



LEVEL 3 EXTENDED CERTIFICATE **APPLIED SCIENCE**

ASC6b: Medical physics
Report on the Examination

1777
January 2019

Version: 1.0

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General

A range of marks was evident with sound college marking and a good understanding of the expected content for this unit. Only a small number of students entered for the January 2019 series.

Issues that arose in summer 2018 through a lack of appropriate equipment to carry out the half-life determination (a requirement for PO3) did not reappear with the submissions seen. It was not clear, however, if colleges realise that there are outcomes of other experiments (specified in the unit content) that should be part of their investigations into properties of radioisotopes, for example penetration of alpha, beta and gamma radiation (these being needed for M7).

Good levels of research coupled with sound understanding of the underlying physics were evident in the higher scoring portfolios. Those with Distinction grade marks also showed their ability to provide, discuss and apply quantitative support for the underlying theory and explanations. This followed through to the way in which images, graphs, data, equations and calculations were incorporated into portfolio evidence to enhance and exemplify the theoretical content.

P01: Understand imaging techniques

P1, M1, D1

These performance criteria are linked and sequential. The most commonly chosen techniques are ultrasound and X-rays, although others listed in the specification (p107) are perfectly acceptable. There were also some unusual alternatives selected by students (but not always very successfully).

Suitable diagrams to illustrate the technique, the apparatus used, and typical images formed were used to support the descriptions and demonstrate greater understanding. Important points for future submissions:

- Although **P1** is often easily met, lower-scoring portfolios did not go on to provide good links between the theory underlying the methods and the way in which images are formed (for **M1**).
- Suitable examples with appropriate explanations will always add to the descriptions.

D1 requires calculations to be performed. Simply quoting relevant equations without applying them or using them to provide quantitative support for the descriptions of the theory will not achieve D1.

Relevant content includes:

- the use of $v = f\lambda$ to calculate and then compare properties of wave forms
- using $E = hf$ to determine and compare photon energies
- the calculation of reflection coefficient for ultrasound waves (linked to appropriate explanations).

P2, M2

P2 and **M2** may follow on directly from P1, although it is acceptable to select different imaging techniques for this section. Good approaches included:

- consideration of the nature of the medical condition chosen and site in the body
- consideration of potential dangers associated with the unsuitable technique (and the converse for the suitable one)
- a comparison of the quality of the images for the two techniques and the relevant site.

The comparison of image qualities can sometimes be less well explained, and much depends on the use of suitable, researched images to exemplify the descriptions.

These criteria provide more examples and opportunities where images from research, well explained, add much to the portfolio content, and these ideas follow through the whole unit.

P02: Understand radiotherapy techniques and the use of radioactive tracers

P3, M3, D2

As in PO1, these first three performance criteria are linked and sequential. If **P3** is not met, for instance, M3 and D2 cannot be awarded.

The specification (p108) again allows a choice of suitable techniques. These normally involved one that is implant based and one involving external therapy. Students may need to be reminded that tracer techniques are assessed elsewhere and are not relevant here. Whilst this is straightforward initially, the descriptions in P3 and explanations for M3 do need good levels of research, and these should all be properly referenced. It is important for students to pick suitable examples of techniques where the required explanations of suitability, or lack of it, are within their understanding and have accessible researched information.

Most portfolios contained the required diagrammatic support, but links to descriptions of the techniques were sometimes not well made. This followed through to links of the technique to the treatment of the disease or disorder identified.

M3 goes on to explain how each technique is used to treat a specified disease.

- How is each chosen therapy administered?
- What radioisotopes (and type of electromagnetic radiation) have been chosen and what are their properties / how do they work?

D2 then explains, compares and contrasts the invasive nature of the two therapies chosen.

P4, M4, D3

Again, it is important for students to understand that these criteria are associated and sequential.

The focus is very much on a single radioisotope and its properties. For the isotope selected, the following are expected:

- name, symbol, mass number, atomic number
- type of decay / radiation emitted
- half-life
- technique used
- medical context.

And for **M4**:

- decay equation
- types of radiation
- properties of radiation emitted
- half-life explained in the context of importance in radiotherapy
- physical half-life and biological half-life.

And for **D3**, quantitative support (calculations) for the explanations:

- time taken for activity to fall to a level unsuitable for further use
- calculation of effective half-life
- photon energy.

P5, M5, D4

These criteria relate specifically to the use of radioisotopes as tracers. Again, good portfolios were typified by appropriate levels of research and a wide ranging consideration of types, examples and links to illnesses or conditions that are investigated in this way.

Some lower-scoring portfolios included irrelevant material on non-medical uses of radioisotope tracers.

Good portfolios often considered both P5 and M5 together and this worked very well and avoided the rather disjointed reports which sometimes typified lower scoring examples.

For **P5**:

- explanation of how tracers are used and the associated medical contexts
- a suitable range of examples (radioisotopes identified, common uses outlined)
- outline of organ affinity, need for short half-life
- type of radiation emitted and detection.

As mentioned above, with much of this unit, diagrammatic support for the points mentioned and explained is important. Together with associated explanations, they will often allow student understanding to be demonstrated more clearly.

For **M5**:

- identify two isotopes used as tracers
- describe the medical contexts in which they are used, purpose, type of illness, location in the body
- include images and diagrams which illustrate the points discussed
- identify properties, decay equations, half-lives, organ affinity
- link properties to reasons why they are suitable for the use described.

D4 requires detailed research and both isotopes previously identified for **M5** must be considered. Graphical data could include decay curves which would allow for determination or demonstration of half-life. Values for physical half-life and biological half-life can be researched and evaluated via calculations of effective half-life.

P6, M6

P6 was often very well researched by students. This carried on to **M6**, although some students were not well prepared in terms of knowledge of the unit content and their accounts fell short of the expected levels of detail.

Relevant content should include:

- consideration of the dangers associated with use of radioisotopes
- precautions for both medical professionals and patients
- the effects of ionising radiation including:
 - the meaning of stochastic and non-stochastic
 - the meaning of somatic and heredity.

P03: Demonstrate the ability to work with radioisotopes in the laboratory

P7, M7, D5

A small number of colleges approached this unit in the summer 2018 without the means to carry out the determination of half-life. In these cases, it was accepted that the data could be obtained via a simulation, and then processed in the normal way.

P03 is, however, entitled 'Demonstrate the ability to work with radioisotopes in the laboratory' and the following would normally all be part of the experimental approach, and, importantly, confirmed in the observation record:

- safe working
- following procedures involving correct handling of radioisotopes
- correct precautions taken to ensure safety
- use of a Geiger counter
- measuring background radiation.

Just using a simulation alone does not provide the evidence required for **P7**. However, it is accepted that this evidence can be covered by using other sources and experiments* to compare the penetration of alpha, beta, gamma radiation (specification p109) which are, in any case, needed for M7.

*If the full protactinium half-life determination is carried out, then these other experiments into penetration can, as the assessment amplification suggests (specification) p112, be done as a group, tutor demonstration or online.

One college approached P7 using the half value thickness (HVT) determination for lead using ^{60}Co . Other variations on this theme are possible. This covered all the safe handling, background count aspects, and also provided data to be analysed using similar methods to those for half-life. This was accepted as a suitable alternative. It also means that the penetration power experiments can be as indicated* above.

M7 requires the results of the experiments to be related to the use of radioisotopes in medical treatments (radiotherapy and tracers).

This will include:

- the importance of half-life (physical, biological, effective)
- comparison of half-lives for a range of different radioisotopes and applications
- the importance of penetrating power and its effect on uses of different isotopes.

D5 involves a summary of advantages and disadvantages of using alpha, beta and gamma radioisotopes in medical treatments. Some very good comparisons were seen, with some selecting a tabulated presentation which worked well and was very comprehensive and detailed.

P04: Understand the medical uses of optical fibres and lasers

P8, M8

P8 requires the descriptions of how optical fibres are constructed and how they transmit light. This was generally well researched and descriptions and explanations appropriate.

M8, similarly, was often well done although some lower-scoring reports tended to just state uses and not go on to explain how the fibres are actually used in the treatments.

P9: This experiment was generally very well done by students. Sometimes the supporting documentation was not complete and colleges are reminded that the following should always be present:

- issued standard procedure and risk assessment
- observation record.

Colleges should remind students that the following are also needed:

- recorded results
- evidence of correct tabulation, precision of recording and units
- ray diagrams
- clear and correct use of results, diagrams and calculations.

P10, M9, D6

P10 is straightforward, although purely cosmetic uses are not acceptable here: both uses have to be for medical conditions.

M9 cannot be awarded if P10 is not met. A full report will cover both medical conditions from P10. It will explain the conditions, how the treatment is administered, and the scientific principles behind the treatment. The role played by the laser light must also be considered.

D6: A different medical condition (from those used in P10 and M9) can be identified for D6, but it does again have to be medical, not cosmetic.

A careful choice is essential here as the medical condition chosen must be able to be treated in two ways, one via laser, and one not. Cataract surgery was a common choice, but there are others which fit the criteria equally well.

Mark Ranges and Award of Grades

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