Revision Sheet

A-Level Physics · Unit 24 Medical physics

9 vocabulary items · 37 marks of exam questions (4 questions)

Part 1 · Vocabulary review (9 items). The terms this unit is examined on most. Mark it yourself from the answer key.

Section A · Chinese to English

Write the English word.

1. _____ [1]

2. _____ [1]

3. _____ [1]

4. _____ [1]

5. _____ [1]

6. _____ [1]

7. _____ [1]

8. _____ [1]

9. _____ [1]

Part 2 · Exam questions (37 marks, 4 questions) begins on the next page. They are ordered easy to difficult and none of them has been set before.

10 **(a)** State the purpose of computed tomography (CT scanning).

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..... [1]

(b) Outline the principles of CT scanning.

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..... [5]

[Total: 6]

11 Positron emission tomography (PET scanning) obtains diagnostic information from a person. The information is used to form an image.

(a) PET scanning uses a tracer.

Explain what is meant by a tracer.

.....

..... [1]

(b) PET scanning involves annihilation.

(i) Explain what is meant by annihilation.

.....

..... [1]

(ii) State the names of the particles involved in the annihilation process.

..... [1]

(c) **(i)** Calculate the total energy released in one annihilation event in **(b)**.

energy = ... J [1]

(ii) Calculate the wavelength of each gamma photon released.

wavelength = ... m [2]

(d) Explain how the gamma photons are used to produce an image.

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..... [3]

[Total: 9]

12 **(a)** Electrons are accelerated through a potential difference of 15 kV. The electrons collide with a metal target and a spectrum of X-rays is produced.

(i) Explain why a continuous spectrum of energies of X-ray photons is produced.

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..... [3]

(ii) Calculate the wavelength of the highest energy X-ray photon produced.

wavelength = ... m [3]

(b) A beam of X-rays has an initial intensity I_o. The beam is directed into some body tissue. After passing through a thickness x of tissue the intensity is I. The graph in Fig. 11.1 shows the variation with x of ln (I/I_o).

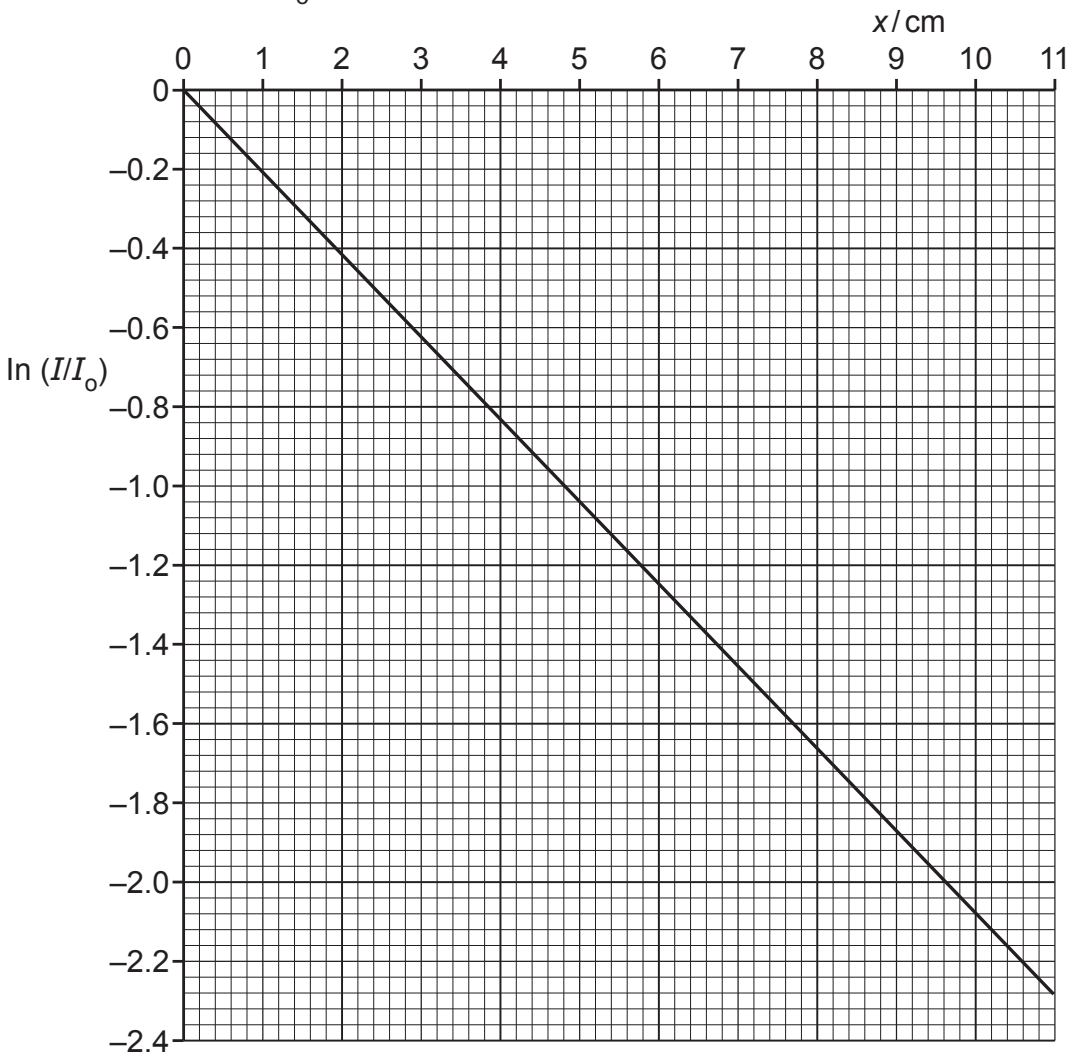

Fig. 11.1

(i) Determine the linear attenuation (absorption) coefficient μ for this beam of X-rays in the tissue.

μ = ... cm^{-1} [2]

(ii) Determine the thickness of tissue that the X-ray beam must pass through so that the intensity of the beam is reduced to 5.0% of its initial value.

thickness = ... cm [2]

[Total: 10]

13 Fluorine-18 ($^{18}_{9}F$) is a radioactive nuclide that is used as a tracer in positron emission tomography (PET scanning). Fluorine-18 decays to a nuclide of oxygen (O) according to

$$^{18}_{9}F \longrightarrow {}^{Q}_{P}X + {}^{R}_{8}O.$$

(a) (i) State what is meant by a tracer.

.....

..... [1]

(ii) State the symbol of the particle that is represented by X and the values of *P*, *Q* and *R*.

X: ..... *P*: .....

Q: ..... *R*: .....

[2]

(b) (i) Explain how the radioactive decay of fluorine-18 results in the emission from the body of the gamma-ray photons that are detected during a PET scan.

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.....

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..... [2]

(ii) Explain how the detection of the gamma-ray photons is used to produce an image of the tissue being examined.

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..... [2]

(c) The half-life of fluorine-18 is *T*.
A patient is injected with amount of substance *n* of fluorine-18.

(i) Determine an expression for the initial value R_0 of the rate *R* of production of gamma-ray photons by the tracer, in terms of *n*, *T* and the Avogadro constant N_A.

R_0 = ... [3]

(ii) On Fig. 9.1, sketch the variation with time t of R.

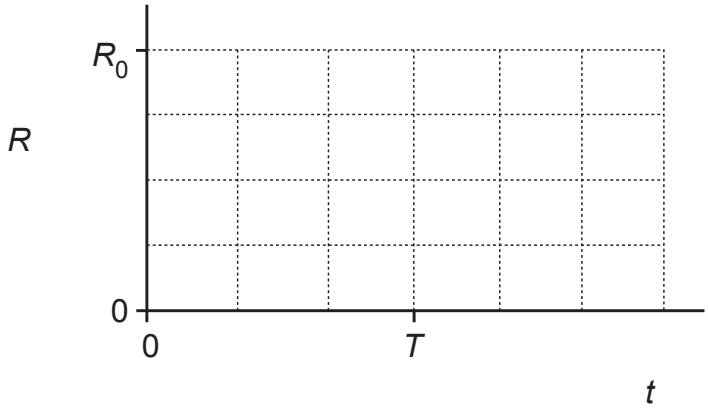

Fig. 9.1

[2]

[Total: 12]