2023 Radiation Oncology Phase 1 Examination Sample Questions

The Royal Australian and New Zealand College of Radiologists®

Phase 1 Examination Sample Questions

Radiation Oncology

Sample Examination Questions

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1. INTRODUCTION

1.1 Purpose

The purpose of this Phase 1 Examination Sample Questions document to assist The Royal Australian and New Zealand College of Radiologists, its staff, trainees, members and other individuals with what is expected for the Phase 1 Examinations.

This document provides information and sample questions on each of the Phase 1 Examinations, these are Anatomy Multiple Choice Questions (MCQ), Anatomy Short Answer Questions (SAQ), Radiation and Cancer Biology Multiple Choice Questions (MCQ), Radiation and Cancer Biology Short Answer Question (SAQ), Radiation Oncology Physics Multiple Choice Questions (MCQ) and Radiation Oncology Physics Short Answer Question (SAQ).

Please keep in mind the format in which these sample questions are shown in this document are not how they will present in the digital examination platform. This is a guide on how each question will be structured, you are able to practice some of these examinations via a demonstration site on the RANZCR website.

2. PHASE 1 EXAMINATIONS

The Phase 1 Examination assesses a trainee's knowledge of the three oncology sciences. Each subject paper is of two-hours duration.

2.1 Anatomy

- Diagram Labelling: 60 labels (30 marks in total). Minimum one diagram per region and maximum of two, for each of the six body regions.
- Multiple Choice Questions (MCQs): 30 questions, one mark per question (30 marks in total). Stand-alone questions to assess factual knowledge of anatomy.
- Short Answer Questions (SAQs): 6 questions, 10 marks per question (60 marks in total). Focusing on key areas of relevant anatomy, e.g., chest, abdominal, pelvis, head and neck.

2.2 Radiation Oncology Physics

- Multiple Choice Questions (MCQs): 60 questions (60 marks in total). Both stand-alone and scenario-based, to assess application of knowledge.
- Short Answer Questions (SAQs): 6 questions (60 marks in total).

2.3 Radiation and Cancer Biology

- Multiple Choice Questions (MCQs): 60 questions (60 marks in total). Both stand-alone and scenario-based, to assess application of knowledge.
- Short Answer Questions (SAQs): 6 questions (60 marks in total).

2.4 Declaration

These sample questions are used for illustrative purposes only. Selected sample questions do not reflect the degree of difficulty or complexity of all questions in an examination.

3. TYPES OF EXAMINATION QUESTIONS

3.1 What is a Multiple-Choice Question (MCQ) and what is required?

MCQs are an objective assessment in which candidates will need to select a correct answer from the choices presented to them. MCQ will consist of a stem and multiple answers to choose from. For each MCQ there will be one correct answer (which is known as the key) and multiple incorrect answers (which are known a distractors). The correct answers equal one mark, and incorrect answers equal no marks. A candidate will only be able to select one answer.

3.2 What is a Short Answer Questions (SAQ) and what is required?

For a SAQ a candidate is required to construct a response to answer the question. The SAQ will consist of a lead in and sub questions. The candidate will need to answer all sub questions. The examples provided show how the questions are marked using the answering criteria.

SAQs fall under a level of achievement of 'D' or 'G' which is outlined in the Radiation Oncology Learning Outcomes (D being a detailed level of knowledge and G being a more general level of knowledge). The questions range from easy to moderate to hard difficulty, covering one of the three classifications which are Knowledge, Application/Understanding or Higher Order.

3.3 What is a Diagram Labelling Question and what is required?

Diagram Labelling Questions are an objective assessment in which candidates will need to identify the correct answer from the labels given in the diagram. Candidates will be given a diagram with labels and will be asked to name/list the structures.

3. DEMONSTRATION DIGITAL EXAMINATION SITE

As the RANZCR Radiation Oncology Examinations are now being delivering on a new digital platform, a demonstration digital examination has been developed. The demonstration digital examination is not intended to be a study tool, but instead a method for candidates to familiarise themselves with the new platform.

The demonstration digital examination site is available on the RANZCR website at Demonstration Site.

4. ANATOMY EXAMINATION QUESTIONS

4.1 Multiple Choice Questions

Anatomy Multiple Choice Question: Sample 1	
Question Text	**A 72-year-old male with castrate resistant, metastatic prostate cancer presents with mid- lower back pain and loss of sensation below the level of the umbilicus. Which spinal level correlates best with his presentation?**
Maximum Marks	**1**

Available Answers	
	T8
☒	T10
	T12
	L1

Anatomy Multiple Choice Question: Sample 2	
Question Text	**The mandibular division of the trigeminal (V3) nerve exits through which base of skull foramen?**
Maximum Marks	**1**

Available Answers	
	Foramen rotundum
	Foramen spinosum
	Foramen lacerum
☒	Foramen ovale

4.3 Short Answer Questions

Anatomy Short Answer Question: Sample 1

Question Lead	**A 60-year-old female is undergoing SBRT for an unresectable cholangiocarcinoma of the common bile duct. The duodenum is identified as a major OAR.**

a.	**Outline the anterior, posterior, medial and lateral relations of the second part of the duodenum.**

Maximum Marks	**2**

Rubric	Anterior: Liver (right lobe of liver acceptable), transverse colon and jejunum (accept small intestine) Posterior: Right kidney, right ureter, right renal vessels, right adrenal gland, IVC and right psoas major Lateral: ascending colon, right colic flexure, right kidney Medial: head of pancreas, ampulla, bile duct and accessory pancreatic duct

Marking Criteria	• **0.5 marks = at least one correct relation per direction** • **Maximum 0.5 marks for each direction**

b.	**What is the macroscopic structure of the gallbladder?**

Maximum Marks	**1**

Rubric	• Gallbladder is a pear-shaped hollow organ 7-12cm long that communicates with the common hepatic ducts via the cystic duct. • Divided in to three parts: fundus (distal portion), body (largest part and middle portion), and the neck (tapers and becomes continuous with the cystic duct).

Marking Criteria	• **0.5 marks = correctly identifying macroscopic appearance with any of the underlined features described** • **0.5 marks = correctly identifying at least 2 of 3 parts** • **0 marks = 1 structure**

Anatomy Short Answer Question: Sample 2

Question Lead	**Suppose you are contouring the target volumes on a 53-year-old male with a T3N0M0 adenocarcinoma of the low rectum. The tumour extends below the dentate line.**

a.	**List the lymph node groups that this lesion could potentially drain to.**

Maximum Marks	**3**

Rubric	• Bilateral inguinal • Bilateral external iliac • Bilateral internal iliac • Bilateral obturator • Mesorectal • Presacral lymph node groups

Marking Criteria	• **0.5 marks = each nodal station** • **Must identify bilateral nodal groups where relevant to obtain 0.5 marks**

b.	**In the same patient, if the primary rectal cancer was above the dentate line, which nodal groups would you remove from your list above?**

Maximum Marks	**1**

Rubric	• Bilateral inguinal • Bilateral external iliac nodes

Marking Criteria	• **0.5 marks = each nodal group** • **Must mention bilateral to obtain 0.5 marks**

c.	**Outline the origin and supply of the superior, middle and inferior rectal arteries.**

Maximum Marks	**3**

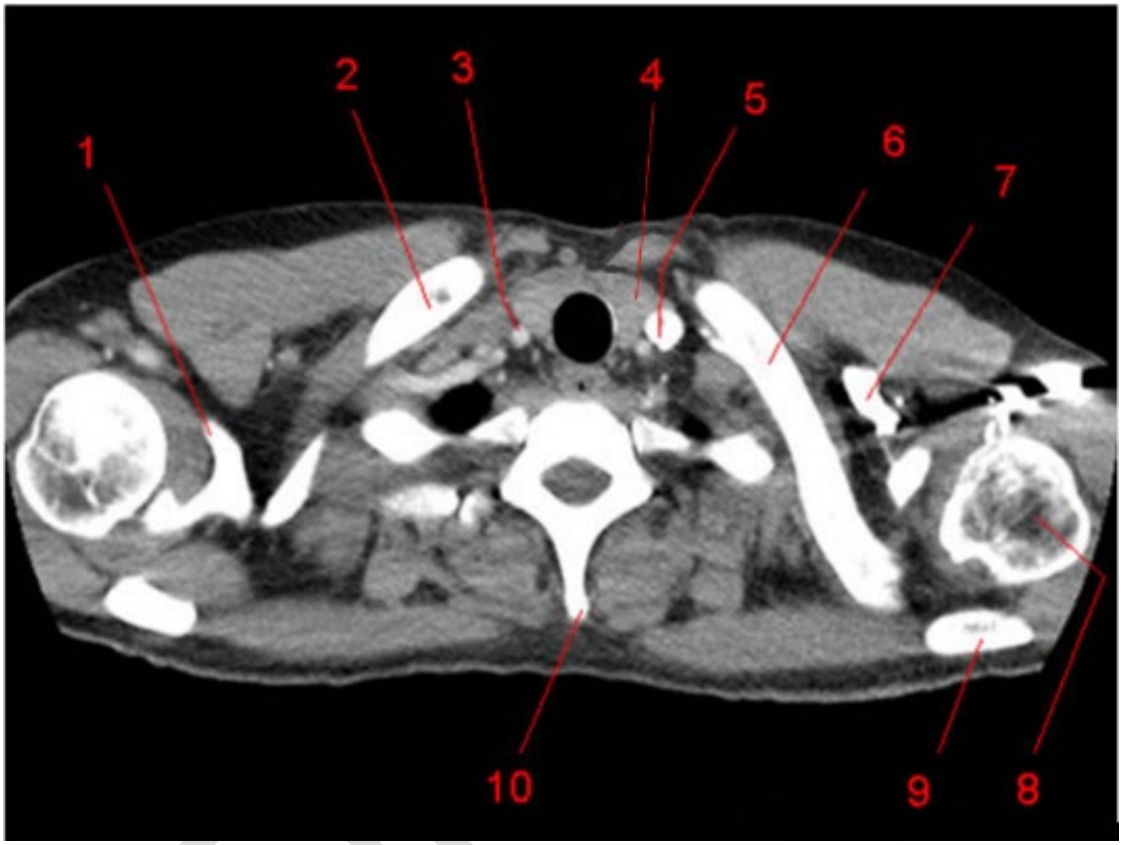
Rubric	Superior Rectal Artery Origin: Branch of the inferior mesenteric artery (IMA) Supply: Upper two thirds of the rectum Middle Rectal Artery Origin**:** Branch of the internal iliac artery. Found inconsistently Supply: Inferior one third of the rectum Inferior Rectal Artery Origin: Branch of the internal pudendal artery Supply: Anorectal junction, anal canal, internal and external anal sphincters and perianal skin

Marking Criteria	• **0.5 marks = origin** • **0.5 marks = supply for each artery** • **For inferior rectal artery, anus/anal canal would be adequate for 0.5 marks**

4.3 Diagram Labelling Questions

Anatomy Diagram Labelling Question: Sample 1

Question Text	**Name the structures labelled 1 to 10 on the axial CT slice below through the upper thorax. Indicate laterality where applicable.**



Maximum Marks	**5**

Rubric	1. right scapula (coracoid process) 2. right clavicle 3. right common carotid artery 4. left lobe thyroid 5. left internal jugular vein 6. left clavicle 7. left subclavian vein 8. left head of humerus 9. spine of left scapula 10. spinous process of vertebra

Marking Criteria	• **0.5 marks per correct label**

6. RADIATION ONCOLOGY PHYSICS EXAMINATION QUESTIONS

6.1 Multiple Choice Questions

Physics Multiple Choice Question: Sample 1

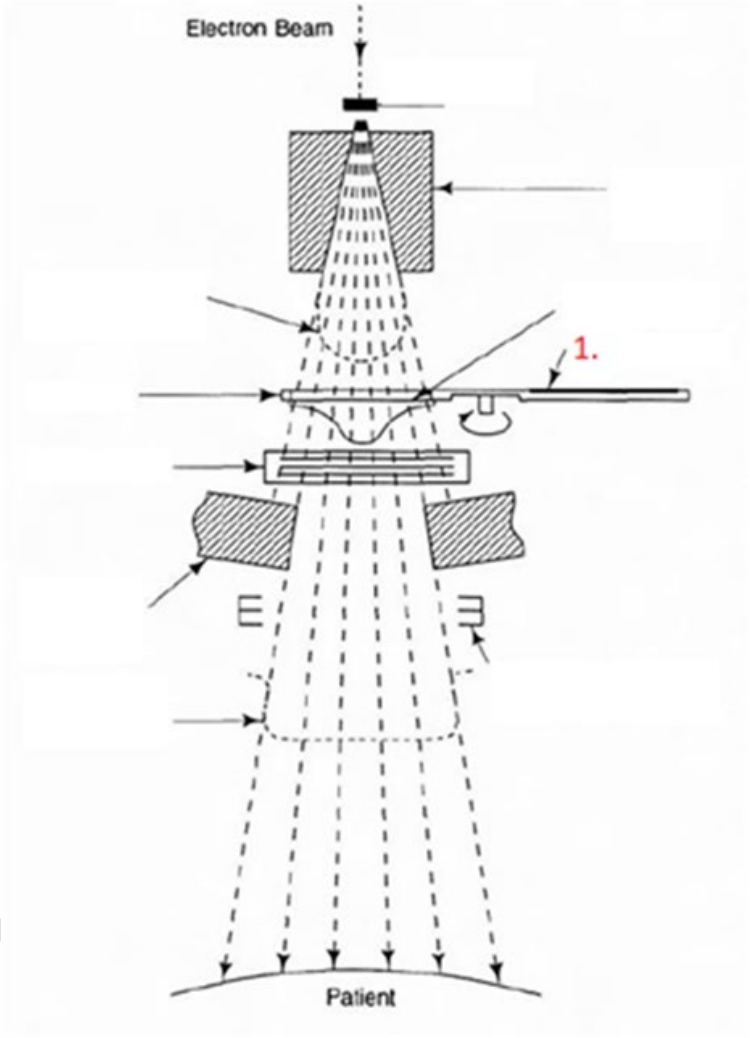
Question Text	**Which of the following best describes the advantage of Megavoltage Cone Beam CT (MV CBCT) over Kilovoltage CBCT for a patient with bilateral hip prostheses?**

Maximum Marks	**1**

Available Answers	
	Decreased image noise
	Increased photoelectric effect
☒	Decreased photoelectric effect
	Increased image dose

Physics Multiple Choice Question: Sample 2

Question Text	In this diagram of Linac head, what is labelled 1?



Maximum Marks	1

Available Answers	
☒	Scattering foil
	Flattening filter
	Primary collimator
	Ionisation chamber

6.2 Short Answer Questions

Physics Short Answer Question: Sample 1	
Question Lead	**With regards to UCRU 83 Report:**
a.	**What are the two principal reasons for the ICRU 83 report on Intensity Modulated Radiotherapy (IMRT)?**
Maximum Marks	**1**
Rubric	• Allows use of absorbed dose to volumes as opposed to point dose. This enables a specific absorbed dose to a target volume to be determined from the Dose Volume Histogram. • Allows standardised comparison of prescribing, recording, and reporting of volume-based dosimetry in IMRT to other treatment modalities.
Marking Criteria	• **1 mark = demonstrating knowledge on both points** • **0.5 marks = If volume based is mentioned, however the response fails to recognise all three components of prescribing, recording, and reporting** • **0 marks = not mentioning volume-based prescribing and reporting systems**

b.	**Briefly describe the following concepts used in the ICRU 83 report pertaining to IMRT. In your answer, include the clinical relevance of these concepts:** ○ **Planning organ at Risk Volume (PRV)** ○ **Internal Target Volume (ITV)** ○ **Dose homogeneity** ○ **Dose conformality**

Maximum Marks	**3**

Rubric	• PRV – Margin added to the critical organs at risk to account for uncertainty and variation in position of the OAR. Clinical relevance is to ensure safe delivery of radiation by avoiding severe complications due to dose uncertainty for critical organs. • ITV - volume encompassing the CTV which considers that the CTV varies in position, shape, and size. Clinical relevance is to ensure motion management (accept set up uncertainty due to target motion). • Dose homogeneity: Uniformity of dose distribution within the target volume. Clinical relevance is to minimise dose variation of hot and cold spots which may impact on tumour control or toxicities. • Dose conformity: The degree to which the prescribed isodose line agrees with the target volume. Clinical relevance is to ensure the target volume is covered by the prescribed dose to ensure expected tumour control and spare surrounding organs at risk.

Marking Criteria	• **3 marks = correctly describing all four terms and correctly identifying clinical relevance for each** • **1.5 marks = correctly describing at least 2 terms and correctly identifying the clinical relevance for each OR correctly. describing all four terms without providing clinical relevance** • **0 marks = anything less**

Physics Short Answer Question: Sample 2

Question Lead	**IMRT is used to treat a 62-year-old man with a bulky oropharyngeal primary with multiple bulky bilateral lymph node masses.**

a.	**List four dosimetric advantages of IMRT over 3DCRT techniques in the above clinical scenario. For each, list the clinical relevance.**

Maximum Marks	**3**

Rubric	• Advantage: Improved conformality of target volume coverage, especially for concave or other complex shaped target volumes. • Clinical Relevance: Allows safe dose escalation, potentially improving tumour control (either acceptable for the answer) • Advantage: Allows creation of non-uniform dose distribution if required for treatment of a volume within another defined volume. • Clinical Relevance: Allows for concomitant or simultaneous integrated boost based on biological risk. • Advantage: Improved dose homogeneity within the target volume. • Clinical Relevance: Improved tumour control. • Advantage: Allows dose volume optimisation to improve OAR sparing • Clinical Relevance: Reduced toxicity.

Marking Criteria	• **3 marks = 4 correct advantages and corresponding clinical relevance** • **1.5 marks = 2 correct advantages and corresponding clinical relevance OR for 4 correct advantages without providing clinical relevance** • **0 marks = anything less**

c.	**Outline three reasons for daily image guided treatment verification in this patient's treatment.**

Maximum Marks	**1.5**

Rubric	1. Improves precision and accuracy of treatment delivery by ensuring reproducibility. 2. Allows for the safe reduction of margins and hence toxicity. 3. Allows for adaptive planning to account for internal or external changes in anatomy and tumour characteristics – e.g., weight loss, tumour shrinkage due to bulky tumour mass.

Marking Criteria	• **0.5 marks = each correct answer**

d.	**List four imaging modalities that can be used in image guided radiation therapy in general. What imaging modality would be best utilised in this patient and why?**

Maximum Marks	**1.5**

Rubric	<u>Four modalities:</u> 1. Cone Beam CT (CBCT) 2. US 3. Electronic Portal Imaging 4. MRI <u>Best modality in this patient:</u> • CBCT (MRI acceptable) to ensure optimal soft tissue detail

Marking Criteria	• **1 mark = correctly identifying all four modalities** • **0.5 marks = correctly identifying at least two modalities** • **0.5 marks = correctly identifying CBCT/MRI and reasoning**

7. RADIATION AND CANCER BIOLOGY EXAMINATION QUESTIONS

7.1 Multiple Choice Questions

Radiation and Cancer Biology Multiple Choice Question: Sample 1

Question Text	**Which gene is mutated in Lo-Fraumeni syndrome?**

Maximum Marks	**1**

Available Answers	
	Rb-1
☒	P53
	ATM
	STK11

Radiation and Cancer Biology Multiple Choice Question: Sample 2

Question Text	**The CDK4/6-cyclin D complex is involved in controlling the transit of cells through which cell cycle checkpoint?**

Maximum Marks	**1**

Available Answers	
	M checkpoint
	S checkpoint
	G2 checkpoint
☒	G1/S checkpoint

7.2 Short Answer Questions

Radiation and Cancer Biology Short Answer Question: Sample 1

Question Lead	**With regards to ionizing radiation:**

a.	**List five types of cell death following ionizing radiation.**

Maximum Marks	**2.5**

Rubric	1. Mitotic catastrophe 2. Apoptosis (accept programmed cell death or interphase death) 3. Radiation induced senescence 4. Necrotic cell death 5. Autophagy

Marking Criteria	• **2.5 marks = correctly identifying all 5 mechanisms** • **1.5 marks = correctly identifying 4 mechanisms** • **0.5 marks = correctly identifying 3 mechanisms** • **No marks = 2 or less mechanisms**

b.	**Describe the mechanism of cell death for mitotic catastrophe and apoptosis, following ionizing radiation.**

Maximum Marks	**3**

Rubric	**Mitotic catastrophe** • Occurs during or shortly after a failed mitosis. • Cell attempts to divide without proper repair of DNA damage, there are stops in metaphase with aberrant mitosis and multinucleated giant cells. • Mitotic catastrophe can also serve as a trigger for other cell death pathways. **Apoptosis (accept programmed cell death or interphase death)** • Occurs via intrinsic and extrinsic pathways. Radiation activates the intrinsic pathway and relies on p53. • Apoptosis can be a result of both early or late cell death. Late apoptosis may be activated by mitotic catastrophe. • DNA damage elicits downstream signaling to either block cell cycle progression to allow DNA repair, or progression to cell death when DNA damage overwhelming. • Defined by morphological criteria (rounding up of the cells, nuclear pyknosis, karyohexis and phagocytosis of the apoptotic body by adjacent cells), the requirement for active participation of the dying cell and DNA laddering on gel electrophoresis.

Marking Criteria	• **0.5 marks = per correct point** • **1.5 marks = for the two types**

Radiation and Cancer Biology Short Answer Question: Sample 2

Question Text	**Name the two key pathways of DNA double stranded repair and list the key steps and the key proteins involved in each pathway.**

Maximum Marks	**4.5**

Rubric	1. Non-homologous end joining (NHEJ acceptable) – modifies broken DNA ends and ligates them together without the need of a template and minimal regard for homology. Steps i. Double stranded break recognition ii. End binding and tethering with Ku 70/80 forming a complex at site of DNA damage. iii. End processing -removal of damaged or mismatched nucleotides by nucleases and resynthesis by DNA polymerases. iv. Strand invasion, DNA synthesis and resolution. v. Ligation Key Proteins • Ku 70, Ku 80, Artemis, DNA dependent protein kinase, DNA ligase IV and XRCC4 2. Homologous recombination – requires a homologous strand (typically sister chromatid), used as a template for DNA repair. Steps i. Recognition of DNA double stranded break ii. Strand exchange – involves pairing of the DNA with the homologous region of its sister chromatid followed by strand invasion to form a DNA cross over or a Holliday junction. iii. Branch migration and new DNA synthesis. iv. Resolution – Holliday junction intermediate is resolved by cleavage of the junction to form separate duplex DNA molecules. Key Proteins • RAD 51, CtIP, BRCA1, BRCA2, RAD52, RAD54

Marking Criteria	• **2 marks = correctly identifying the key steps and proteins for each pathway** • **1 mark = correct identifying 2-3 steps and at least 2 proteins** • **0.5 marks = listing the two pathways. Details not required** • **0 marks = anything less** • **Examiner discretion for other correct steps/proteins not listed in answer**

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