Rewarding Learning

ADVANCED
General Certificate of Education
2024

Life and Health Sciences

Assessment Unit A2 3

assessing

Medical Physics

[AZ031]

WEDNESDAY 12 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.

1 (a) (i) Values between 36.5–37.5 °C [1]

(ii)

Lowest body temperature/°C	Highest body temperature/°C	
21	43	
26	44	✓
23	42	
29	47	
24	43	

[1]

(iii) Fever/heat stroke/hyperthermia [1]
Sweating [1] [2]

(iv) Child might have consumed something cold/not enough contact with mouth [1]

(v) Forehead/IR thermometer [1]
Quicker/not affected by food or drink/doesn't require patient cooperation [1]
Must be correctly positioned to obtain accurate reading/can be affected by external factors [1]

or
Tympanic thermometer [1]
Quicker/not affected by food or drink [1]
Must be correctly positioned to obtain accurate reading/ear wax might affect reading [1]

or
forehead strip thermometer [1]
not affected by food or drink/no patient cooperation required [1]
not accurate/takes time [1] [3]

AVAILABLE MARKS: 8

2 (a) Indicative content

AVAILABLE MARKS

- Electroencephalogram
- Measures electrical activity in the brain
- Electrodes are placed on the head
- Brain waves are recorded
- Diagnose brain tumour/brain damage/epilepsy/seizure disorders/ brain inflammation/brain death/sleep disorders
- Drugs/caffeine/alcohol/overtiredness

Response	Marks
Candidate identifies and describes **5 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.	**[5]–[6]**
Candidate identifies and describes **3 or 4** 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.	**[3]–[4]**
Candidates clearly identify **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]**

[6]

(b) (i)

Brain waves	Delta	THETA (θ)	ALPHA (α)	BETA (β)	GAMMA (δ)
Frequency range/Hz	0.5–3.5	4–8	8–12	12–38	38–42

All 4 waves identified in any order (words or symbols) [1]

[$\frac{1}{2}$] for each wave correctly matched with correct frequency (round down) [2] [3]

(ii) Deep sleep [1]

(iii) Sketch to show varying amplitude [1]
Less than 4 waves in one second [1]
x-axis scale each division 0.25 seconds [1] [3] 13

					AVAILABLE MARKS
3 (a) (i)	Decay constant the fraction of nuclei that decay/probability of a nucleus decaying	[1]			
	per unit time	[1]			
	or				
	ratio of A/N [1] where A is activity and N is the number of nuclei present [1]		[2]		
(ii)	$A = A_O e^{-\lambda t}$	[1]			
	$250 = A_O e^{-(1.33 \times 10^{-2} \times 120)}$	[1]			
	$250 = A_O \times 0.203$				
	Initial activity = 1230 Bq	[1]	[3]		
(b) (i)	At the start/time = 0	[1]			
	there are 24.70×10^9 nuclei decaying	[1]			
	every second	[1]	[3]		
(ii)	26% of 24.70 is 6.42(2) GBq or 74% or 0.74 × 24.70	[1]			
	(24.70 – 6.42(2) =) 18.278 GBq				
	18.28 GBq ecf for correct rounding	[1]	[2]		
(iii)	10.5 hrs = 37800 s	[1]			
	$\ln A = \ln A_0 - \lambda t$	[1]			
	$\ln (18.28 \times 10^9) = \ln 24.70 \times 10^9 - \lambda \times 37800$				
	[1] [1] subs	[2]			
	$23.63 = 23.93 - \lambda \times 37800$ ecf				
	$\lambda = 7.937 \times 10^{-6}\ s^{-1}$				
	(accept 7.96 or 7.97 × $10^{-6}\ s^{-1}$ for no rounding in **(iii)**)	[1]	[5]		
(iv)	Time taken	[1]			
	for the activity to reduce to half (of its original value)	[1]	[2]		
(c)	$t_{\frac{1}{2}} = \frac{0.693}{\lambda}$	[1]			
	$= \frac{0.693}{4.00 \times 10^{-6}}$	[1]			
	= 173250 seconds	[1]			
	= 173250/(86400) = 2.01 days	[1]	[4]		21

						AVAILABLE MARKS
4	**(a)**	**(i)**	High energy/frequency (or short wavelength) electromagnetic waves		[1]	
		(ii)	Can pass through soft tissue/less dense material Are absorbed by bone/teeth	[1] [1]	[2]	
		(iii)	Detect tooth decay/gum disease/cracked tooth/ viewing teeth under the gum		[1]	
		(iv)	Minimising exposure (by increasing distance) X-rays are ionising They damage cells/cause cancer	[1] [1] [1]	[3]	
	(b)		Any **eight** from: • Electrons are produced at the cathode • By heating a wire • They are accelerated/travel at high speeds • By using a positively charged anode • The electrons strike the anode/target • and rapidly decelerate (producing X-rays) • A copper block/oil/spinning anode is used to cool • Low energy X-rays are removed using the aluminium filter • A vacuum is used so the electrons don't collide with other atoms		[8]	15
5	**(a)**		Any **three** from: (Patient is placed in) a large magnetic field Radio frequency pulses are applied Radio waves are detected from hydrogen atoms body (3 × [1])		[3]	
			Any **three** from: (Patient is) injected with radioactive isotope Radioisotope travels through the body/taken up by organ Gamma radiation is detected outside the body Using a gamma camera (3 × [1])		[3]	
	(b)	**(i)**	Pacemaker fitted–magnetic field can cause damage/metallic implant–currents formed/obesity–can't fit in machine or scanner/ferrous or magnetic implant–large force correct condition linked to appropriate explanation		[2]	
		(ii)	MRI scan shows structure/tissue (in great detail) Gamma ray image shows heart function/metabolic activity	[1] [1]	[2]	
	(c)	**(i)**	The counts observed when no radioactive source is present (or other appropriate)		[1]	
		(ii)	X-rays/cosmic rays/rocks/radon		[1]	
		(iii)	Maximise distance/minimise explosive time/lead shielding/dosimeter badge		[1]	13

						AVAILABLE MARKS
6	**(a)**	**(i)**	Positron emission tomography	[1]		
		(ii)	Heart	[1]		
		(iii)	Gamma	[1]	[3]	
	(b)	**(i)**	Beta is a fast-moving electron	[1]		
			This is medium range/only penetrates a few cms/ penetrates more than alpha and less than gamma	[1]	[2]	
		(ii)	Alpha – helium nucleus	[1]		
			Low penetration power/would not penetrate tumour	[1]	[2]	
		(iii)	Patient will remain radioactive for longer than necessary causing harm to body thereafter		[2]	
		(iv)	No surgery required/patient not radioactive	[1]		
			Damage to healthy tissue/radiation burns/more hospital apps	[1]	[2]	11
7	**(a)**	**(i)**	Sounds with frequencies between 1MHz and 18 MHz		[1]	
		(ii)	Wave can penetrate deeper into the body	[1]		
			Image quality/resolution poor	[1]	[2]	
		(iii)	Brightness scan/image of internal structures		[1]	
		(iv)	Gel placed on skin	[1]		
			Probe is moved across the abdomen	[1]	[2]	
		(v)	The image is brighter		[1]	
	(b)	**(i)**	Product of density (of tissue) × velocity of sound (in the tissue)		[1]	
		(ii)	$kgm^{-2}s^{-1}$		[1]	
		(iii)	R is the fraction of the incident sound energy which is reflected		[1]	
		(iv)	All the sound is reflected or none of the sound is transmitted		[1]	
		(v)	$z = \rho v$	[1]		
			$z = 1075 \times 1590$ or 1900×4080	[1]		
			$z = 1\,709\,250$ [1] $7\,752\,000$ [1]	[2]		
			$R = \frac{(z_2 - z_1)^2}{(z_2 + z_1)^2}$	[1]		
			$R = \frac{(7\,752\,000 - 1\,709\,250)^2}{(7\,752\,000 + 1\,709\,250)^2}$ ecf	[1]		
			R = 0.4079 (0.408)	[1]		
			Percentage transmitted = 59.2%	[1]	[8]	19
					Total	**100**