Rewarding Learning

ADVANCED
General Certificate of Education

Life and Health Sciences

Assessment Unit A2 3

assessing

Medical Physics

[AZ031]

Assessment

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.

The abbreviation 'ecf' stands for 'error carried forward'.

						AVAILABLE MARKS
1	**(a)**	**(i)**	Hydrogen (nuclei) [1] Abundant/Water contains hydrogens (and the body is largely composed of water) [1]		[2]	
		(ii)	<u>superconducting</u> magnet (not electromagnet)		[1]	
		(iii)	RF coils		[1]	
		(iv)	Resonant frequency/Larmor frequency (be generous with spelling)		[1]	
		(v)	Radio waves		[1]	
		(vi)	gradient coils		[1]	
	(b)		no metallic objects, pacemakers, metallic fragments, metal hearing aid, metal implants, metallic jewellery, glasses, credit cards, metallic surgical clips, tattoos or makeup containing metal (Any **two**)		[2]	
	(c)		Small space/loud noise/long time		[1]	
	(d)		clear image formed/high resolution/sharp image [1] no ionising radiation [1]		[2]	12

AVAILABLE MARKS

2 **(a)** Any **four** from:

1. Digital thermometer which uses heat sensor (or thermistor) to detect temperature change. [1]
   These can be used in the mouth, armpit or rectum [1]
2. Digital Infrared wave sensor (tympanic thermometer) [1]
   detects IR waves when placed in ear [1]
3. Remote/forehead/non contact thermometer [1]
   is aimed at the forehead and it detects IR waves [1] [4]

(b) **Indicative Content**

- Core temperature is 37 + or – 0.5°
- Lower temperature = 26–28 °C
- Upper temperature = 43–45 °C
- Above core temperature – called hyperthermia
- Signs are sweating/headaches/vomiting. Only one sign is required
- Below core temperature – called hypothermia
- Signs are shivering/tired/dizzy/increase in heart rate and blood pressure/slurred speech/blue tinge. Only one sign is required
- Eating before taking reading/cold drinks/electric blankets. Drugs/alcohol consumption/not waiting long enough/ear wax (Max of 2 points for the factors)

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 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 well 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 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]

12

						AVAILABLE MARKS
3	**(a)**	**(i)**	Electrical activity		[1]	
		(ii)	Electrodes		[1]	
		(iii)				

Patient information	Type of scan
Patient has an epileptic seizure	EEG
Patient displays bradycardia	ECG
Alpha waves from relaxed patient	EEG
Delta waves from sleeping patient	EEG
Patient exhibits brain death	*EEG*

[$\frac{1}{2}$] each, round down [2]

(b) C
E
G
D [4]

(c) Irregular amplitude [1]
12–30 waves in 1 second [1] [2] 10

4 **(a)** **(i)** Any **six** from:
Record/measure background activity [1]
Set radioactive source in front of GM tube [1]
Use a scaler/counter [1]
Record initial activity [1]
Start/use stopwatch [1]
record activity at certain time intervals [1]
Until activity has reduced by over half (**or** returned to background .. but not zero) [1] [6]

(ii) Minimise handling time/Lead shielding/tongs/remote handling/special clothing, e.g. white coat/gloves [1]

(b) **(i)** x-axis – 0, 20, 40, 60, 80, 100, 120, 140 (scale should increase in equal intervals and fill <u>over</u> half the size of the graph paper)
Time/s [1]

(ii) Points plotted (each error [–1]) [2]
No marks can be awarded if the scale is non linear

(iii) smooth curve [1]
No sections drawn with a ruler

(iv) • Line continued back to meet y-axis
Threshold mark/cannot access the 2nd mark without extending the line back on the graph [1]
• 435 Bq (± 1 square) or student's own value [1] [2]

(v) • Line(s) drawn at half activity [1]
• 72 sec (± 1 square) or consistent with student's graph [1] [2] 15

						AVAILABLE MARKS
5	**(a)**	**(i)**	Electrons accelerated to **high speed or** using a **large voltage** [1] strike a metal target [1] and **rapidly** slow down (producing X-rays) [1]		[3]	
		(ii)	They are absorbed by aluminium (shields) [1] These X-rays cannot contribute to an image [1]		[2]	
	(b)		expensive not readily available greater cancer risk } Any **two**		[2]	
	(c)	**(i)**	X-rays absorbed by more dense material/passes through less dense material [1] not enough contrast between tissue [1]		[2]	
		(ii)	lead shield on body parts not being examined		[1]	
	(d)		less/no health risks/ionising radiation [1] real time images [1]		[2]	12
6	**(a)**	**(i)**	Any **four** from: • Incoherent bundle to illuminate (stone/target) • Coherent bundle to retrieve image • Eyepiece/camera to form image/view image • Objective lens to focus rays into coherent bundle • Air/irrigation channel to clean		[4]	
		(ii)	Operations channel/tools channel		[1]	
	(b)		• Ultrasound sent into the body [1] • Reflects off the kidney stones to produce image [1] • Produces a B scan [1] • Uses frequencies with range 1–6 MHz (must include units) [1] [0] awarded if the correct units are not provided		[4]	
	(c)		Any **six** from: Endoscope • Can observe stones [1] • May be able to remove stones (using surgical instrument channel) [1] Ultrasound • Not all stones may be removed/discomfort during procedure/ invasive procedure [1] • No invasive instruments with ultrasound [1] • But risks/pain with passing stones/not all stones removed [1] Surgery • Major surgery has risks/recovery time/permanent damage [1] • All stones removed/no passing of stones [1]		[6]	15

						AVAILABLE MARKS
7	**(a)**	**(i)**	Velocity of sound × density (of tissue) **or** Product of velocity of sound in tissue and density of tissue		[1]	
		(ii)	1000×1450		[1]	
			1.45×10^6		[1]	
			$kg\,m^{-2}\,s^{-1}$ Independent mark – award if units are correct even if calculation is wrong		[1]	[3]
	(b)	**(i)**	fat and bone		[1]	
		(ii)	blood and soft tissue		[1]	
		(iii)	For the following calculations: If answer is correct but no method shown award all 3 marks. If answer is wrong the mark scheme shows where partial credit can be given. Award [0] if initial equation is incorrect even if answer is right – do not reward wrong physics			
			$R = \frac{(z_2 - z_1)^2}{(z_2 + z_1)^2}$		[1]	
			$\frac{(6.0 \times 10^6 - 1.7 \times 10^6)^2}{(1.7 \times 10^6 + 6.0 \times 10^6)^2}$		[1]	
			0.312		[1]	[3]
		(iv)	$0.312 \times 100 = 31.2$		[1]	
			$100 - 31.2 = 68.8\%$		[1]	[2]
			Ecf marks are to be applied for correct method using candidates answer for (iii)			11
8	**(a)**	**(i)**	cancer detection		[1]	
		(ii)	gamma rays, gamma camera		[1]	
	(b)	**(i)**	$t_{\frac{1}{2}} = 0.693/\lambda$		[1]	
			$\lambda = 0.693/3.05$		[1]	
			$= 0.227$ **or** 0.23 either of these values can be carried over to (ii) and (iii)		[1]	[3]
		(ii)	$t = 3.75$ days	Independent mark	[1]	
			$A_o = (2.22 \times 10^9 \div 60) = 37 \times 10^6$	Independent mark	[1]	
			$A = A_o e^{-\lambda t}$	Independent mark	[1]	
			$= 37 \times 10^6 e^{-(0.227 \times 3.75)}$	Substitution of their values for initial activity and time	[1]	
			$= 15.8 \times 10^6$ Bq	Correct calculation based on their values	[1]	[5]
			E.g. if student uses correct eq but fails to change the time into days and completes the calculation correctly they lose only 1 mark for 1 error. If they don't change initial activity and time but complete a correct calculation they would lose 2 marks for 2 errors. There is NO ecf error for decay constant as a correct value is provided in b (i)			

(iii) $\ln A = \ln A_o - \lambda t$ [1]

$\ln 37 \times 10^5 = \ln 37 \times 10^6 - 0.227t$ [1]

$t = 10.1$ days [1] [3]

correct eq [1]

If student uses an incorrect value of initial activity, e.g. 2.22×10^9 instead of 37×10^6 but correctly finds 1/10th for A then award full marks

Students can also approach this using percentages or fractions

Total

AVAILABLE MARKS
13
100