Rewarding Learning

ADVANCED
General Certificate of Education
2022

Life and Health Sciences

Assessment Unit A2 3

assessing

Medical Physics

[AZ031]

WEDNESDAY 22 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.

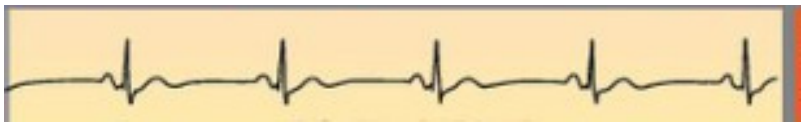
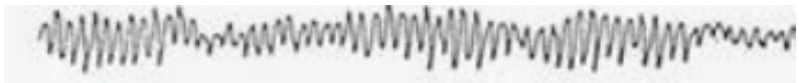
The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed 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.

COVID-19 Context

Given the unprecedented circumstances presented by the COVID-19 public health crisis, senior examiners, under the instruction of CCEA awarding organisation, are required to train assistant examiners to apply the mark scheme in case of disrupted learning and lost teaching time. The interpretation and intended application of the mark scheme for this examination series will be communicated through the standardising meeting by the Chief or Principal Examiner and will be monitored through the supervision period. This paragraph will apply to examination series in 2021–2022 only.

					AVAILABLE MARKS
1	**(a)**	**(i)**	140/90	[1]	
		(ii)	90/60	[1]	
	(b)	**(i)**	Any **six** from: • Cuff placed on upper arm (at heart level) • Cuff is inflated (using hand pump) • Until no blood flows (in the brachial artery)/no sound heard • Stethoscope is placed over the artery (below elbow) • Cuff pressure is released (slowly) • When (tapping) sound is first heard the systolic reading is recorded • Cuff pressure reduced until no sound heard, record the diastolic pressure (6 × [1])	[6]	
		(ii)	Any **two** from: Caffeine/drugs/smoking/obesity/age Exercise before Eating food before taking reading Stress levels (2 × [1])	[2]	
		(iii)	Take another reading (on a different day)	[1]	11
2	**(a)**	**(i)**	Heart	[1]	
		(ii)	Brain	[1]	
		(iii)	Measures electrical activity/use electrodes	[1]	
	(b)	**(i)**	shape correct 3–6 spikes in 4 seconds no significant change in amplitude	[1] [1] [1]	
					
		(ii)	shape correct more than 8 waves in 2 seconds amplitude varies	[1] [1] [1]	
					9

3 Indicative content

- Gamma emitter
- Short half-life
- Quickly excreted
- Can be detected outside body
- Non-toxic
- Targeted

- **Technetium-99**
- Tracer in medical imaging of a range of organs

- **Rubidium-82**
- PET scan of heart

- **Thallium-201**
- Cardiac stress test

} max 4 indicative points

Response	Mark
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 excellent. 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 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]

AVAILABLE MARKS

8

					AVAILABLE MARKS
4	**(a)**	**(i)**	Radiation detected when no (known) sources present	[1]	
		(ii)	Any **two** from: • Cosmic rays • Radon gas • Radioactive rocks (2 × [1])	[2]	
	(b)		radiation ionises (cells)/cell damage which can cause cancer	[1] [1]	
	(c)	**(i)**	lead only gamma radiation can pass through the lead	[1] [1]	
		(ii)	aluminium absorbs X-rays The stronger the X-rays the thicker the material they pass through	[1] [1]	
		(iii)	alpha Can only travel a few cm in air	[1] [1]	
	(d)	**(i)**	Any **two** from: forget to wear badge/coat badge not examined for a long time can be affected by strong sunlight/not always accurate only measures local dose (not body dose) (2 × [1])	[2]	
		(ii)	Lead shielding/protective clothing/remote handling/limit time	[1]	14
5	**(a)**		$\lambda = 0.693/\tau$ $= 0.693/1930$ $= 3.59 \times 10^{-4}\ day^{-1}$	[1] [1] [1]	
	(b)	**(i)**	radioactivity random and counts for less time inaccurate	[1]	
		(ii)	Geiger Muller tube counter/scaler/ratemeter	[1] [1]	
		(iii)	390/1000 = 0.39 504/60 = 8.4 8.4–0.39 (= 8.01)	[1] [1] [1]	
		(iv)	$A = A_o e^{-\lambda t}$ $A = 8.01 \times e^{-3.59 \times 10^{-4} \times 365}$ ecf [1] [1] A = 7.03 8.01–7.03 = 0.98 ecf	[1] [2] [1] [1]	
		(v)	$\ln A = \ln A_o - \lambda t$ $\ln 1.4 = \ln 8.01 - 3.59 \times 10^{-4} t$ t = 4860 days (4858.54) t = 13.3 yrs	[1] [1] [1] [1]	18

					AVAILABLE MARKS
6	**(a)**	**(i)**	reflection	[1]	
			spreading/diffraction/scattering	[1]	
		(ii)	deeper organs, lower frequency 1–6 MHz	[1]	
			Higher frequencies are attenuated	[1]	
			Organ, e.g. kidneys	[1]	
			Surface organs, higher frequencies 7–18 MHz	[1]	
			Better imaging	[1]	
			Organ, e.g. breast tissue	[1]	
	(b)	**(i)**	fraction of initial sound energy which is reflected	[1]	
		(ii)	• $v = 1.097 \times 1450$ (= 1590.7)	[1]	
			• $z = \rho v$	[1]	
			• $z = 1075 \times 1.097 \times 1450$	[1]	
			• $z = 1.710 \times 10^6$	[1]	
			• $kg\,m^{-2}s^{-1}$	[1]	
		(iii)	$R = \dfrac{(z_2 - z_1)^2}{(z_2 + z_1)^2}$	[1]	
			$Z = 952 \times 1450 = 1\,380\,400$	[1]	
			$R = \dfrac{(1\,710\,000 - 1\,380\,400)^2}{(1\,710\,000 + 1\,380\,400)^2}$ ecf	[1]	
			$R = 0.01137$		
		(iv)	$1 - 0.01137 = 0.9886$	[1]	
			Percentage transmitted = 98.9%	[1]	19
7	**(a)**	**(i)**	magnetic resonance imaging	[1]	
		(ii)	creates large magnetic field	[1]	
			to align the hydrogen nuclei	[1]	
			to detect radio waves (emitted from the nuclei)	[1]	
	(b)	**(i)**	Any **three** from: it is noisy the space is small it doesn't hurt you must keep still it takes a long time (3 × [1])	[3]	
		(ii)	metal items/implants/jewellery	[1]	
			large magnetic field	[1]	
	(c)		Any **two** from: no radiation risks better image resolution 3D image produced (2 × [1])	[2]	11

					AVAILABLE MARKS
8	**(a)**	**(i)**	thin flexible tube inserted into patient	[1] [1]	
		(ii)	Any **six** from: non-coherent bundle of fibres for illumination coherent bundle of fibres for observation eyepiece/camera on end of observation bundle to view objective lens on observation bundle to focus light into fibres water/irrigation (channel) to clean lens (6 × [1])	[6]	
	(b)		can take sample (to see if tumour is cancerous) no radiation risks	[1]	
			can be uncomfortable/sedation/invasive takes longer	[1]	10
				Total	**100**