



Rewarding Learning

**ADVANCED
General Certificate of Education
2025**

Life and Health Sciences

Assessment Unit A2 3

assessing

Medical Physics

[AZ031]

MONDAY 9 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 | (a) (i) | any two from: | | | |
| | | electromagnetic (EM) waves | [1] | | |
| | | high energy / high frequency / low wavelength | [1] | | |
| | | can travel in a vacuum | [1] | | |
| | | can travel at the speed of light | [1] | | |
| | | can be polarised | [1] | | |
| | | causes ionisation | [1] | [2] | |
| | (ii) | X-rays pass through soft tissue / less dense tissue / air filled lungs | [1] | | |
| | | more dense material absorbs more X-rays | [1] | | |
| | | liquid is denser than air | [1] | | |
| | | the image will be lighter if there is liquid / dense regions | | | |
| | | less black / grey / white / bright | [1] | [4] | |
| | (b) (i) | emits / releases electrons (when heated) | [1] | | |
| | | accelerates electrons | [1] | | |
| | | electrons rapidly decelerated (to produce X-rays) | [1] | [3] | |
| (ii) | | high atomic number / high melting point | | [1] | |
| | | (iii) the highest energy X-rays pass through aluminium filter | [1] | | |
| | | [1] | [2] | | |
| (iv) | so the electrons don't lose energy / collide with air particles / scatter | | [1] | | |
| | (v) | rotate target (anode) / oil or liquid / copper block | | [1] | |
| | | | | | |
| | (c) (i) | ionises cells | | [1] | |
| | | (ii) leave room during X-ray / use of lead shielding | | [1] | |
| 2 | (a) | Quicker recovery time / less invasive / shorter operation time / no general anaesthetic required / less chance of infection | | | |
| | | any 2 [1] each | | [2] | |
| | (b) (i) | Total internal reflection | | [1] | |
| | | (ii) | illumination bundle – order of fibres not maintained throughout | [1] | |
| | | | observation bundle – order of fibres maintained throughout / parallel | [1] | |
| | | | otherwise image would be scrambled | [1] | [3] |
| | | (iii) | to focus / refract light into the image bundle | | [1] |
| | (iv) | to burn / deliver energy to a structure | | [1] | |
| | (v) | to clean the lens / clean field of vision | | [1] | |
| | | | | | |

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3 Indicative content

alpha

- Helium nucleus
- Relative charge +2
- Relative mass 4
- 5 cm or less / few cms
- paper

beta

- Electron
- Relative charge -1
- Relative mass 1/1836 or 1/1840 or 1/2000
- Several metres
- aluminium

| 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 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] |

[8]

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AVAILABLE
MARKS

4 (i) 36.5 – 37.5 °C [1]

(ii) 44 °C [1]

(iii)

| Thermometer | How in works | How to take a temperature reading | Limitation |
|------------------------------|--|---|---|
| Underarm digital thermometer | The electrical sensor changes resistance at different temperatures | Place under the armpit and wait for the thermometer to beep | The temperature measurement will be lower than core body temperature |
| Contactless thermometer | Measures IR coming from person | Point at forehead | Can be affected by direct sunlight/ sweaty forehead |
| Tympanic thermometer | Measures IR from eardrum | Place in ear and (wait for beep/wait few seconds) | Can't be used on very young children/ inaccurate when there is too much earwax/ requires patient cooperation/not suitable for ear infections |

[6]

5 (i) gamma / X-ray [1]

(ii) cancer detection
cardiac imaging
thyroid test
any 2 [1] each [2]

(iii) positron emission tomography [1]
injected into body [1]
positron [1]
positron meets an electron [1]
annihilates producing gamma rays [1]
detected using a gamma camera [1] [6]

AVAILABLE MARKS

8

9

| | | | | AVAILABLE MARKS | | |
|-----------------|------|---|---|--|--------------------------|-----|
| 6 | (a) | (i) | 60 – 100 | [1] | | |
| | | (ii) | place (two) fingers over the artery to count pulse for 15 or more seconds convert to number beats per minute repeat (and average) | [1] [1] [1] [1] | [4] | |
| | (b) | (i) | sounds (with frequencies) over 20 000 Hz | | [1] | |
| | | (ii) | 7 000 000 | [1] | | |
| | | | 18 000 000 | [1] | [2] | |
| | | (iii) | no deep penetration required Better resolution/image | [1] [1] | [2] | |
| | (iv) | the screen has regions of different brightness / contrast (award 1 mark for this statement if no further) bright images indicate strong reflected signal from more dense structures / blockage | [1] [1] | [2] | 12 | |
| | 7 | (a) | (i) | To prevent reflection at surface of skin / improve transmission Density of gel similar to that of the skin/removes air | [1] [1] | [2] |
| | | | (ii) | The probe also receives pulses which are reflected from inside the body The probe cannot send and receive pulses at the same time The time between pulses is used for the probe to receive | [1] [1] [1] [1] | [4] |
| | | (b) | (i) | product of speed of sound in a material and density of the material | [1] [1] | [2] |
| (ii) | | | $z = \rho v$ $1.60 \times 10^6 = 1570 \times \rho$ | [1] [1] | | |
| | | | $\rho = 1019$ (1020) kgm^{-3} | [1] [1] | [4] | |
| (iii) | | $(1570 \times 2.68) \times (1019 \times 1.29)$ $= 5.53 \times 10^6$ (5531520) ecf or $Z_B = 1.29 \times 2.68 \times 1.60 \times 10^6$ [1]/ 5.53×10^6 (5531520) [1] | [1] [1] | [2] | | |
| (iv) | | $I_r = I_o - I_t$ | | [1] | | |
| (v) | | $R = \frac{(Z_A - Z_B)^2}{(Z_A + Z_B)^2}$ | | [1] | | |
| (vi) | | $R = \frac{(5530000 - 1600000)^2}{(5530000 + 1600000)^2}$ ecf $R = 0.304$ (0.309) | [1] | | | |
| 70 % (71 %) ecf | | [1] | [3] | 19 | | |

| | | | AVAILABLE MARKS | | | | | |
|---|-----------------|---|-------------------------------|-----|------------|--|-----|--|
| 8 | (i) | counts observed when no radioactive source is present | [1] | | | | | |
| | (ii) | use a geiger muller tube to detect the (background) radiation | [1] | | | | | |
| | | use a counter to record the counts | [1] | | | | | |
| | | record the number of counts over 5 minutes | [1] | | | | | |
| | | use a stop clock to record the time | [1] | | | | | |
| divide the number of counts by the time | | [1] | [5] | | | | | |
| (iii) | subtracted | | [1] | | | | | |
| (iv) | medical sources | | | | | | | |
| | X-rays | | | | | | | |
| | weapons testing | | | | | | | |
| | nuclear power | | | | | | | |
| | any two | | | | | | | |
| [1] each | | [2] | 9 | | | | | |
| 9 | (a) | (i) $\lambda = 0.693/\text{half-life}$ | | | [1] | | | |
| | | (ii) $0.693/1.61 \times 10^{-3}$ = 430 | [1] | | [1] | | [2] | |
| | (b) | (i) | 12.2 counts/decays | | [1] | | | |
| | | | in one second | [1] | [2] | | | |
| | | (ii) | $A = 10.98$ | [1] | | | | |
| | | | $\ln A = \ln A_0 - \lambda t$ | [1] | | | | |
| | | | Subs for A and A_0 ecf | [1] | | | | |
| Sub for λ | [1] | | | | | | | |
| 65.4 | [1] | | [5] | 10 | | | | |
| Total | | | | | 100 | | | |