Rewarding Learning

ADVANCED
General Certificate of Education
2024

Life and Health Sciences

Assessment Unit A2 4

Sound and Light

[AZ041]

FRIDAY 21 JUNE, AFTERNOON

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 **(i)** Any **two** from
- transverse waves
- can travel in a vacuum
- can travel at 3×10^8 ms^{-1} (in a vacuum) [2]

(ii)

Wave	Infra-red	Visible light	**Ultra-violet**	**Microwaves**	**Radio**
Wavelength in a vacuum	850 nm	5×10^{-7} m	100 nm	3.00 mm	1500 m

One correct award [1]
All three correct [2]

(iii) $v = f\lambda$ [1]
$v = 352 \times 10^{12} \times 850 \times 10^{-9}$ ecf [1] for each correct sub [2]
$v = 3 \times 10^8$ [1] [4]

(iv) $f = 3 \times 10^8 / 5 \times 10^{-7}$ [1]
$f = 6.0 \times 10^{14}$ Hz ecf [1] [2] 10

2 **Indicative content**

- An oscillating magnetic and electric field
- Microphone
- Electron
- Oscillator
- Dipole aerial/antenna
- Oscillator produces an alternating current
- Which causes the electrons to vibrate in the antenna
- At the same frequency as the oscillator
- Modulator

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 5 or 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 good. Candidates use the most appropriate form and style of writing. Relevant material is organised with clarity and coherency.	[5]–[6]
Candidate clearly identifies 3 or 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 identifies 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] 8

3 **(a)** **(i)** TIR at same angle [1]

(ii) Refraction in the air
(angle of refraction > angle of incidence) [1]
Reflection in glass
(angle of reflection = angle of incidence) [1] [2]

(b) **(i)** TIR occurs throughout fibre [1]

(ii) multimode fibres have thick cores [1]
making it possible for light to travel many different paths [1]
more reflections lead to greater path lengths [1]
therefore the light signals arrives at different times [1]
modal distortion/signal distortion occurs [1] [5] 9

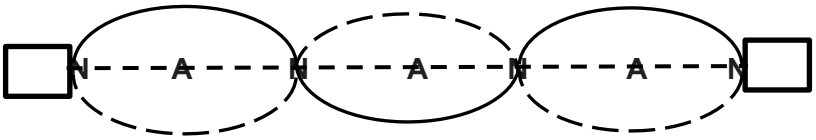
4 **(a)** **(i)** A to D [1]

(ii) A to C/C to D/B to C [1]

(iii) C and D [1]

(b) Time = 5 × 1/f [1]
= 5/82.4 [1]
= 0.0607 s [1] [3]

AVAILABLE MARKS

						AVAILABLE MARKS
	(c)	**(i)**	Signal generator		[1]	
		(ii)	increase/change the frequency (from zero)	[1]		
			until one loop is observed	[1]		
			adjust (frequency) until maximum (very large) amplitude	[1]	[3]	
		(iii)	$3f_o$		[1]	
		(iv)			[1]	
		(v)	1.26 × (2/3) = 0.84 m		[1]	
		(vi)	node – a position where the string does not vibrate/zero amplitude		[1]	
		(vii)	All N and all A correctly labelled		[1]	15
5	**(i)**		Energy per second/power	[1]		
			per unit area	[1]	[2]	
	(ii)		$I = I_o \times 10^{(\text{dB level}/10)}$	[1]		
			$I = 1 \times 10^{-12} \times 10^{(112/10)}$	[1]		
			$I = 0.1585$	[1]	[3]	
	(iii)		$I = 0.1585 - 157.6 \times 10^{-3} = 9 \times 10^{-4}$	ecf	[1]	
			dB level = $10\log(I/I_o)$		[1]	
			$= 10\log(9 \times 10^{-4}/1 \times 10^{-12})$	ecf subs	[1]	
			= 89.5 dB	ecf	[1]	
			NO	ecf	[1]	[5]	10
6	**(a)**	**(i)**	The iris controls the amount of light entering the pupil	[1]		
			when the light is bright the iris size is increased pupil size decreases	[1]	[2]	
		(ii)	Provides nutrients (proteins, glucose, vitamins) to the cornea (and lens)	[1]		
			Provides pressure/keeps the eyeball shape round	[1]	[2]	
	(b)	**(i)**	An eye defect where the eye cannot focus clearly on close-up objects but can focus on far away objects		[1]	
		(ii)	Cornea is made more curved	[1]		
			This increases the power of the eye/decreases the focal length/provides more refraction	[1]	[2]	
	(c)		$P = 1/f$	[1]		
			$f = 1/18.1$	[1]		
			$f = 0.055$ (m)	[1]	[3]	10

AVAILABLE MARKS

7 (i)

U/m	V/m	$\frac{1}{u}/m^{-1}$	$\frac{1}{v}/m^{-1}$
0.60	1.708	1.67	0.585
0.75	1.092	1.33	0.916
1.00	0.795	1.00	1.26

Units in table heading correct [1]
All values of 1/U correctly calculated [1]
All values of 1/V correctly calculated [1] [3]

(ii) 1/f = 1/u + 1/v [1]
Subs .. e.g 1/f = 1.67 + 0.585 ecf [1]
f = 0.444 (accept 0.443)
f = 0.445
f = 0.442
award [1] for 1 correct calculation and [2] for another correct value [2]
f ave = 0.443 m = 44.3 cm ecf [1] [5]

(iii) 1/0.443 = 1/0.25 – 1/old near point
[1] [1] [1] [3]
old near point = 57.4 cm [1] [4]

(iv) 44.3 cm [1]
Beyond this the images produced by the lens is real/this is the focal length of the lens [1] [2] 14

8 (a) (i) Similar lower value [1]
Higher upper value
accept wider frequency range for [1] [1] [2]

(ii) Dog threshold of hearing is – 20dB/lower [1]
Whereas human hearing is 0 dB [1] [2]

(b) (i) pinna (auricle), tympanic membrane (ear drum), auditory canal
if only one or two correct answer 1 mark [2]

(ii) stapes/stirrup [1]

(iii) Any **six** from**:**
- Three tubes
- Fluid filled
- At right angles to each other
- Contain tiny hair cells/cilia
- Can detect movement (in any direction)
- When the head moves the fluid in the tubes move and
- Disturb the hair cells
- Electrical signal sent to the brain
- (The brain) uses this to balance [6] 13

						AVAILABLE MARKS
9	**(a)**	**(i)**	Depends on the listener		[1]	
		(ii)	length of ear canal effects the frequency resonance occurs or amount of nerve cells in cochlea affects loudness at certain frequencies eardrum damage means the listener may be (partially) deaf eustachian tube/ear canal blocked		[1]	
		(iii)	1000 Hz		[1]	
	(b)	**(i)**	102 phons (greater than 100 phons and less than 105 phons)		[1]	
		(ii)	increase in loudness/sensitivity Due to resonance in Auditory canal	[1] [1]	[2]	
		(iii)	A less frequency dependent/all frequencies are loud for A B – sounds at both low and high frequencies require a large intensity to make them seem loud/ear is less sensitive to low and high frequencies	[1] [1]	[2]	
		(iv)	3, 1, 2 All values on the horizontal line have equal loudness If above the horizontal line they are louder and below are quieter	[1] [1] [1]	[3]	11
					Total	**100**