

2024



ASMIRT

Guidelines

MRI Level 1 Course Syllabus Study and Examination Guide

Your profession. Your future.



There are a number of protected titles for medical radiation practice. They include:

Medical Radiation Practitioner (MRP)

Diagnostic Radiographer (DR)

Medical Imaging Technologist (MIT)

Radiographer

Nuclear Medicine Scientist (NMS)

Nuclear Medicine Technologist (NMT)

Radiation Therapist (RT).

For the purposes of our documentation we use the broad descriptor Medical Radiation Practitioner (MRP) recognising that it covers a range of areas of practice.



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MRI Level 1 Course Syllabus Study and Examination Guide

Overview

The following key capabilities and enabling components cover the knowledge, skills and attributes needed by all diagnostic radiographers, nuclear medicine technologists and radiation therapists who use MRI *MRPBA Professional capabilities for medical radiation practice (2020) Domain 1: Key Capabilities 8. & 9.*

Key capabilities – <i>What registered medical radiation practitioners must be able to do</i>	Enabling components – <i>Evidence of this capability for general registration as a medical radiation practitioner</i>
<p>9. Perform magnetic resonance imaging (MRI).</p>	<ol style="list-style-type: none"> a. Operate MRI systems safely and effectively. b. Apply knowledge of the principles of MRI physics and surrounding environment to ensure patient/client and others' safety. c. Select equipment and imaging parameters relevant to the patient/client presentation and where appropriate, modify imaging parameters to achieve optimal diagnostic outcomes. d. Collaborate in the design and evaluation of MRI protocols. e. Perform and evaluate MRI examinations where appropriate, modify the examination according to the MRI findings and clinical presentation. f. Process image data sets. <p>MRI includes contrast-enhanced studies and the safe and appropriate selection of MRI contrast agents for the patient/client presentation.</p> <p>MRI safety includes but is not limited to:</p> <ul style="list-style-type: none"> • maintaining the integrity of MRI safety zones • applying principles of electro-magnetic forces and fields (static and gradient and radiofrequency) • minimising the bioeffects of magnetic fields (including tissue heating and peripheral nerve stimulation) • exposure limits (including specific absorption rates) • assessing and managing risks associated with devices/implants/projectiles, acoustic risks, and • implementing emergency procedures in the event of quench or the distressed and/or deteriorating patient.

<p>8. Apply knowledge of safe and effective use of medicines.</p>	<p>a. Apply the principles of safe and effective use of medicines to practice.</p> <p>b. Recognise the risks, precautions and contraindications of the use of medicines, informed by the patient’s/client’s current pathology status.</p> <p>c. Apply knowledge of pharmacokinetics, pharmacodynamics and the potential range of reactions to medicines.</p> <p>d. Safely and effectively deliver medicine to patients/clients, in accordance with procedures.</p> <p>e. Actively monitor the effects of medication and manage adverse reactions to medicines, in accordance with protocols.</p> <p>Knowledge of safe and effective use of medicines relevant to practice may include state and territory and/or federal legislation about the supply and administration of medicines. It also includes understanding how pathological conditions may affect the delivery of some medicines.</p> <p>Procedures for safe and effective delivery of medicines must be consistent with the NSQHS’s Medication Safety Standard and may include checking products, confirming correct labelling, accurate calculations and measurements and correct route.</p>
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Justification

ASMIRT is providing this certification as recognition that a medical radiation practitioner (MRP) is performing with professional skill in Magnetic Resonance (MR) imaging. This certification provides practitioners and employers with direction for study and educational programs, a benchmark of industry-standard skill, and formal recognition of the ability of the MRP.

MR Certification of medical radiation practitioners by ASMIRT implies MRPs have the knowledge to:

- Operate proficiently in an MR clinical environment and during complex procedures
- Assess patient suitability for and oversee safe administration of contrast media
- Evaluate appropriate MR protocols for scanning purposes
- Individualise scanning technique to suit patient procedure
- Evaluate normal anatomy, and unexpected or urgent medical findings
- Understand ongoing quality assurance and safety implications

Introduction

The MRI Level 1 Certification process is aimed at radiographers who have a minimum of one year full time equivalent experience in a broad range of MRI examinations. In order to pass the theoretical component, candidates are expected to undertake revision of textbooks and other relevant literature prior to sitting the exam.

The MRI Level 1 certification encompasses theoretical and clinical components. In order for a candidate to apply for a 'MRI Level 1 Certificate', the candidate must meet all of the following requirements:

1. Achieve a pass grade of 75% with no element below 65% for the MRI Level 1 Certification Examination (Part A)
2. Perform the required clinical component as outlined below (Part B)

MRI Level 1 Certification Examination

The formal examination will involve a paper not exceeding 165 multiple-choice questions covering a range of topics (refer to the following study guide for details). The examination is divided into 4 modules. The sections with the number of questions related to each module are listed below:

Part A: Hardware and Instrumentation – 25 Questions

Part B: Imaging Procedures and Relative Anatomy/Pathology – 50 Questions

Part C: Patient Care and Safety/Contrast Media – 25 Questions

Part D: Pulse Sequences/Artefacts & Physics - Physical Principles – 65 Questions

Reading Material

These texts are considered by ASMIRT to provide the applicant with a sound understanding necessary to complete the theoretical component and assist with additional knowledge for the clinical aspects of Level 1.

MCQ for all you really need to know about MRI Physics

NessAvier 1996 ISBN 0-9669082-3-4

MRI in Practice 5th edition

Westbrook C., Talbot J. Wiley-Blackwell 2018 ISBN 978-1-119-39196-8

MRI From Picture to Proton 3rd edition (2017)

McRobbie, D. Moore E. Graves M, Prince M. Cambridge University Press
ISBN 978-0-521-68384-5

Essentials of MRI Safety, 1st Edition (2020)

McRobbie, D. Wiley-Blackwell
ISBN 978-1119557173

Handbook of MRI Technique 4th edition (2014)

Westbrook, C., Wiley- Blackwell ISBN: 978-1-118-66162-8

MRI Bioeffects, Safety, and Patient Management 2nd Edition (2022):

Shellock FG, Crues JV. Biomedical Research Publishing Group,

Questions and Answers in Magnetic Resonance Imaging 2nd edition (2000)

Elster, Allen. D. Burdette, Jonathon. Mosby Inc. ISBN 978-0323011846

Also available on <http://www.mriquestions.com/index.html>

MRI. The Basics 4th edition 2018

Hashemi, R.H. Bradlet W.G. Lisanti, CJ. Wolter Kluwer Health, ISBN 9781496384324

Clinical Magnetic Resonance Imaging 3rd edition

Edeleman, Hesselink, Zlatkin, Crues. Published by Saunders 2005,

ISBN 978-9996019494

Magnetic Resonance In Medicine: A Critical Introduction

The Basic Textbook of the European Magnetic Resonance Forum (2018) Rinck, Peter A.

BoD, Germany ISBN 978-3-7460-9518-9 Blackwell

Also available on <http://www.magnetic-resonance.org/contents.htm>

Magnetic Resonance Imaging: Physical and Biological Principles – 4th edition 2015

Bushong Stewart C., Clarke G. 2015. Elsevier ISBN 9780323073547

Magnetic Resonance Imaging Study Guide and Exam review 2nd edition 1996

Bushong Stewart C. CV Mosby ISBN 9780815113409

Review Questions for MRI 2nd Edition 2013

Kaut & Faulkner Blackwell ISBN 9781444333909

Magnetic Resonance Imaging of the Brain & Spine – 4th Edition

Atlas Raven ISBN 0-88167-694-2

Magnetic Resonance Imaging in Orthopaedics and Sports Medicine – 3rd Edition 2006

Stoller, D Lippincott Wolters Kluwer

Magnetic Resonance Angiography: Concepts and Applications

Potchen, Haacke, Siebert Mosby ISBN 1-55664-270-9

<https://mr-tip.com/serv1.php> www.mriquestions.com

LEARNING OBJECTIVES

Part A: Hardware & Instrumentation

The candidate should have knowledge and be able to demonstrate understanding of:

- Design of the various magnets used in MRI
- Magnetic and radiofrequency (RF) shielding and its consequences.
- The various gradient systems and their implications.
- The basic RF system design including phased array.
- The basic design and use of RF coils including phased array.
- The basic computer architecture.

Part B: Imaging Procedures & Anatomy & Pathology

The candidate will be able to demonstrate an understanding of routine imaging procedures including the recognition of image weighting and relevant 3D anatomy/pathology on an MRI image.

Topics include:

3D Anatomy:

- Neuroanatomy, including grey/white matter differentiation, the ventricular system and vascular structures
- Spinal anatomy - spinal column, spinal canal & contents
- Joint anatomy - knee, shoulder, hip

Pathology:

- Commonly Imaged Pathologies and their MRI appearance

Patient Positioning Coil Positioning & Placement

Part C: Patient Care, Patient Safety & Contrast Media

This section aims to highlight the potential biological effects and hazards associated with both the static magnetic field and time varying radiofrequency magnetic fields. On completion of this section the MR Radiographer will have examined all areas associated with preparation of persons entering the magnetic field and be familiar with all safety aspects related to the hardware of a MR scanner. The MR Radiographer will be able to demonstrate knowledge of the safety considerations of MRI.

Topics include:

- Patient Screening
- Static Magnetic Fields
- Gradient Magnetic Fields
- Radiofrequency (RF)

- Specific Absorption Rate (SAR)
- Basic Emergency Procedures and patient monitoring

Contrast Media (CM):

** All applicants should read the product information sheets available from the manufacturers**

Today the MR contrast agents currently marketed in Australia are:

- Dotarem - Gadoteric Acid – Macrocylic (Guerbet)
- Clariscan – Gadoterate Meglumine - Macrocylic (GE Healthcare)
- Gadovist – Gadobutrol – Macrocylic (Bayer)
- Magnevist - Gadopentetate Dimeglumine - Linear (Bayer)
- Multihance – Gadobenate Dimeglumine - Linear (Bracco)
- Omniscan – Gadodiamide Linear (GE Healthcare)
- Optimark – Gadoversetamide - Linear (Guerbet)
- Primovist – Disodium Gadoxetate (Bayer)
- Prohance – Gadoteridol Macrocylic (Bracco)

This section details the application of intravenous paramagnetic contrast media in MRI. Applicants will be able to identify patients at risk and patients with contraindications to CM, describe emergency procedures for patient care after allergic-type reaction or extravasation of IV CM, outline pharmacological influences on IV CM use and scanning protocols and explain RANZCR safe-use guidelines including terminology and assess patient suitability for use of CM.

Issues that covered include:

- What is the molecular make up and biological factor i.e. distribution, clearance and excretion and toxicity (contraindications).
- The mechanisms of T1 (Spin Echo as well as Gradient Echo) relaxation and how Gadolinium enhances the contrast between tissues under this scanning regime.
- The blood brain barrier and how it interacts with contrast to alter the pooling of contrast media in pathological states.

Part D: Physics & Physical Principles

On successful completion of this section the candidate will have a general understanding of MRI phenomena, spatial encoding, pulse sequences, image weighting, basic QA and image quality optimization Candidates will be able to define the various components that comprise an MRI system, their features and functionality, demonstrate the key elements of the RF system when acquiring images including the use of coils for image optimization and explain the types of magnet shielding and their functionality.

Principles of NMR:

- Properties of Nucleus interaction
- Fourier Transformation
- Spatial Encoding
- K-Space analysis and sampling techniques
- Image weighting / Contrast
- T1 relaxation time, T2 decay time, T2* decay time

Image Quality:

- QA
- Signal to Noise Ratio
- Contrast to Noise Ratio
- Spatial resolution - implications to imaging parameters

Pulse Sequences:

- Pulse sequence structure, design, imaging characteristics
 - 2D/3D, Spin Echo (SE) , Gradient Echo (GRE) , Fast/Turbo Spin Echo (FSE/TSE)
 - Inversion Recovery (IR), Echo Planar Imaging (EPI), fMRI (BOLD), Diffusion
- Ancillary pulse options
 - Fat suppression, Magnetisation transfer, FSE optimisation, Ernst angle correction
- Compensation techniques
 - Flow compensation, Phase correction, Pre-saturation
- MR Angiography
 - Time of Flight (2D and 3D) Phase contrast, Contrast Enhanced MRA

The applicant will be expected to demonstrate an understanding of the concepts of pulse sequence diagrams (recognise various types-SE vs GRE etc. and identify the individual components), the effects and implications of ancillary pulse/compensation options (implications to parameter choices, clinical applications and effects on overall impression of an image).

The MRA component requires the applicant to understand and explain the differences in 2D vs 3D Time of Flight. MR techniques, relative advantages/disadvantages of each technique and an understanding of the implications of changing pulse parameters (TR, TE, Flip Angle, gating, Single slab vs MOTSA), scan orientation and acquisition technique (e.g. stationary pre sat vs travelling pre sat).

Artefacts:

The artefact module is designed to assist the candidate recognise and describe artefacts induced by the system hardware, pulse sequences, poor operator choices, physiological and patient motion. It is important that the candidate can not only recognise these faults but also suggest an alternative approach to imaging the patient in order to remove or reduce the effects of this artefact.

Sample Examination Questions:

1. The amount of radio-frequency energy necessary to produce a 40-degree flip angle is determined by:

- (a) The strength of the external magnetic field.
- (b) The coil being used.
- (c) The amplitude and duration of the R.F. pulse.
- (d) All of the above.

Answer: (d)

2. The gradient that is on during the sampling of the echo is:

- (a) The phase encoding gradient.
- (b) The frequency encoding gradient.
- (c) The slice selecting gradient.
- (d) a. and b.

Answer: (b)

3. If the radio-frequency shielding in the scanner environment is disrupted, it may result in:

- (a) A reduction in slice thickness.
- (b) More use of cryogenics.
- (c) A generalised reduction in image signal.
- (d) Slower image reconstruction times.

Answer: (c)

4. When imaging the pituitary fossa for micro-adenoma, the optimal scanning planes are:

- (a) Sagittal/Coronal
- (b) Sagittal/Axial
- (c) Axial/Coronal

Answer: (a)

5. An unconscious patient presents for a spinal MRI examination with a suspected history of previous brain surgery. The patient should therefore:

- (a) Go through a thorough screening process including inspection for other surgical scars, interviewing next of kin, review of other imaging and performing radiographs.
- (b) Not undergo an MRI scan.
- (c) Only be admitted to the MR scan room if the referring doctor has certified the patient is safe.
- (d) Be scanned feet first.

Answer: (a)

6. A quench refers to the sudden loss of magnet superconductivity when its temperature is raised. Associated with this there is:

- (a) Rapid boil off of cryogenes into the atmosphere associated with a loud roaring noise.
- (b) Cryogenic gasses may be released into the MR room resulting in a drop of temperature and increased pressure.
- (c) a. and b.
- (d) Rapid boil off of cryogenes into the MR room and a fire within the magnet bore.

Answer: (c).

7. A patient with an implanted cardiac pacemaker should not be taken into the MR scan room without research into its MRI Safety Status and monitoring during the scan. Reasons for this include:

- (a) The pacemaker may undergo motion and/ or modification of function by the static magnetic field.
- (b) If the patient is also claustrophobic, they are at an increased risk of suffering from an anxiety induced heart attack.
- (c) Thermal heating, voltages and currents may be induced in the pacemaker leads and myocardium during the MR examination.
- (d) Rapid boil off of Cryogenes into the MR room and a fire within the magnet bore.

Answer: (c).

8. Both Dotarem and Gadovist will cause a _____ in T1 and T2 relaxation times of tissues where it is distributed.

- (a) increase
- (b) decrease
- (c) no change

Answer: (b)

9. Both Dotarem and Gadovist are _____ contrast agents.

- (a) ferromagnetic
- (b) diamagnetic
- (c) paramagnetic

Answer: (c)

10. In clinical doses the resultant changes on T1weighted spin echo images of the tissues affected by the contrast media will be _____ signal intensity.

- (a) decreased
- (b) increased
- (c) no change in

Answer: (b)

11. The inversion time necessary to perform an equivalent inversion recovery spin echo sequence on a 1.5 Tesla system will be _____ than on a 3T system.

- (a) The same
- (b) Longer
- (c) Shorter
- (d) Does not matter

Answer (c)

12. An inversion recovery spin echo sequence with TR 2000, TI 700 will give a

- (a) Heavily T1W image
- (b) Heavily T2W image
- (c) Heavily PD image
- (d) None of the above

Answer (a)

13. The "readout" gradient is also known as _____?

- (a) Slice selection
- (b) Phase
- (c) Frequency
- (d) Oblique

Answer (c)

14. What would be the appearance of CSF on a transverse image of the Brain using the following TR / TE / BW - 500 / 8 / 105kHz

- (a) Hyperintense to white matter
- (b) Isointense to Fat
- (c) Hypointense to white matter
- (d) None of the above

Answer: (c)

15. A T2 weighted sequence is characterized by parameters as listed below:

- (a) Long TR / Short TE
- (b) Short TR / Long TE
- (c) Short TR / Short TE
- (d) Long TR / Long TE

Answer: (d)

16. The T2 weighted Fat Suppressed FSE transverse scan through the proximal portion of the chest demonstrates water suppression as opposed to fat suppression. Which of the following options listed below would not reduce this artefact thus reducing the diagnostic accuracy of this image?

- (a) Swap Phase and Frequency and increase the number of acquisitions (Nex) used
- (b) Perform higher order shim prior to scanning
- (c) Use FSE (TSE) Inversion recovery sequence to enable a more even fat suppressed image
- (d) Use filler material (Saline , Kaopectate , perfluorocarbon bags) to produce a more uniform tissue volume in order to gain a more uniform shim

Answer: (a)

The MRI Certification Examination Structure – An Overview

The examination involves a series of 165 directed questions which will be accessed from an online examination platform and displayed on a local computer system.

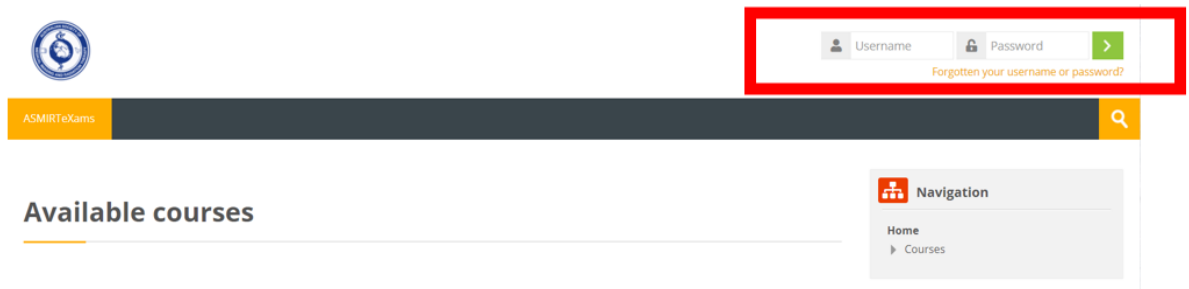
It will be conducted over a duration of 3 hours (180 minutes).

1. The examination will be performed on a specific local I.T. / computer screen system.
2. Each examination question in each section will follow the same consistent approach for evaluating the correct answer using a multiple-choice answering system.
3. The candidate will access the on-line examination using a unique username and password (provided by ASMIRT). Once the candidate has entered the portal, the MRI examination will be available on the dashboard for selection.
4. Once the candidate has selected the MRI examination and are ready to commence the examination, they are permitted to do so.
 - The candidate has three (3) hours to complete the examination. A timer commences count down on the screen to show elapsed time.
 - After three (3) hours has elapsed, the candidate will no longer have access to the examination.

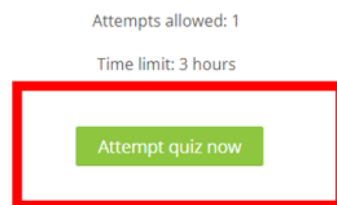
Pre – MRI Level 1 Examination Platform Access (For Both Supervisor and Candidate)

1. Once the candidate has registered for the examination, the candidate will be required to nominate a supervisor to supervise this examination. The candidate will need to negotiate with the supervisor an appropriate date and time to undertake this examination. A supervisor declaration form will need to be completed and submitted to ASMIRT for approval.
2. Once the supervisor has been approved, they will be given access (via a unique username and password) to the examination portal to undertake a “Test” MRI Examination.
 - URL link
 - Username: xxx
 - Password: xxx
3. This will ensure that the supervisor will be able to test the local computer that will be used for the examination to check any workplace “firewall” issues, suitability of the room/location including noise and light, functionality of the examination platform, and the examination process.

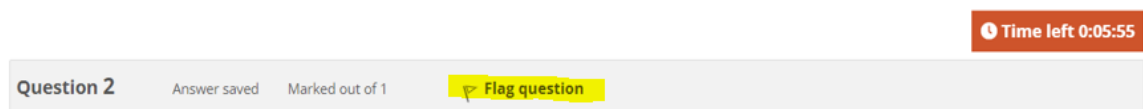
4. Concurrently, the candidate will be provided with their unique username and password, to enable the candidate to undertake a “practice” examination of anywhere between 2 to 4 questions to ensure there is an understanding of the functionality of the system.
5. ASMIRT recommends that the above checks by the supervisor and the examination preview by the candidate should be undertaken a week before the actual examination.
6. The candidate will be required to click on top right-hand side of the page and insert their unique username and password, then click on the green arrow to log in.



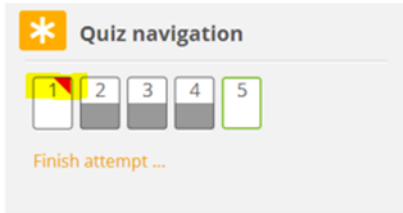
7. The candidate will then be presented with the examination. When the candidate is ready to begin, click on green button **ATTEMPT QUIZ NOW**.



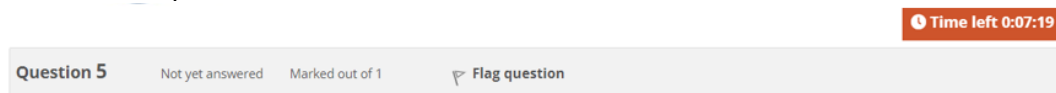
8. Upon viewing, the candidate will be presented with a directed question and be presented with several alternative answers and be required to choose the correct answer under a multiple-choice format.
9. If the candidate is unsure about a question and would like to return to it later, they can “flag” the question by click on the flag.



10. This will also appear on the candidate’s Quiz Navigation section (located in the top right-hand corner of each question) as a red flag to highlight the question that they would like to return to.



11. The candidate should also note that once the question has been completed, that question will be highlighted in “grey” on the “Quiz Navigation” section on the right-hand side of the examination (See image above). The Quiz Navigation will indicate how many questions have been completed and the sections the questions are located in.
12. Unanswered questions will be shown as blank. Those that are flagged and unanswered have a red flag and are blank.
13. Please take note of the timer. Once the exam commences, this will continue until you have completed the exam.



14. Once all of the exam questions have been completed, the summary of the attempt will be displayed.

General Knowledge Quiz

Summary of attempt

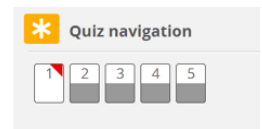
Question	Status
1	Not yet answered
2	Answer saved
3	Answer saved
4	Answer saved
5	Answer saved

Return to attempt

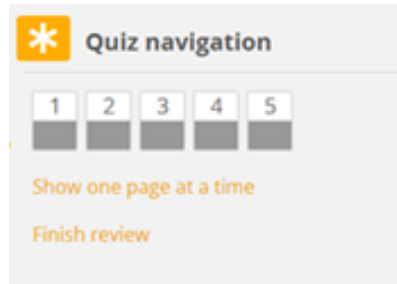
Time left 0:06:43

This attempt must be submitted by Thursday, 14 October 2021, 10:35 AM.

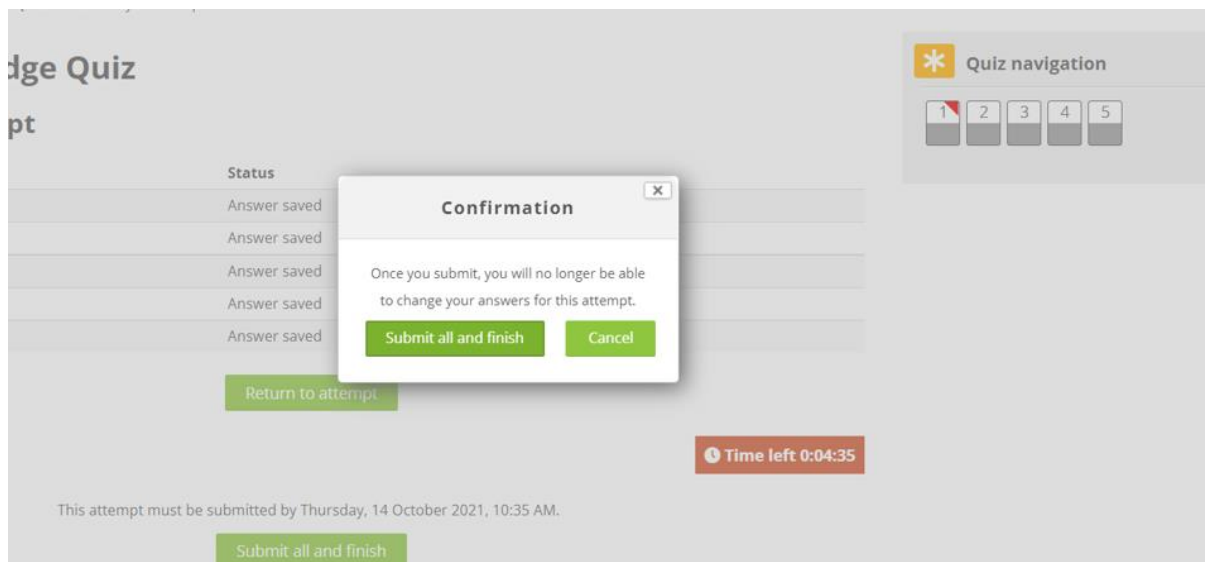
Submit all and finish



15. You will have an opportunity to go back to any flagged questions to change / provide an answer if there is time left.
16. Click on **RETURN TO ATTEMPT** and select the question you wish to return to.
17. Once you have completed all the questions, the Quiz Navigation boxes will all have a grey section.



18. By unticking the flag, it will remove the flag from the question and the quiz navigation. To save confusion, remember to uncheck the flag once you have answered the question.
19. Once the candidate has submitted all answers, the questions and selected responses will appear. Complete the process by scrolling to the bottom of the page and click on **FINISH REVIEW**.
20. Once the candidate is satisfied that all answers have been completed, click on **SUBMIT ALL AND FINISH**.
21. The candidate will be provided a confirmation text box. Upon completion of the examination, click on **SUBMIT ALL AND FINISH**. Make sure that this green button has been clicked prior to the time expiring, to ensure that your answers are recorded, and the exam completed.



22. Candidates will only have **ONE** attempt to sit this examination.

The candidate will have a twenty (20) minute time limit on the Pre – MRI examination. ASMIRT recommends that candidates use as much of that time to ensure completely familiarity with all possible combinations of the examination, as well as the “Red Flag” system, and the “Quiz Navigation” system.

MRI Level 1 Certification Examination Summary

- 1) The candidate will be given access (via a unique username and password) to the MRI Certification Examination once registration processes and supervisors have been verified.
- 2) The candidate will negotiate an agreed date and time with their supervisor to sit the examination. At this agreed date and time, the examination can commence. To ensure that there is appropriate examination support from the ASMIRT certification team, candidates sitting this examination in both Australia and countries outside of Australia will need to ensure that the examination time is conducted within an Australian time zone of 8am – 8pm.
- 3) It is the assumption of the examination markers that the “Test” Pre - MRI examination has been attempted, to ensure that the candidate understands both the requirements of the examination and the examination functionality.
- 4) The examination’s time duration is 180 minutes to answer 165 questions. After the allotted 180 minutes, the examination will automatically be closed.
- 5) If the candidate finishes the examination before the allotted time expires, the **SUBMIT ALL AND FINISH** button must be selected. This ensures that all answers are recorded.
- 6) This examination will be conducted over a designated period of one week. This allows for both flexibility and ease for both the candidate and supervisor. Examination marking will commence once the examination period has concluded.
- 7) All ASMIRT examinations are three hours in length. Candidates may be sitting in an examination room with other candidates sitting other examinations with the same supervisor. They may be leaving at different times depending on how quickly they complete their examination. Candidates may leave early but please be respectful of other candidates (if applicable).
- 8) Candidates are not to screen capture, take photos or write questions down during the examination.
- 9) Examination results will be emailed to candidates within a fortnight of the examination week concluding.
- 10) In the instance that there are unforeseen circumstances with the technology, the supervisor will contact the ASMIRT certification team to promptly report the problem, and a new date and time will be negotiated with the candidate to re sit the examination.