1 **(a)** State one reason for using non-invasive techniques in medical diagnosis.

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.... **[1]**

(b) Describe the use of medical tracers to diagnose the condition of organs.

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.... **[2]**

(c) Describe the principles of positron emission tomography (PET).

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.... **[5]**

[Total: 8]

2 (a) Describe the principles of ultrasound scanning.

In your answer, you should make clear how the steps in the process are sequenced.

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.... **[4]**

(b) Explain the difference between an ultrasound A-scan and B-scan.

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.... **[1]**

[Total: 5]

3 (a) Outline the main principles of the use of magnetic resonance to obtain diagnostic information about internal organs.

In your answer, you should make clear how the principles you describe allow body structures to be distinguished.

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.... **[8]**

(b) Describe one advantage and one disadvantage of MRI.

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.... **[2]**

[Total: 10]

4 (a) State and describe **one** way in which X-ray photons interact with matter.

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.... **[2]**

(b) The intensity of a collimated beam of X-rays is reduced to 10% of its initial value after passing through 3.0 mm of soft tissue. Calculate the thickness of soft tissue that reduces the intensity to 50% of its initial value.

thickness = ... mm **[3]**

(c) X-rays are used to image internal body structures.

(i) Explain how image intensifiers are used to improve the quality of the X-ray image.

In your answer, you should explain clearly the process involved which makes the image brighter.

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.... **[3]**

(ii) Explain how contrast media are used to improve the quality of the X-ray image.

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.... **[2]**

[Total: 10]

5 Fluorodeoxyglucose (FDG) is a radiopharmaceutical used for PET scans. It contains radioactive fluorine-18, which is a positron-emitter with a half-life of 6.6×10^3 s.
A patient is injected with FDG which has an initial activity of 250 MBq.

(a) Calculate the decay constant of fluorine-18.

decay constant = ... s^{-1} **[2]**

(b) Show that the initial number of fluorine-18 nuclei in the FDG is about 2×10^{12}.

[1]

(c) About 9.9% of the mass of FDG is fluorine-18. Use your answer in **(b)** to determine the initial mass of FDG given to the patient. The molar mass of fluorine-18 is $0.018 \text{ kg mol}^{-1}$.

mass = ... kg **[3]**

(d) A typical PET scan takes 20 minutes. Determine the activity of FDG in the patient after this time.

activity = ...MBq **[2]**

(e) Positron emission tomography (PET) can be used to locate an area of increased activity within the brain. Describe the principles of PET.

In your answer you should make clear how the position of increased activity is located.

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.... **[4]**

[Total: 12]