LEVEL 3 EXTENDED CERTIFICATE

APPLIED SCIENCE

ASC6b: Medical physics
Report on the Examination

1775 (1777)
June 2018

Version: 1.0

General

ASC6b was a popular choice of unit, although it would have needed a subject specialist and the right materials and equipment to meet all the performance outcomes fully. Some leeway was available if a protactinium source was not available for the half-life investigation, and alternative simulation based approaches were acceptable. However, it still remained important to cover all the practical aspects required by the unit content to meet P7 and 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.

PO1: Understand imaging techniques

P1, M1, D1

These performance criteria are linked and sequential. The most commonly chosen techniques were ultrasound and X-rays, although others listed in the Specification (p107) are perfectly acceptable. Suitable diagrams to illustrate the apparatus used and typical images formed were used to support the descriptions and demonstrate greater understanding.

Most learners achieved **P1** although the weaker 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 will always add to the descriptions.

D1 requires calculations to be performed. Just 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.

P2, M2

P2 and M2 may follow on directly from P1, although it is acceptable to select different imaging techniques for this section. It is important that the selected condition is described, including its nature and site in the body. This was generally well done as was, for M2, the consideration of potential dangers associated with the unsuitable technique (and lack of them for the suitable one). A comparison of the quality of the images for the two techniques and the relevant site was sometimes less well explained. This criterion is another where suitable images from research, well explained, enhance the portfolio evidence.

PO2: 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 again allows a choice of suitable radiotherapy techniques (p108) and these normally involved one that is implant based and one involving external therapy. Whilst this is straightforward initially, the descriptions in P3 and explanations for M3 do need good levels of research, which should all be properly referenced.

For **P3**, diagrams are specifically mentioned in the performance descriptor and whilst most portfolios tended to include diagrams, their links to descriptions of the techniques were not well made. This followed through to links of the technique to 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 (or type of electromagnetic radiation) have been chosen and what are their properties?
- What properties of the radioisotopes (or EMR) make one suitable for therapy and one suitable for diagnosis?

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

P4, M4, D3

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

The focus is very much on a single radioisotope and its properties. Again, links to the radiotherapy technique used are very important, and this was an area that was sometimes only weakly attempted. Good descriptions tended to follow on from also including the medical context(s) in which this technique is used. Similarly, good portfolios often tended to deal with P4 and M4 together, identifying each property and explaining the importance of that property in turn.

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 good levels of research and a wide ranging consideration of types, examples and links to illnesses or conditions that are investigated in this way. Some weaker portfolios included irrelevant material on non-medical uses. Good portfolios often considered both P5 and M5 together and this worked very well and avoided rather disjointed reports which sometimes typified lower scoring examples.

For **P5**, the following are expected:

- explanation of how tracers are used and 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.

and 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
- 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 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 learners. This carried on to M6, although some were not well prepared in terms of knowledge of the unit content. Relevant content should include:

- 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.

PO3: Demonstrate the ability to work with radioisotopes in the laboratory

P7, M7, D5

A small number of schools/colleges approached this unit without the means to carry out the determination of half-life. Either the cost was prohibitive or, in some cases, they were not allowed to keep short half-life materials at the school/college. In these cases, it was accepted that the data could be obtained via a simulation, and then processed in the normal way. PO3 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 on 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 does not provide the evidence required. 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.

The half value thickness (HVT) determination for lead using ^{60}Co was also used to meet **P7**. Other variations on this theme are possible. This covered all the safe handing, 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[*] below.

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[*] If the full protactinium half-life determination is carried out, then these other experiments into penetration can, as the Assessment Amplification suggests p112, be done as a group, tutor demonstration or online.

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.

PO4: 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 weaker reports tended to just state uses and not go on to explain how the fibres are actually used in treatments. Both diagnosis and treatment should be considered.

P9

This experiment was generally very well done by students. Sometimes the supporting documentation was not complete — the following should always be present:

- issued SP and RA

- observation record.

Also, students need to ensure that the following are included:

- recorded results

- evidence of correct tabulation, precision of recording and units

- ray diagrams

- clear and correct use of results, diagrams, 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.

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

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

Converting Marks into UMS marks

Convert raw marks into Uniform Mark Scale (UMS) marks by using the link below.
UMS conversion calculator