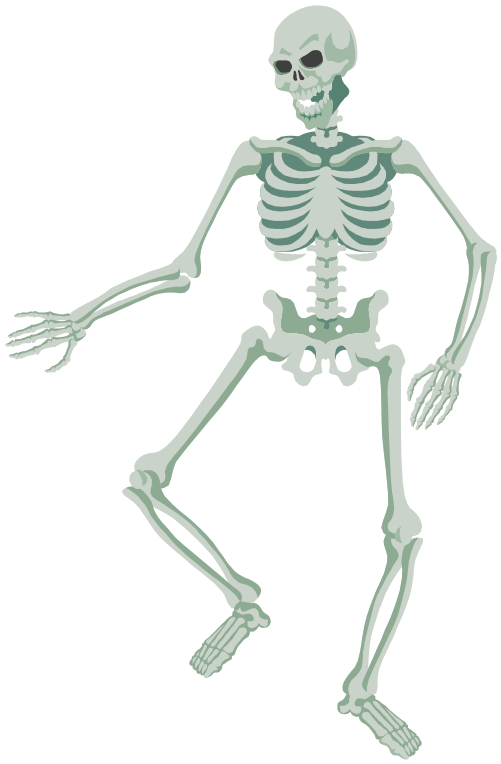
Australasian College of Physical Scientists and Engineers in Medicine

ABN 44 005 379 162

REQUIREMENTS FOR ACCREDITATION

IN RADIOLOGICAL PHYSICS



CANDIDATE'S KIT

Revised December 2003 JCPH

Contents

1 INTRODUCTION

1.1 A panel consisting of the Chief Examiner and at least two other examiners is responsible to the Council of the Australasian College of Physical Scientists and Engineers in Medicine for the administration and examination of candidates wishing to be assessed for accreditation in Radiological Physics.

1.2 The purpose of the ACPSEM Accreditation in Radiological Physics is to recognise individuals who are capable of:

(a) Indicating a high standard of knowledge in Radiological Physics theory and practice,

(b) Implementing a professional acceptance testing, commissioning, radiation safety, patient & personnel dosimetry and continuing quality control (QC) program in diagnostic radiology covering the broad areas of;

i) radiography,
ii) fluoroscopy,
iii) mammography,
iv) film processing,
v) CT,
vi) ultrasound,
vii) MRI,
viii) radiation safety, and
ix) dosimetry.

Individuals must be capable of interpreting the significance of any QC measurements that indicate less than desirable equipment performance and be able to offer possible explanations and/or solutions for remedying any problems that arise from the QC program.

(c) Managing appropriate radiation safety requirements, including patient dosimetry and shielding,

(d) Ensuring that relevant international, national and state standards and regulatory requirements are adhered to, and

(e) Teaching the full breadth of Radiological Physics programs, eg. Part I: FRANZCR syllabus.

1.3 To gain accreditation, candidates must satisfy the panel of their ability to initiate and carry out the above requirements.

1.4 The accreditation assessment program involves four sections. These are:

(a) Documentation of professional experience,

(b) Documentation of professional practice'

(c) A written examination,

(d) A combined practical and oral examination.

1.5 Before any examination or accreditation may be undertaken, documentation on the professional experience and practice of the candidate must be forwarded to the Chief Examiner, Radiological Physics Accreditation Panel, ACPSEM. The accreditation panel will assess the documentation and the Chief Examiner, Radiological Physics Accreditation Panel may request that further information or experience is required.

1.6 The candidate must pass all assessment requirements referred to in this document to gain accreditation.

1.7 Notification of the candidate's result will be on a Pass or Fail basis.

1.8 There is a fee required for accreditation, payable upon application. This fee has been set to recover in part some of the costs associated with the conduct of the examination. The fee for examination is set by the Education Committee, ACPSEM (see section 7 for details of application process).

2 DOCUMENTATION

2.1 The candidate shall provide a curriculum vitae which provides information on past professional experience, and copies of reports prepared and papers published relating to radiological imaging equipment, such as commissioning, quality assurance, patient/staff dosimetry and radiological protection.

2.2 A signed statement from the Head, Chief or Director of the Department in which the candidate is working shall be required to attest to the accuracy of the information provided by the candidate.

2.3 The candidate shall provide the names and addresses of two medical physicists who are prepared to attest to the candidate’s professional capabilities. At least one of these physicists should be accredited in Radiological Physics.

3 MINIMUM REQUIREMENTS

3.1 The candidate must have at least 4 years of professional practice in Radiological Physics.

3.2 The candidate shall provide documentation substantiating that they are;

(a) A member of the ACPSEM, associate grade or higher, or

(b) A member of an equivalent professional organisation, or

(c) Eligible for College membership at associate grade or higher.

3.3 The candidate shall provide copies of documentation substantiating that within the last two years they have;

(a) Performed a substantial range of assessment tasks and prepared reports on the following radiological imaging equipment,

i) A general room, including automatic exposure control (AEC),

ii) A fluoroscopy room or mobile C-arm, including automatic brightness control (ABC),
iii) A CT and/or angiography suite and/or MRI unit, and
iv) A mammography and/or ultrasound unit,

(b) Published papers on those topics in a refereed journal.

3.4 As a minimum requirement, the candidate shall have a sound understanding of the fundamental physics and technology of:

(a) Radiation safety & dosimetry,
(b) Generators,
(c) Tubes,
(d) AEC & ABC,
(e) Film/screen combinations,
(f) Grids,
(g) Fluoroscopy,
(h) Image intensifiers,
(i) Computed Tomography (CT),
(j) Mammography,
(k) Basic digital technology,
(l) Basic Digital Radiography (DR) including Computed Radiography (CR),
(m) Basic Digital Subtraction Angiography (DSA),
(n) Basic ultrasound and
(o) Basic Magnetic Resonance Imaging (MRI).

This will include substantial experience in the commissioning and quality assurance protocols of the more common radiological imaging equipment. The depth of experience and knowledge shall be sufficient to satisfy the requirements of any of the examinable material in the written examination and practical assessment.

3.5 A log book, documenting the candidate's experience, would provide a useful guide to the Chief Examiner, Radiological Physics Accreditation Panel on work done. This should provide, as a minimum, the procedure undertaken, the date, and affirmation by a senior member of the physics staff.

3.6 After the submitted documentation has been approved by the Chief Examiner, Radiological Physics Accreditation Panel, the applicant shall be advised of the dates and arrangements for the subsequent examinations.

4 WRITTEN EXAMINATION

4.1 All candidates will be required to sit a 3.5 hour written examination covering the major areas of Radiological Physics. The arrangements for this examination shall be organised at the discretion of the Accreditation Panel with appropriate supervision organised for the applicant to carry out the exam locally.

4.2 The written examination shall comprise two sections:

(a) 200 general multiple choice questions to be completed over 2 hours (some example questions given in Appendix B), and

(b) Six short answer questions, the candidate to choose three, to be completed over 1.5 hours. The candidate shall answer one short answer question on each of the general areas of radiation safety, the basic science of imaging and advanced medical imaging technology (CR/DR, CT, DSA, MRI, Mammography and Ultrasound). Some example questions are given in Appendix C.

There shall be a short break between the MCQ and short answer exam, the duration of which shall be at the discretion of the exam supervisor.

4.3 The broad syllabus shall be:

(a) Radiation safety
(b) Basic radiation biology
(c) Dosimetry
(d) QA methods
(e) QA equipment
(f) Production of x-rays
(g) Interaction between x-rays and matter
(h) Generators
(i) X-ray tubes
(j) Exposure control
(k) Film/screen combinations
(l) Grids
(m) Image quality
(n) Film processing
(o) Fluoroscopy
(p) Image intensification & image viewing systems
(q) Mammography
(r) CT
(s) Basic digital technology
(t) Basic digital radiography (CR and DR)
(u) Basic DSA
(v) Basic ultrasound
(w) Basic MRI.

4.4 It is expected that the candidate achieve a minimum grade of 75% in the multiple choice section of the written examination. A candidate who does not achieve at least 65% will not be allowed to continue with the practical and oral examination. A candidate who achieves greater than 65% but less than the expected 75% may, at the discretion of the Accreditation Panel, be required to resit an MCQ examination.

The pass mark for the short answer examination is 65%. In instances when the candidate has not quite achieved this level but has performed exceptionally well in the MCQ examination he or she may be allowed to proceed with the practical and oral examination but only at the discretion of the Accreditation Panel.

4.5 Questions shall be based on the attached list of recommended texts (Appendix A). The examination will be carried out under "open book" conditions. **HOWEVER, CANDIDATES SHOULD REALISE THAT TOO GREAT A DEPENDENCE ON BOOKS WILL RESULT IN THEM NOT COMPLETING ALL**

QUESTIONS WITH A RESULTING PENALTY. Accordingly, whilst the "open book" status remains it is recommend that candidates treat the examination as if it was closed book. The questions may be either theoretical or practical in nature, but the overall aim of the examination will be to relate the candidate's answers to the practical aspects of Radiological Physics and Quality Assurance of radiological imaging equipment.

4.6 The written examination shall be held at a date early enough to provide sufficient time for the Radiological Physics Accreditation Panel to mark the candidate's paper before the practical and general oral examinations are finally undertaken.

4.7 The final practical and oral examination shall initially be arranged in conjunction with the Annual Conference on Physical Sciences and Engineering in Medicine. It will be the candidate's responsibility to arrange the finance necessary to attend the examination during the Conference.

4.8 It is envisaged that practical examinations can be held at a mutually agreeable site and time if enough candidates require this to occur. Negotiations shall be with the Chief Examiner, Radiological Physics Accreditation Panel.

5 PRACTICAL EXAMINATION

5.1 It is compulsory that the candidate pass the practical examination.

5.2 The practical examination set by the Chief Examiner, Radiological Physics Accreditation Panel shall comprise two tasks of approximately 30 minutes per task. The candidate shall be advised of the nature of the tasks at least 15 minutes before the first task is to be attempted.

5.3 The progress of the work during the practical examination shall be the responsibility of the Chief Examiner, Radiological Physics Accreditation Panel, or their designated alternate, carrying out the accreditation.

5.4 Typical examinable tasks are listed in Appendix D.

5.5 Questions may be asked by the examiners during the practical examination but these interruptions will be limited to points of immediate and pertinent concern at the time. General questions on the practical examination shall be asked at the end of the practical examination and during the general oral and these may relate to issues such as why testing is done in a particular way or the related physics behind the measurement process.

5.6 The candidate shall not be expected to have a working knowledge of the equipment with which they will be asked to use to carry out the practical examination. A member of the staff from the department where the examination is being held shall operate the equipment for the candidate if required.

5.7 If time is limited, the Chief Examiner of the Accreditation Panel, or their designated alternate, shall ask the candidate to delete some aspects of the procedure in which

they are being examined. This shall be at the discretion of the Chief Examiner.

5.8 The result of the practical examination shall not be disclosed to the candidate at this stage.

6 GENERAL ORAL EXAMINATION

6.1 The oral examination shall involve the candidate answering specific questions during a period of approximately 30 minutes.

6.2 This oral is to ensure that the examiners are able to complete their assessment on whether the candidate may be accredited. This may involve questions being asked on:

(a) The written examination, and/or
(b) The two cases examined during the practical, and/or
(c) Details submitted in the curriculum vitae, reports and publications, and/or
(d) Other areas related to radiological imaging equipment commissioning and quality assurance.

6.3 At the end of the oral exam the examiners shall vote on whether the candidate has successfully completed the accreditation. The examiners shall prepare a report and forward it to the Chief Examiner, Radiological Physics Accreditation Panel who shall then forward it to the Chairperson of the Education Committee.

7 APPLICATION TO UNDERTAKE THE EXAMINATION

7.1 Applications for accreditation in any year are accepted from January 1st to March 31st (i.e. applications close on 31st March). Applications require a $50 non-refundable deposit towards the examination fee to be forwarded to the Honorary Treasurer of the ACPSEM. Late applications may be accepted if all examination positions are not yet filled and there is sufficient time for inclusion in the examination process. This will be at the Chairman's discretion. Withdrawal of an application at any stage will result in loss of the deposit and require a fresh application at any future time. Candidates will be informed of the success or otherwise of their application by 31st of April.

7.2 Advanced bookings are not accepted except in exceptional circumstances (e.g. a candidate from another country) and must be approved by the Chairman of the Education Committee.

7.3 When there are more applications from suitable candidates than examination positions available, those at the bottom of the queue will be allocated to the following year. (If this number is large, additional examinations will be programmed.)

7.4 Candidates, once the application is accepted, will have 4 weeks to send the balance of the fee to the Honorary Treasurer of the ACPSEM. If the fee is not received by this time, the Chairman will send notice giving one week's grace. After this period the examination position may be allocated to the next person in the queue. They will similarly have four weeks to forward fees.

8 RESULT OF ACCREDITATION

8.1 The candidate shall be advised in writing by the Honorary Registrar ACPSEM of the result of the accreditation if they are completely successful. All other outcomes will be notified by the Chairperson of the Education Committee.

8.2 Enquires from candidates regarding their assessment should be directed to the Chairperson of the Education Committee.

8.3 Any further discussion or consideration of the result of the accreditation shall not proceed any further without the specific approval of the Chairperson of the Education Committee. In extraordinary circumstances, the Council of the ACPSEM may request further information on the result of the candidate's assessment.

8.4 In certain circumstances, where it is considered that a candidate has a significant deficiency of knowledge, but that deficiency does not warrant failure of the candidate, then the candidate may be requested to perform supplementary work to the satisfaction of the Chief Examiner, Radiological Physics Accreditation Panel.

9 FAILURES OF CANDIDATES

9.1 A candidate who fails the accreditation examination on the first attempt will be guaranteed a place in the following year provided that they indicate an intention to re-sit the exam and forward a $50 not refundable deposit towards the examination fee within the time frame for receipt of applications outlined in Section 7.1.

9.2 A candidate who fails the examination on the first attempt, and is not re- examined within two examination periods, must apply afresh and be examined in all components. (Note that examination periods are used rather than years because examinations are not held exactly every 12 months but vary according to the timing of the annual conference.)

9.3 A candidate who fails the examination a second time, within 2 examination periods of the first attempt, may not apply again for 12 months and must apply afresh and be examined in all components.

9.4 The re-examination fee will be 100% if all components are examined, 33% for the written part only and 75% if either or both the practical or oral component is examined.

(The Chairperson of the Education Committee will communicate this policy to the candidate with the notification of failure).

10 APPEALS PROCEDURE

10.1 To be finalised in collaboration with the Education Committee.

11 RECOGNITION OF FOREIGN QUALIFICATIONS

11.1 The ACPSEM does not recognise certification, accreditation or other qualifications obtained from other organisations for credit towards the College's Accreditations. However, candidates may present a case for exemption in part or in whole of the examination process. Exemption would be considered on a case by case basis taking into account the experience of the candidate, the nature of the qualification and any other relevant factors. As a minimum requirement, the examination for the overseas qualification must include a practical component. Exemption would require the approval of the majority of examiners and the Chairman of the Education Committee.

12 EXAMINERS HINT

12.1 The examiners strongly suggest that to maximise a candidate's knowledge base in Radiological Physics they should undertake to tutor radiology registrars undergoing the Part 1 FRANZCR: Radiodiagnosis Program in Applied Imaging Technology.

13 CANDIDATES TEST EQUIPMENT

13.1 Candidates are permitted to bring their own test equipment. This includes all measurement devices and jigs, software and pro-forma test and data sheets.

Appendix A: Recommended Syllabus Texts

1. ***'ICRP Publication 60, 1990 Recommendations of the International Commission on Radiological Protection'***, Pergamon Press, Oxford, November, 1990.
2. ***'ICRP Publication 84, Pregnancy and Medical Radiation',*** Pergamon Press, Oxford, March, 2000.
3. ***'ICRP Publication 85, Avoidance of Radiation Injuries from Medical Interventional Procedures',*** Pergamon Press, Oxford, June, 2000.
4. ***'ICRP Publication 87, Managing Patient Dose in Computed Tomography,*** Pergamon Press, Oxford, December, 2000.
5. ***'Exposure of the Pregnant Patient to Diagnostic Radiations - A Guide to Medical Management'***, Wagner, L.K., Lester, R.G. & Saldana, L.R., Medical Physics Publishing, Wisconsin, 2nd Ed., 1997.
6. ***'Minimizing Risks from Fluoroscopic X-rays'***, Wagner, L.K. & Archer, B.R., 3rd Ed., 2000.
7. ***'Applied Imaging Technology'***, Heggie, J.C.P., Liddell, N.A. & Maher, K.P., St. Vincent's Hospital Melbourne, 4th Ed., 2001.
8. ***'The Essential Physics of Medical Imaging'***, Bushberg, J.T., Seibert, J.A., Leidholdt, E.D. Jr & Boone, J.M., Williams & Wilkins, Baltimore, 2nd Ed., 2002.
9. ***'Magnetic Resonance Imaging'***, Sprawls, P., Medical Physics Publishing, Wisconsin, 2000.
10. ***'Computed Tomography'***, Kalender, W.A., MCD Verlag, 2000.
11. ***'Radiological Physics Examinations (RAPHEX) Vol.2 Diagnostic'***, Brownie,S.V. & Shahabi,S., Advanced Medical Publishing, Madison Wisconsin, USA. (updated yearly).
12. ***'Specification, Acceptance Testing and Quality Control of Diagnostic X-Ray Imaging Equipment'***, American Association of Physicists in Medicine, Medical Physics Monograph No.20, 1994.

Additional Reading

13. ***'ICRP Publication 73, Radiological Protection and Safety in Medicine',*** Pergamon Press, Oxford, 1996.
14. ***'Medical Effects of Ionising Radiation',*** 2nd Ed., Mettler, F.A. & Upton, A.C., Saunders, 1995.
15. ***'Radiobiology for the Radiologist'***, 5th Ed., Hall E.J., Lippincott, Williams & Wilkins, 2000.
16. ***'Physical Principles of Medical Imaging',*** Sprawls, P., Medical Physics Publishing, Wisconsin, 2nd Ed., 1995.
17. ***'Radiation Exposure in Computed Tomography'***, 4th Ed., Nagel, H.D., COCIR, December 2002.
18. ***'Categorical Course in Diagnostic Radiology Physics: Practical MR Safety Considerations for Physicians, Physicists and Technologists',*** RSNA, 2001.

19. ***'Categorical Course in Diagnostic Radiology Physics: CT and US Cross-sectional Imaging'***, RSNA, 2000.

20. ***'Categorical Course in Diagnostic Radiology Physics: Cardiac Catheterisation Imaging'***, RSNA, 1998.

21. ***'Categorical Course in Physics: Technology Update and Quality Improvement of Diagnostic X-Ray Imaging Equipment'***, RSNA, 1996.

22. ***'Categorical Course in Physics: Physical and Technical Aspects of Angiography and Interventional Radiology'***, RSNA, 1995.

23. ***'Categorical Course in Physics: Technical Aspects of Breast Imaging'***, RSNA, 1994.

24. ***'Intravascular Brachytherapy & Fluoroscopically Guided Interventions'***, American Association of Physicists in Medicine, Monograph No. 28, July 2002.

25. ***'Practical Digital Imaging and PACS'***, American Association of Physicists in Medicine, Medical Physics Monograph No.25, 1999.

26. ***'The Expanding role of Medical Physics in Diagnostic Imaging'***, American Association of Physicists in Medicine, Proceedings of the 1997 Summer School, 1997.

27. ***'Quality Control in Diagnostic Radiology'***, American Association of Physicists in Medicine, Report No. 74, July 2001.

28. ***'Cardiac Catheterisation Equipment Performance'***, American Association of Physicists in Medicine, Report No. 70, February 2001.

29. ***'Managing the Use of Fluoroscopy in Medical Institutions'***, American Association of Physicists in Medicine, Report No. 58, October 1998.

30. ***'Recommended Standards for Routine Testing of Diagnostic X-Ray Imaging Systems'***, IPEM Report 77, IPEM Publications, York, 1997.

31. ***'Radiation Shielding for Diagnostic X-Rays'***, BIR/IPEM, February 2000.

32. ***'Assurance of Quality in the Diagnostic Imaging Department'***, 2nd Ed., BIR, 2001.

33. ***'CEC Quality criteria for CT, European Guidelines'***, EU16262, Commission of the European Communities, Luxemburg, 1999.

34. ***'Type Testing of CT scanners: Methods and Methodology for Assessing Imaging Performance and Dosimetry'***, Report MDA/98/25, Medical Devices Agency, London, 1998.

35. ***'Measurement of the Performance Characteristics of Diagnostic X-ray Systems used in Medicine, Part III Computed Tomography X-ray Scanners'***, 2nd Ed., Edyvean, S., Keat, N., Jones, A.P., IPEM Report 32, 2003.

36. ***'Performance Evaluation of Computed Radiography Systems',*** Samei E.H., Seibert J.A., Willis C.E. et al, Med Phys 28, 361-371, 2001.

37. ***'The Safe Use of Ultrasound in Medical Diagnosis'***, BMUS/BIR, 2000.

38. ***'The Basics of Film Processing in Medical Imaging'***, Haus, A.G. & Jaskulski, S.M., Medical Physics Publishing, Wisconsin, 1997.

39. ***'Imaging Systems for Medical Diagnostics'***, Krestel, E., Siemens, 1990.

40. ***'The Physics of Radiology'***, Johns, H.E. & Cunningham, J.R., Thomas Springfield, 4th Ed., 1983.

41. ***'Diagnostic X-ray Equipment Compliance Testing Workbooks'***, Health Department of Western Australia, Radiological Council, 18 Verdun Street, Nedlands, 6009.

42. Relevant Australasian Standards, State and National Regulations.

Appendix B: Sample Multiple Choice Questions

1. Which of the following is a stochastic effect?

   A. Genetic Defects
   B. Erythema
   C. Epilation
   D. Reduced blood cell count

2. If a dosimeter chamber wall is to be *air equivalent* it must have an effective atomic number of approximately:

   A. 14
   B. 11
   C. 7
   D. 1

3. The following statements about characteristic X-rays are true or false?

   A. They are produced as a result of nuclear de-excitation of the anode material.
   B. They are readily produced if the X-ray tube potential is below the K-edge of the anode elements.
   C. They arise as a result of atomic de-excitation processes
   D. They are never produced in Compton scattering processes.
   E. The energy of the characteristic X-rays is a signature of the elemental material in the anode.

4. The linear attenuation coefficient of a medium depends on (T/F):

   A. The energy of the X-rays.
   B. The density of the medium.
   C. The atomic number of the medium.
   D. The intensity of the X-ray beam.

5. The Modulation Transfer Function (MTF) of a screen/film combination at 2 lp/mm is 0.6 and for the relevant radiographic geometry that for the focal spot is 0.2. The *system* MTF is:

   A. 0.8
   B. 0.12
   C. 0.2
   D. 0.6
   E. 0.4

6. The *contrast ratio* of an image intensifier is influenced by (T/F):

   A. The veiling glare in the intensifier.
   B. The minification gain.
   C. Scattering or lateral diffusion of light in input and output phosphors.
   D. X-ray scattering in CsI:Na phosphor.
   E. Vignetting.

7. The Hounsfield unit represents a difference of:

   A. 1% of the average linear attenuation coefficient of soft tissues.
   B. 1% of the linear attenuation coefficient of water.
   C. 0.1% of the average linear attenuation coefficient of soft tissue.
   D. 0.1% of the linear attenuation coefficient of water.

8. Which of the following tests on a CT unit would be affected by a change in kV?

   A. Uniformity check.
   B. Linearity check.
   C. High contrast (spatial) resolution.
   D. Low contrast resolution

9. An object lies 7.7 cm beneath the patient's skin. How long after the ultrasound pulse is fired will it be before the echo from this object is detected?

   A. 1.54 microseconds.
   B. 200 milliseconds.
   C. 0.01 milliseconds.
   D. 0.1 milliseconds.

10. Which of the following is a piezoelectric material?

   A. Granite.
   B. Lead zirconate titanate.
   C. Lithium fluoride.
   D. Bismuth germanate.

11. The lateral resolution of an ultrasound instrument is influenced by:

   A. The frequency at which the crystal oscillates.
   B. The degree to which the crystal is damped.
   C. The crystal diameter.
   D. Both A and B.

Appendix C: Sample Short Answer Questions

1. In diagnostic radiology the photon beam attenuation through photon absorption phenomena gives the ideal photon image, while attenuation through scatter contributes no useful information and only degrades the final image quality. Discuss the origin of scatter, its physical characteristics and its relationship with beam parameters. Also define radiologic contrast and discuss the contrast reduction by scattered radiation.

2. Describe, using labelled sketches, the RF pulse sequences and gradient applications for the following MR imaging techniques:
   (a) saturation recovery (partial saturation),
   (b) inversion recovery, and
   (c) spin echo.

3. An experienced radiographer comes to you complaining of variable density films in a dedicated chest room. What equipment tests would you instigate? Explain your reasons.

4. (a) Many mammography X-ray units employ a molybdenum anode with a thin 0.03 mm molybdenum filter in the tube port. Why is this choice appropriate for mammography? What other possible anode/filter combinations are potentially useful? Give reasons for their applicability.

   (b) Describe any other features of the X-ray tube that are largely unique to mammography. Give reasons for these design features and the impact that they may have on the image quality.

   (c) Discuss the impact that the focal spot size, imaging geometry and resolution of the film/screen combination have on the image resolution. Supplement your answer with relevant sketches.

   (d) Discuss, using examples, why magnification mammography allows the imaging of finer detail than conventional contact mammography. What are the disadvantages of the technique?

   (e) A 50 mm thick, 50% adipose - 50% glandular breast is radiographed at 25 kVp and requires 150 mAs to achieve the desired film optical density. A grid was used in the exposure.

   Calculate :
   (i) The skin entrance dose in air
   (ii) The mean glandular absorbed dose.

   The following information may be useful;
   X-ray output @ 25 kVp = 0.08 mGy/mAs @ 60 cm from the focus
   FSD = 53 cm
   Bucky factor = 2.5
   Tube current = 100 mA
   HVL = 0.32 mm Al

The tabulated value of the mean glandular dose per unit skin absorbed dose in air for a breast of this type and thickness using 25 kVp and an HVL of 0.32 mm Al is 0.154 mGy/mGy.

5. Give definitions and typical numerical values for the following parameters as they pertain to CT imaging;
   (i) x-ray tube kilovoltage,
   (ii) effective photon energy for the measured attenuation coefficients,
   (iii) the spatial resolution (at high contrast),
   (iv) the image display matrix size,
   (v) the image noise,
   (vi) the CT values for air, lung, brain, water, trabecular bone, cortical bone,
   (vii) the patient dose per tomogram slice and per examination

6. (a) A 35 year old woman underwent an abdominal examination at a country hospital which involved two plain abdominal X-rays and 10 minutes of fluoroscopy. It is subsequently revealed that she was 7 weeks pregnant at the time of exposure and you are asked for an opinion as to the magnitude of the foetal dose and any possible risks to the foetus. The technical details of the examination are sketchy at best. Provide an estimate of the foetal dose indicating how you have obtained this answer. What advice about the possible risks to the foetus might you offer? On the physical evidence would you recommend abortion?

   (b) Your cardiac catheterization laboratory is equipped with a Dose Area Product meter (DAP) which gives readings in $Gy.cm^2$. Briefly describe how it operates and how you might confirm its calibration.

   (c) At the conclusion of a prolonged angioplasty and stenting procedure the DAP reading is 1490 $Gy.cm^2$. What is your worst case estimate of the absorbed dose to the skin assuming a constant beam entrance position? Provide sufficient detail in your answer for us to confirm the elements of the calculation.

7. (a) An X-ray equipment tester performs a linearity of output measurement at a nominal 70 kVp on a new X-ray tube [anode angle 16°] operated from a high frequency generator and intended for general radiography. The air kerma measurements are made using a diagnostic ion chamber of volume 30 cm^3 positioned at 75 cm from the focus. The chamber is operated at a bias of 300 V as per the manufacturer's requirements. The tester presents you, a qualified expert, with the results shown in the table and says the unit has failed the local criterion that the coefficient of linearity should be less than 0.1 over the full range of tube currents. Do you concur with this finding? Give reasons for your answer.

Normalised Air Kerma Measurements

Focus	mA	Air Kerma (μGy/mAs)
Fine	50	120
	100	121
	200	119
Broad	300	123
	400	115
	500	105
	750	100
	1000	90

(b) The same test report contains an estimate of the HVL. The tester has measured the HVL at 70 kVp and obtained a value of 2.1 mm Al which he/she has called a pass. The tester's report says that the markings on the tube housing and collimator indicate that the total filtration in the beam is 2.1 mm Al. Again comment on his/her finding and suggest any recommendations you might make.

Appendix D:- Practical Examination Tasks

Please show and explain all actions, requirements of legislation and/or standards, acceptable limits to tested parameters and assumptions of how you would set up to measure, calculate or use the following:

General Radiographic, Mammographic, Capacitor Discharge and Dental Units

- Irradiated & illuminated beam coincidence
- Focal spot assessment
- Leakage Radiation
- Exposure time accuracy
- Exposure reproducibility
- AEC
- Linear tomography slice thickness
- Dental requirements
- Focal spot-central ray-LBD coincidence
- LBD illuminance output
- kVp accuracy
- Exposure linearity
- HVL
- Linear tomography resolution
- Capacitor discharge requirements
- Mean glandular dose in Mammography

General Fluoroscopic, Cardiac and DSA

- Applicable radiographic tests
- Beam collimation to input of II
- Skin entrance air kerma rate
- Automatic brightness control functionality
- High contrast resolution
- Monitor field size accuracy
- Focal Spot –central ray- TV chain coincidence
- Image intensifier air kerma input
- Low contrast resolution
- Low and high contrast resolution in DSA

Computed Tomography

- Slice thickness
- Low contrast resolution
- Contrast scale
- Table & Gantry movements
- CT number accuracy
- Linearity
- CTDI
- High contrast resolution
- Radiation scatter profiles
- CT number spatial uniformity
- Artefact assessment

Ultrasound

- Dead zone
- Axial & lateral distance accuracy
- Focal zone
- Axial & lateral resolutions
- Sensitivity
- Gray scale & dynamic range

Magnetic Resonance

- Low contrast resolution
- Spatial uniformity
- Safety
- High contrast resolution
- Artefact assessment
-

Radiation Safety

- Shielding calculations
- Dosimetry calculations
- Instrumentation assessment
- Barrier thickness assessment
- Safety equipment assessment
- Scatter measurements