

Instructions: Write your answers using a pen in the spaces provided. If you need additional space to answer a question, use the blank space at the end of the paper and clearly indicate that this has been done.

Time allowed: 45 minutes

This task is out of 30 marks

Mark obtained: _____ / 30

1. Contrast soft and hard x-rays.

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1M

2. This image shows an X-ray image of human femur (the large upper-leg bone). (H8)



(a) Identify the medical problem evident from this image .

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1M

(b) Outline two properties of X-rays allow such an image to be produced.

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2M

3. Outline two significant advances in physics, upon which the development of the production of X-radiation for medical imaging was dependent.

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2M

4. With the aid of a diagram, explain the process used to produce a CAT scan.

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4M

5. List the advantages and disadvantages of the imaging techniques represented by the following images.



Fig (I)

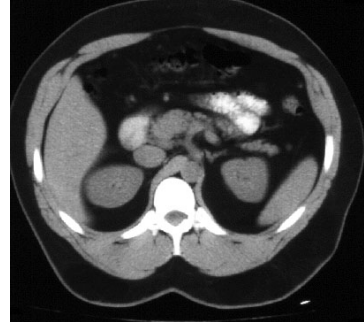


Fig (II)

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4M

6. The following questions refer to the images shown below.



Fig. (I)

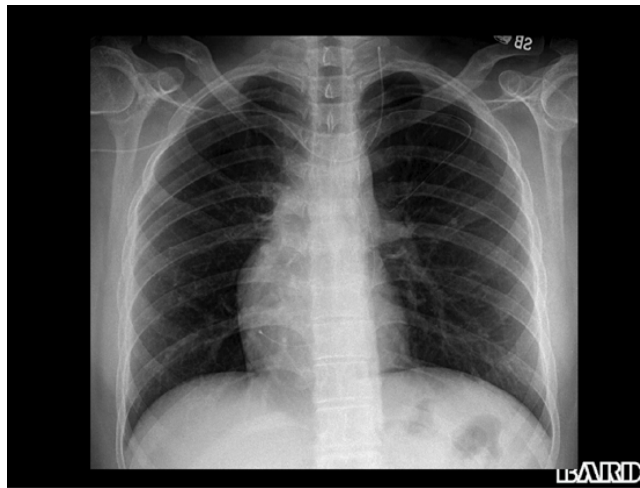


Fig (II)

(a) Identify the medical imaging technology use to produce the images above.

Fig (I)..... 2M

Fig (II).....

(b) With reference to the type of information that the images provide, explain why a doctor might choose the imaging technology that produced the image in Fig. (I) rather than the imaging technology that produced the image in Fig. (II).

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7. (a) An alpha-emitting radioactive isotope has a half-life of 20 seconds.
Calculate the amount of the isotope remaining after 1 minute, if the initial sample had a mass of 1.6 kg.

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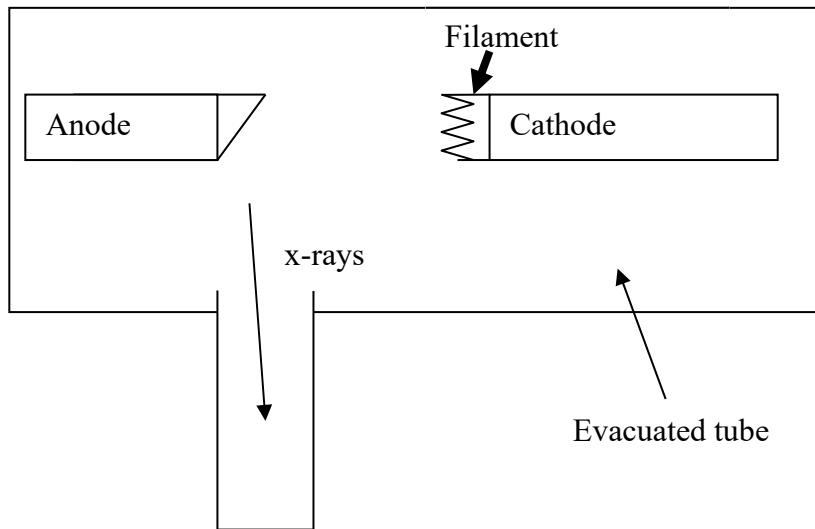
(b) Would you consider the above isotope to be suitable for use in medical diagnosis? Justify your answer.

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(c) Outline how an isotope can be used to target a specific part of the body for medical imaging purposes.

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8. Pictured below is a simple X-ray tube. Complete the questions that follow the diagram



(a) On the diagram sketch field lines to represent the electric field present in the X-ray tube. 1M

(b) Explain how energy transformations result in the production of X-rays. In your answer, you should refer to two different methods by which X-radiation is produced.

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9. A medical researcher conducted an investigation to determine whether CAT scans or X-rays are a superior method of detecting brain tumours. Several people known to have small brain tumours were tested to see whether each technique could detect the cancer. The results are shown below.

Person	Size of tumour (mm)	Detected by X-ray	Detected by CAT scan
A	4	YES	YES
B	2	NO	YES
C	6	YES	YES
D	1.5	NO	NO
E	1	NO	YES

The researcher concluded from the results that X-rays were accurate in detecting all cancers greater than 2 mm in size and that CAT scans are accurate at diagnosing all cancers greater than 1 mm in size.

- (a) Assess the validity of the conclusion made by the researcher.

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2M

- (b) Outline one significant improvement to the research that would improve the validity.

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1M

	<i>Students learn to:</i>	<i>Students:</i>
2. The physical properties of electromagnetic radiation can be used as diagnostic tools	<ul style="list-style-type: none"> ▪ describe how X-rays are currently produced 	<ul style="list-style-type: none"> ▪ gather information to observe at least one image of a fracture on an X-ray film and X-ray images of other body parts ▪ gather secondary information to observe a CAT scan image and compare the information provided by CAT scans to that provided by an X-ray image for the same body part
	<ul style="list-style-type: none"> ▪ compare the differences between 'soft' and 'hard' X-rays 	
	<ul style="list-style-type: none"> ▪ explain how a computed axial tomography (CAT) scan is produced 	
	<ul style="list-style-type: none"> ▪ describe circumstances where a CAT scan would be a superior diagnostic tool compared to either X-rays or ultrasound 	
3. Radioactivity can be used as a diagnostic tool	<ul style="list-style-type: none"> ▪ outline properties of radioactive isotopes and their half lives that are used to obtain scans of organs 	<ul style="list-style-type: none"> ▪ perform an investigation to compare an image of bone scan with an X-ray image ▪ gather and process secondary information to compare a scanned image of at least one healthy body part or organ with a scanned image of its diseased counterpart
	<ul style="list-style-type: none"> ▪ describe how radioactive isotopes may be metabolised by the body to bind or accumulate in the target organ 	
	<ul style="list-style-type: none"> ▪ identify that during decay of specific radioactive nuclei positrons are given off 	
	<ul style="list-style-type: none"> ▪ discuss the interaction of electrons and positrons resulting in the production of gamma rays 	

Marking Scheme

Q.1	Criteria	Mark
	States that soft X-rays have a longer wavelength (or lower frequency) than hard X-rays	1

Q.2a	Criteria	Mark
	Identifies the problem as being a broken bone (or fracture)	1

Q.2b	Criteria	Mark
	States that X-rays can penetrate soft tissues of the body AND that X-rays are absorbed by bone.	2
	States ONE of the above	1

Q.3	Criteria	Mark
	Presents two advances in physics relevant to the production of X-radiation	2
	Presents one advance in physics relevant to the production of X-radiation OR outlines two TECHNOLOGICAL advances	1

Q.4	Criteria	Mark
	Draws a diagram showing the relative positions of the patient, X-ray source and detector AND describes the rotation of the X-ray beam around the body AND indicates that the X-rays are detected on the opposite side of the body to the source AND indicates that data is analysed by a COMPUTER to produce the image	4
	Three of the above	3
	Two of the above	2
	One of the above	1

Q.5	Criteria	Mark
	Lists four advantages/disadvantages of the images .. Possible issues: lack of soft tissue resolution (radiograph), CATs can distinguish soft tissues; CATs are very expensive, X-rays are relatively cheap. X-rays are a 2-D image of a 3-D structure making the image difficult to interpret . Both techniques involve exposure to potentially harmful radiation etc. Response must list at least one advantage and one disadvantage for each imaging technique	4

Q.6(a)	Criteria	Mark
	(i) Bone Scan	1
	(ii) x-ray	1

Q.6(b)	Criteria	Mark
	Outlines the nature of the information in the scan (eg hot spots) and relates this information to the type of diagnosis that could be made (eg diagnosing cancer)	2
	One of the above	1

Q.7(a)	Criteria	Mark
	0.2kg	1

Q.7(b)	Criteria	Mark
	Identifies that the isotope is not suitable and justifies this with two reasons such as <ul style="list-style-type: none"> • Half life too short • Alpha emitting isotopes are not suitable 	2
	Identifies that the isotope is not suitable and justifies this with one reason	1

Q.7(c)	Criteria	Mark
	Answer states that the radioisotope can be attached to a chemical that is used by the body	1

	Lists three advantages/disadvantages. Response must refer to both imaging techniques	3
	Lists two advantages/disadvantages of the images (either or both imaging techniques discussed)	2
	Lists one advantage/disadvantage of the images	1

Q.8 a	Criteria	Mark
	Correctly draws the electric field lines from anode to cathode	1

Q.8 b	Criteria	Mark
	Correctly states that KE of electrons is	4

transformed into electromagnetic radiation (x-radiation) and provides a thorough explanation of the production of * characteristic radiation (k shell electrons knocked out of their shell by cathode ray electrons; X rays emitted as electrons from higher energy levels move into that shell) * Bremsstrahlung radiation (production of X rays by the rapid deceleration of cathode ray electrons)	
Provides a thorough explanation of the production of X rays for both techniques, OR Identifies the energy transformation but does not thoroughly explain both techniques	3
Provides a reasonable explanation of the production of X rays for both techniques, OR Identifies the energy transformation and provides a reasonable explanation of the production of X rays for one technique.	2
Provides a reasonable explanation of the production of X rays for one technique OR Identifies the energy transformation	1

Q.9(a) Criteria	Mark
Answer makes a judgement of the validity and justifies this with a statement related to the conclusion. (not the method)	2
Answer makes a judgement without a reasonable statement or makes a statement without a judgement.	1

Q.9(b) Criteria	Mark
A significant improvement stated Eg repeat the study with several more subjects or examine a range of subjects with varying cancer sizes.	1