AQA

# LEVEL 3 CERTIFICATE / EXTENDED CERTIFICATE

# APPLIED SCIENCE

ASC6B: Medical physics
Report on the Examination

1775 (1776 & 1777)
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## General

ASC6b was again a popular choice of unit and some excellent portfolios were seen.

In this series, fewer centres misinterpreted the Unit's practical requirements relating to radioactivity, properties and half-life, although there are still some occasions evident where the unit content was not fully understood.

Higher scoring portfolios were based on extensive research of the medical applications of imaging, radiotherapy, tracers, optical fibres and lasers, and a sound understanding of underlying physics.

Good descriptions of medical physics techniques in PO1 and PO2 included:

- the relevant medical conditions to be treated
- how the techniques are applied
- the properties of the types of radiation and/or radioisotopes involved
- how images are formed
- supporting calculations

The best work was supported by a range of:

- images
- graphs
- data
- decay equations
- mathematical relationships

The ability to provide, explain, and apply, via calculations, quantitative support for the background theory also typified high scoring Distinction level portfolios.

Overall, many centres approach this unit very well and with a good understanding of the requirements of the Unit content and marking criteria. Good, high scoring portfolios demonstrated extensive levels of research, and the learners' own knowledge and understanding are clearly evident. Descriptions of techniques and medical applications were supported well by carefully chosen and clearly presented images, diagrams, decay equations, graphs. The calculations required for quantitative support were well done in the very best portfolios, but they are often a good discriminator between, say, merit and distinction work. Lower scoring portfolios inevitably tended to be based on more limited content, some poorly reworded cut and paste material, and made less use of supporting evidence, some of which was also poorly presented.

**PO1: Understand imaging techniques**

P1, M1, D1

Key points:

- P1, M1, D1 are linked via the underlying theory and are sequential
- ultrasound and X-rays were the most common choices for imaging techniques
- other techniques listed in the Specification (p107) are acceptable

It is important that diagrams fully illustrate:

- the apparatus used
- typical images

In the portfolios submitted, most learners achieved P1. However, the weaker portfolios did not go on to provide good links between the theory and the way in which images are formed for M1. Suitable examples and images will always add to the descriptions.

D1 requires calculations to be performed. Relevant content includes:

- The use of $v = f\lambda$ to calculate and then compare properties of relevant wave forms
- Using $E = hf$ to determine and compare photon energies
- The calculation of reflection coefficient between two media (and its implications).

NB: Just quoting relevant equations, without applying them or using them to provide quantitative support for the theory, will not achieve D1.

P2, M2

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

The content required includes the following information as a basis for discussion and explanation:

- the selected condition is described, including its nature and site in the body
- a suitable technique is identified
- an unsuitable technique is identified
- a comparison of the quality of the images for the two techniques
- potential dangers to the patient of the unsuitable technique
- lack of dangers for the suitable technique

This criterion is another where suitable images, well explained, enhance the portfolio evidence.

**PO2: Understand radiotherapy techniques and the use of radioactive tracers**

P3, M3, D2

These three performance criteria are linked and sequential. If P3 is not met for instance, M3 and D2 cannot be awarded, although this is likely to be the case anyway if the basic descriptions for P3 are not all present.

Typical successful approaches seen were exemplified by the following:

P3:

- a sensible/suitable choice of radiotherapy techniques (see Specification p108)
- one that is implant based and one involving external therapy
- good levels of research leading to -
    - the descriptions of the two techniques and the disease linked with each

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. Often, in weaker portfolios, the diagrams were not referred to nor used to enhance understanding. This followed through to links of the technique to the disease or disorder identified. The P3 Criterion is “Describe, with the aid of diagrams …” not just “state” or “identify”.

NB: As with any research, proper referencing is expected. Downloads must be reworded to demonstrate the learners’ own knowledge and understanding and un-reworded cut and paste cannot be awarded credit.

M3: explain how each technique is used and include:

- in each case, how the technique is used to treat the relevant specified disease
- how each chosen therapy is administered

D2: explain, compare and contrast the invasive nature of the two therapies chosen. Given the nature of D2, learners who are aiming at distinction level need to choose carefully the two techniques for P3 and thus for M3 and D2.

P4, M4, D3

Again, it is important for learners to understand that these criteria are associated and sequential. Good portfolios often tended to deal with P4 and M4 together, identifying each property of the selected radio-isotope sequentially and explaining the importance of that property in turn.

P4 and M4:

The focus is very much on a single radioisotope. Its properties and links need to be made to the radiotherapy technique using the radioisotope and the medical context(s) in which this technique is employed.

For the isotope selected, good portfolios included:

- Name, symbol, mass number, atomic number
- Type of decay/radiation emitted
- Half life
- Technique used
- Medical context

And for M4:

- Decay equation
- Part played by and the importance of the type 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.

Good portfolios were typified by:

- Extensive levels of research and a wide ranging consideration of types of tracer
- Examples and links to illnesses or conditions identified
- Good support from suitable images
- Consideration of P5 and M5 together* for the range of examples selected

* This worked very well and avoided rather disjointed reports which sometimes typified lower scoring examples.

P5:

- Outline 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

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: detailed research and consider both isotopes identified for M5.

- Graphical data should include decay curves
- Determination or demonstration of half-life
- Values for physical half-life and biological half-life researched and evaluated via calculations of effective half-life

P6, M6

These two marking criteria are a good example of where a detailed knowledge and understanding of the Unit Content is essential. This then has to be backed up by detailed research.

Relevant content in high scoring portfolios included:

- Consideration of the dangers of radioactivity, comparison of alpha, beta, gamma
- Precautions taken for **both** medical professionals and patients
- Scientific principles behind the precautions taken
- 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 centres approached this unit 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 to determine half-life. However, this does not cover the practical requirements of the Unit – see below.

An alternative which covers the same principles in terms of the use of data, is to perform experiments on half value thickness (eg for Co-60). This has the advantage of also allowing coverage of the various required practical elements.

PO3 entitled "Demonstrate the ability to work with radioisotopes in the laboratory" and the following would 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

This evidence can be obtained via practical activities including:

- A full protactinium half-life determination or…

- A HVT determination for instance for Co – 60
- A comparison of the penetration properties of alpha, beta, gamma radiation (Specification p109)

It is also worth noting that:

- Just using a simulation does not provide all the evidence required for P7
- Evidence for penetration for alpha, beta, gamma radiation is also required as part of M7
- If the full protactinium half-life determination or HVT are carried out, then these other experiments into penetration can 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 often worked well and was very comprehensive and detailed.

**PO4: Understand the medical uses of optical fibres and lasers**

P8, M8

P8 was met by most learners and requires descriptions of how optical fibres are constructed and how they transmit light. This was generally well researched and descriptions and explanations appropriate. Although the importance of total internal reflection was sometimes missing in weaker submissions. The inclusion of relevant diagrams and images, with appropriate reference made to them, always enhances the overall content.

M8was often well done, but there was a significant number whose reports were weaker as they 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 and a range of examples incorporated. As with many criteria, clear references to supporting diagrams and images enhance the content and prompt additional relevant content from those who might otherwise be less organised in their approach.

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

- Issued SP and RA
- Observation record.

Centres should remind learners 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, calculations.

P10, M9, D6

P10
This is straightforward:

- Identify two medical conditions where laser light is used in treatment
- Do not include purely cosmetic uses as these are not acceptable.

M9
NB: M9 will not be available if P10 is not met.

A full report will:

- cover both medical conditions from P10
- explain the nature of the conditions to be treated
- explain how the treatment is administered
- explain the scientific principles behind the treatment including the role played by the laser light in each treatment.

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

- A careful choice is essential
- The medical condition chosen must be able to be treated in two ways, one via laser, one not
- Both advantages and disadvantages of each treatment need to be considered for the specified condition.

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.