round the block
- Mark a normal in the middle of the straight edge
- Aim a ray of light through the curved side directed towards the normal
- Increase the angle of incidence (in the glass)
- Until the ray (in air) is refracted at 90° (to the normal)/alongside of block
- Mark incident ray
- Remove glass block and draw in the ray
- Measure the angle of incidence; this is the critical angle (or measure between the incident and reflected ray and halve the angle to get c)
- Using a protractor
- Angle measured between the incident ray and the normal
- Repeat and average
- Dark room

Response	Marks
Candidate identifies and describes **7 or more** of the points shown in the indicative content. There is a widespread and accurate use of appropriate scientific terminology. Presentation, spelling, punctuation and grammar are excellent. Candidates use the most appropriate form and style of writing. Relevant material is highly organised with clarity and coherency.	[7]–[8]
Candidate identifies and describes between **5 and 6** of the points shown in the indicative content. There is a widespread and accurate use of appropriate scientific terminology. Presentation, spelling, punctuation and grammar are excellent. Candidates use the most appropriate form and style of writing. Relevant material is organised with clarity and coherency.	[5]–[6]
Candidate clearly identifies between **3 and 4** of the points shown in the indicative content. There is some use of appropriate scientific terminology. Presentation, spelling, punctuation and grammar are sufficient to make the meaning clear. Candidates use an appropriate form and style of writing. There is some attempt to organise material.	[3]–[4]
Candidates clearly identify at least **1 or 2** of the points shown in the indicative content. There is limited reference to scientific terminology. Presentation, spelling, punctuation and grammar may contain some errors. The form and style are of a satisfactory standard. There is only a limited attempt to organise material.	[1]–[2]
Response is not worthy of credit.	[0]

[8]

(b) (i) When the angle of incidence in the more dense material is greater than the critical angle [1]
all the light is reflected inside the glass/no refraction occurs in the less dense medium [1] [2]

(ii) Axial mode/TIR [1]

(iii) When application is connecting over very large distances/WAN [1]

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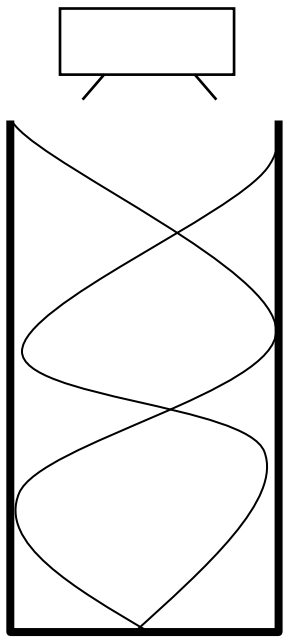
					AVAILABLE MARKS
10	**(a)**	Two identical waves meet travelling in opposite directions	[1]		
		(or a wave meets its reflection)	[1]	[2]	
	(b)	**(i)** N at bottom and A at top		[1]	
		(ii) 112 cm		[1]	
		(iii) 		[1]	
		(iv) $5\lambda/4 = 28$	[1]		
		22.4 cm	[1]	[2]	7
		Please credit $\lambda = \frac{112}{5}$ = 22.4 (cm) with ecf from **(b) (ii)**			
				Total	**100**