CONTENT SPECIFICATIONS FOR THE EXAMINATION IN MAGNETIC RESONANCE IMAGING

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The purpose of the ARRT Examination in Magnetic Resonance Imaging is to assess the knowledge and cognitive skills underlying the intelligent performance of the tasks typically required of staff technologists practicing in this specialized area. In order to identify the knowledge and skills covered by the examination, the ARRT conducted a job analysis study involving a nationwide sample of MRI technologists[1]. The results of the job analysis are reflected in this document.

The table below presents the four major content categories covered on the examination, along with the number of test questions in each major category. The remaining pages of this document list the specific topics addressed within each major content category. The approximate number of test questions allocated to each topic appears in parentheses.

Content Category		Number of Questions[2]
A.	Patient Care	30
B.	Imaging Procedures	62
C.	Data Acquisition and Processing	65
D.	Physical Principles of Image Formation	43
		200

1. A special debt of gratitude is due to the hundreds of professionals participating in this project as committee members, survey respondents, and reviewers.

2. Each exam includes an additional 20 unscored (pilot) questions. On the pages that follow, the approximate number of test questions allocated to each content category appears in parentheses.

A. PATIENT CARE (30)

I. Legal and Ethical Principles (4)

A. Confirmation of Exam Requisition
   1. verification of patient identification
   2. comparison of request to clinical indications

B. Legal Issues
   1. common terminology (e.g., negligence, malpractice)
   2. legal doctrines (e.g., respondeat superior, res ipsa loquitur)

C. Patient's Rights
   1. informed consent (written, oral, implied)
   2. confidentiality (HIPAA)
   3. Patient's Bill of Rights (e.g., privacy, access to information, health care proxy, research participation)

D. ARRT Standard of Ethics

II. MRI Screening and Safety (11)

A. Screening
   1. biomedical implants (e.g., pacemakers, clips)
   2. ferrous foreign bodies
   3. medical conditions
   4. prior diagnostic or surgical procedures

B. Equipment Safety
   1. placement of conductors (e.g., ECG leads, coils, cables)
   2. cryogen safety
   3. ancillary equipment in proximity
   4. emergency procedures (e.g, quench, fire)

C. Environment
   1. climate control (temperature, humidity)
   2. gauss lines
   3. magnetic shielding
   4. RF shielding
   5. warning signs

D. Biological Considerations
   1. RF Field
      a. specific absorption rate (SAR)
      b. biological effects
      c. FDA guidelines
   2. Static and Gradient Magnetic Fields
      a. biological effects
      b. FDA guidelines
   3. Acoustic Noise

III. Patient Assessment, Monitoring and Management (6)

A. Routine Monitoring
   1. vital signs
   2. physical signs and symptoms
   3. sedated patients
   4. claustrophobic patients

B. Emergency Response
   1. reactions to contrast
   2. other allergic reactions (e.g., latex)
   3. cardiac/respiratory arrest (CPR)
   4. physical injury, trauma, or RF burn
   5. other medical disorders (e.g., seizures, diabetic reactions)
   6. life-threatening situations (e.g., quench, projectiles)

C. Patient Transfer and Body Mechanics

D. Assisting Patients with Medical Equipment
   1. implantable devices (e.g., infusion catheters, pumps, pacemakers, others)
   2. oxygen delivery systems
   3. other (e.g., nasogastric tubes, urinary catheters)

(Section A continues on the following page)

A. PATIENT CARE (Cont.)

IV. Interpersonal Communications (5)

A. Modes of Communication
   1. verbal, written
   2. nonverbal (e.g., eye contact, touching)

B. Challenges in Communication
   1. patient characteristics (e.g., cultural factors, physical or emotional status)
   2. strategies to improve understanding

C. Patient Education
   1. explanation of procedure (e.g., risks, benefits)
   2. follow-up instructions
   3. referral to other services

D. Medical Terminology

V. Infection Control (4)

A. Terminology and Basic Concepts
   1. types of asepsis
   2. sterile technique
   3. pathogens (e.g., fomites, vehicles, vectors)
   4. nosocomial infections

B. Cycle of Infection
   1. pathogen
   2. source or reservoir of infection
   3. susceptible host
   4. method of transmission (contact, droplet, airborne, common vehicle, vector borne)

C. Standard Precautions (general patient contact)
   1. handwashing
   2. gloves, gowns
   3. masks
   4. medical asepsis / disinfection

D. Additional or Transmission-Based Precautions (e.g., Hepatitis B, HIV, tuberculosis)
   1. airborne (e.g., negative ventilation)
   2. droplet (e.g., particulate mask)
   3. contact (e.g., gloves, gown)

E. Disposal of Contaminated Materials
   1. linens
   2. needles
   3. patient supplies

B. IMAGING PROCEDURES (62)

TYPE OF STUDY	NUMBER OF QUESTIONS
1. Head & Neck	**(16)**
a. brain	
b. internal auditory canal	
c. pituitary	
d. orbit	
e. soft tissue neck (e.g., parotids, nasopharynx, etc.)	
f. angiography	
g. spectroscopy	
h. fMRI	
2. Spine	**(12)**
a. cervical	
b. thoracic	
c. lumbo-sacral	
3. Thorax	**(5)**
a. brachial plexus	
b. cardiac	
c. breast	
d. mediastinum	
e. angiography	
4. Abdomen	**(8)**
a. liver, spleen, pancreas	
b. kidneys, adrenals	
c. peritoneum, retroperitoneum	
d. biliary	
e. angiography	
5. Pelvis	**(6)**
a. bladder	
b. rectum	
c. ovary	
d. uterus/cervix	
e. vagina	
f. prostate	
g. testes	
h. angiography (iliac and run-off)	
6. Musculoskeletal	**(15)**
a. temporomandibular joint	
b. shoulder	
c. elbow	
d. wrist	
e. hand	
f. hip	
g. ankle	
h. knee	
i. foot	
j. long bones	
k. arthrography	
l. angiography	

FOCUS OF QUESTIONS

Questions about each of the studies listed on the left may focus on any of the following factors:

1. ANATOMY & PHYSIOLOGY
   - imaging planes
   - pathological considerations
   - protocol considerations

2. CONTRAST
   - type of agent (FDA approved)
   - contraindications
   - dose calculation
   - administration route
   - effects on image

3. PATIENT POSITIONING
   - coil selection & position
   - patient orientation
   - landmarking
   - physiologic gating & triggering

C. DATA ACQUISITION AND PROCESSING (65)

1. Pulse Sequences (13)

a. Spin Echo
   1. conventional spin echo
   2. fast spin echo (FSE)

b. Inversion Recovery
   1. STIR
   2. FLAIR

c. Gradient Recall Echo (GRE)
   1. conventional gradient echo
   2. fast gradient echo

d. Echo Planar Imaging (EPI)

2. Data Manipulation (7)

a. k-space Mapping & Filling

b. Fourier Transformation

c. 3-D Post Processing
   1. Maximum Intensity Projection (MIP)
   2. Multiplanar Reconstruction Techniques (MPR)

d. Cardiac Analysis

3. Special Procedures (7)

a. MRA / MRV
   1. flow dynamics
   2. time-of-flight
   3. phase contrast
   4. contrast enhanced

b. Functional Techniques
   1. diffusion
   2. perfusion
   3. spectroscopy
   4. fMRI

c. Dynamic Imaging

4. Sequence Parameters & Options

(see chart below)

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a. Imaging Parameters (22)
   1. TR
   2. TE
   3. TI
   4. number of signal averages (NSA)
   5. flip angle (Ernst angle)
   6. FOV
   7. matrix
   8. number of slices
   9. slice thickness & gap
   10. phase & frequency
   11. echo train length
   12. effective TE

b. Imaging Options (16)
   1. 2-D/3-D
   2. bandwidth
   3. slice order
   4. saturation pulse
   5. gradient moment nulling
   6. suppression techniques (e.g., fat, water, etc.)
   7. selective excitation
   8. physiologic gating & triggering
   9. in-phase/out-of-phase
   10. rectangular FOV
   11. anti-aliasing
   12. parallel imaging

Questions will address the interdependence of the imaging parameters and options listed on the left, and how those parameters and options affect image quality and contrast.

1. IMAGE QUALITY
   - contrast to noise (C/N)
   - signal to noise (S/N)
   - spatial resolution
   - acquisition time

2. CONTRAST
   - T_1 weighted
   - T_2 weighted
   - proton (spin) density
   - T_2* weighted

D. PHYSICAL PRINCIPLES OF IMAGE FORMATION (43)

1. Instrumentation (14)

a. Electromagnetism
   1. Faraday's law
   2. types of magnets (superconductive, permanent, resistive)
   3. magnetic field strength

b. Radiofrequency System
   1. coil configuration
   2. transmit & receive coils
   3. transmit & receive bandwidth
   4. pulse profile
   5. phased array

c. Gradient System
   1. coil configuration
   2. slew rate
   3. rise time
   4. duty cycle

2. Fundamentals (17)

a. Nuclear Magnetism
   1. Larmor equation
   2. precession
   3. gyromagnetic ratio
   4. resonance
   5. RF pulse
   6. equilibrium magnetization
   7. energy state transitions
   8. phase coherence
   9. free induction decay (FID)

b. Tissue Characteristics
   1. T_1 relaxation
   2. T_2 relaxation
   3. T_2^* (susceptibility)
   4. proton (spin) density
   5. flow
   6. diffusion
   7. perfusion

c. Spatial Localization
   1. vectors
   2. X, Y, Z coordinate system
   3. physical & logical gradient
   4. slice select gradient
   5. phase-encoding gradient
   6. frequency (readout) gradient
   7. k-space (raw data)

3. Artifacts (6)

a. Cause & Appearance of Artifacts
   1. aliasing
   2. Gibbs, truncation
   3. chemical shift
   4. magnetic susceptibility
   5. radiofrequency
   6. motion & flow
   7. partial volume averaging
   8. crosstalk

b. Compensation for Artifacts

4. Quality Control (6)

a. Slice Thickness

b. Spatial Resolution

c. Contrast Resolution

d. Signal to Noise

e. Center Frequency

f. Transmit Gain

g. Geometric Accuracy

h. Equipment Inspection (e.g., coils, cables, and door seals)