Name of the Student:_____
Max. Marks : 21 Marks **Time : 21 Minutes**

Mark Schemes

Q1.

(a) Material with nuclei which are unstable / will decay / emits ionising / radiation. ✔

At least two of the descriptors

1

(b) Calc with answer showing T_E = 68.98 or 69 ✔

$$\frac{1}{T_E} = \frac{1}{110} + \frac{1}{185}$$

1

(c) Mention of time between 10 to 70 minutes with reference to effective half life / time for a scan ✔

and to allow the **blood** to carry the isotope around the body ✔

and to allow the isotope to be taken in by the body part to be investigated ✔

3

(d) Positron (collides with an) electron and results in annihilation ✔

All the mass of positron and electron is converted to energy in gamma photons ✔

Must be two photons travelling in opposite directions to conserve momentum ✔

MAX 2

(e) Use of 0.18 to 0.2 m and 3×10^8 m/s for speed of em waves through the head to get a time between 0.6 and 0.7 $\times 10^{-9}$ s for time to travel across head ✔

then explanation of difference in trig times from a minimum of 0 s at centre of head to a maximum of their calculated answer at edge of head. ✔

2

[9]

Q2.

(a) Points to consider:

The risk comes as X-rays are ionising radiation: the photons could

ionise cells causing mutations / cancer.

Use of lead diaphragm plates to define beam so that only the area to be investigated is exposed to the X-rays – limits exposure to ionising photons.

Use of aluminium filter in path of beam to remove a large percentage of the low energy photons which are not needed for the image to be produced – reduces ionising photons which could be absorbed by the body.

(Anode voltage) selected to produce best energy photons for imaging – limits the photons required to produce a suitable image.

When using film, use of intensifying screens – give exposure in shorter time limits exposure.

Use of grid between the patient and image receptor to stop scattered X-rays blurring the image – thus stopping the need for further X-ray and further exposure.

6 marks will clearly explain the risk involved. They will then mention three ways of minimising the exposure and discuss these.

5 marks will clearly explain the risk involved. They will then mention three ways of minimising the exposure and discuss 2 of these.

4 marks will mention the risk involved. They will mention at least two ways of minimising the exposure and may discuss both or discuss one of these together with explaining the risk involved.

3 marks will mention the risk involved. They will mention at least two ways of minimising the exposure and may discuss one of these or explain the risk involved

2 marks will mention the risk and may state one way of limiting exposure or state and discuss either.

1 mark will have any sensible comment.

0 marks has no relevant Physics.

6

(b) Ultrasound is non-ionising / has no known adverse effects ✔

Ultrasound can be used for better definition image between tissue and blood ✔

Allow credit for converse arguments re. not X-rays

2

(c) correct sub of numbers in the equation

$$6.25\times10^{-4}=\left(\frac{Z-1.64\times10^{6}}{Z+1.64\times10^{6}}\right)^{2}$$ ✔

As Z decreases, the negative root is needed

$$-2.5\times10^{-2}=\left(\frac{Z-1.64\times10^{6}}{Z+1.64\times10^{6}}\right)$$ ✔

rearrange equation

$1.025\ Z = 1.64 \times 10^{6} – 4.1 \times 10^{4}$ ✔

correct answer

1.56×10^6 (kg m^{-2} s^{-1}) ✔

Candidates who ignore the negative root can get three marks max for arranging the equation correctly and getting 1.72 by using the positive root.

Basic rule -1 for each error.

Last two marks for working can be given for wrong values above that point.

4

[12]