A2 Level Physics

Chapter 21 – Medical Imaging

21.2.2 Diagnostic Methods in Medicine

Worked Examples

© Tutor Packs

Diagnostic Methods in Medicine

Exam style question 1

Fig. 8.2 shows an image of the brain using a positron emission tomography (PET) scanner.

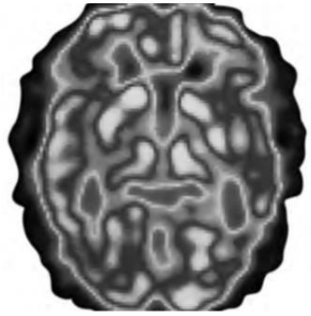

Fig. 8.2

The lighter regions in Fig. 8.2 show the active areas of the brain. Fluorine-18 is a common tracer injected into a patient before a PET scan.

Explain the basic principles of PET scanning, including how the image is formed.

Diagnostic Methods in Medicine

Exam style question 1

Explain the basic principles of PET scanning, including how the image is formed.

1) The brain is surrounded by a ring of gamma detectors.
2) The positrons from the F-18 nuclei annihilate electrons inside the patient.
3) The annihilation of a positron and an electron produces two identical gamma photons travelling in opposite directions.
4) The delay time between these two photons is used to determine the location of the annihilation.
5) Computer connected to detectors is used and an image is formed by the computer using the electrical signals from the detectors.

tutorpacks.co.uk

© Tutor Packs

Diagnostic Methods in Medicine

Exam style question 2

Technetium-99m is a common medical tracer injected into patients before they have a scan with a gamma camera. Technetium-99m is a gamma emitter with a half-life of about 6 hours. Each gamma ray photon has energy $2.2 \times 10^{-14}\ J$.

A patient is given a dose with an initial activity of 500 MBq.

(a) Explain what is meant by activity.

(b) Calculate the initial rate of energy emission from the dose of technetium-99m.

(c) Name and describe the function of the main components of a gamma camera.

Diagnostic Methods in Medicine

Exam style question 2

(a)Explain what is meant by activity.
Rate at which the nuclei of a sample decay.

(b) Calculate the initial rate of energy emission from the dose of technetium-99m.
We already have the initial activity of $500\ MBq$, so this is the rate at which the nuclei of a sample decays. We also have the energy that each gamma ray photon releases therefore to calculate the initial rate of energy emission is given by:

$$rate\ of\ emission = (500 \times 10^{6}\ Bq)(2.2 \times 10^{-14}\ J)$$
$$rate\ of\ emission = 1.1 \times 10^{-5}\ J\ s^{-1}$$

(c) Name and describe the function of the main components of a gamma camera.

- Collimator/lead tubes:

Allows parallel gamma ray photons to travel along the axis of lead tubes to the scintillator. Having thin, long, narrow lead tubes makes the image sharper and less blurred.

- Scintillator / Sodium Iodide crystal:

Will absorb γ-ray photons and produces thousands of photons of visible light.

- Photomultiplier tubes / photocathode and dynodes:

Each photomultiplier tube has a photocathode in it that converts light photons into electrical signals by the photoelectric effect.

- Computer:

Signals from photomultiplier tubes are used to generate an image.

tutorpacks.co.uk

© Tutor Packs

Diagnostic Methods in Medicine

Exam style question 3

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

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

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

Diagnostic Methods in Medicine

Exam style question 3

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

Less chance of infection.

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

1) Tracer is injected into the body.
2) Tracer is absorbed by organs and shows blockage.
3) Beta detector/gamma camera us used to detect radiation from the body to find the blockage.

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

1) A positron (beta-plus emitting tracer) source is used.
2) The positron annihilates with an electron inside the patient.
3) This produces two gamma photons.
4) The photons travel in opposite directions.
5) The patient is surrounded by a ring of gamma detectors.
6) The arrival times of the photons indicates location (e.g. of a tumour inside the body).
7) A 3-D image is created by the computer connected to the detectors.

tutorpacks.co.uk

tutorpacks.co.uk

© Tutor Packs

Please see '21.2.1 Diagnostic Methods in Medicine notes' pack for revision notes.

For more revision notes, tutorials and worked examples please visit www.tutorpacks.co.uk.

tutorpacks.co.uk

tutorpacks.co.uk

© Tutor Packs