

Interactive Example Candidate Responses

Paper 4 (May/June 2016), Question 12

Cambridge International AS & A Level

Physics 9702

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12 High-energy electrons collide with a metal target, producing X-ray photons.

The variation with wavelength of the intensity of the X-ray beam is illustrated in Fig. 12.1.

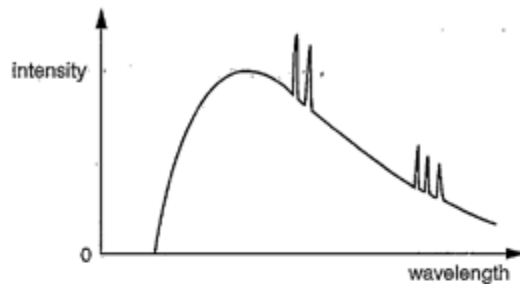


Fig. 12.1

(a) Explain why there is

(i) a continuous distribution of wavelengths.

Electromagnetic radiation is emitted as electrons accelerate. Electrons have a wide range of acceleration so there is a range of wavelengths. Electrons are accelerating continuously so continuous distribution of wavelengths.

[3]

(ii) a sharp cut-off at short wavelength,

For shortest wavelength, acceleration is greatest.

[2]

(iii) a series of peaks superimposed on the continuous distribution of wavelengths.

De-excitation of some electrons in target atom gives the spectra forming some peaks on distribution graph.

[1]

(b) In the X-ray imaging of body structures, longer wavelength photons are frequently filtered out of the X-ray beam.

(i) State how this filtering is achieved.

Place a aluminium filter in x-ray beam.

[1]

Your
Mark

12(a)(i)

12(a)(ii)

12(a)(iii)

12(b)(i)

12(b)(iii)

Q12	Mark scheme
(a)(i)	(X-ray) photon produced when electron/charged particle is stopped/accelerated (suddenly) range of accelerations (in target) hence distribution of wavelengths B1 M1 A1 [3]
(a)(ii)	electron gives all its energy to one photon electron stopped in single collision B1 B1 [2]
(a)(iii)	de-excitation of (orbital) electrons in target/anode/metal B1 [1]
(b)(i)	aluminium sheet/filter/foil (placed in beam from tube) B1 [1]
(b)(ii)	(long wavelength X-rays) do not pass through the body B1 [1] [Total: 8]

(ii) Suggest the reason for this filtering

As the big wavelength x-ray are absorbed by aluminium rather than body.

[1]

[Total: 8]

Your
Mark

12(a)(i)

12(a)(ii)

12(a)(iii)

12(b)(i)

12(b)(iii)

Q12	Mark scheme	
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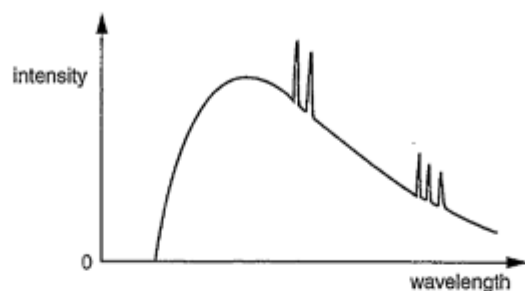


Fig. 12.1

(a) Explain why there is

(i) a continuous distribution of wavelengths,

Because there was a continuous range of deceleration of electrons when they hit metal plate & the X-rays emitted also had continuous distribution of wavelength. For each acceleration there is particular wavelength. [3]

(ii) a sharp cut-off at short wavelength,

It is because of the maximum energy/frequency electron which can give to single photon hitting the metal & emitting single photon. [2]

(iii) a series of peaks superimposed on the continuous distribution of wavelengths.

It is because of low impact time of between metal & the electron & also because of transition in metal when electron collision hit the metal. [1]

(b) In the X-ray imaging of body structures, longer wavelength photons are frequently filtered out of the X-ray beam.

(i) State how this filtering is achieved.

An Aluminium filter is placed in the way of X-ray beam. [1]

Select
page

Your
Mark

12(a)(i)

12(a)(ii)

12(a)(iii)

12(b)(i)

12(b)(iii)

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(b)(i)	aluminium sheet/filter/foil (placed in beam from tube) B1 [1]
(b)(ii)	(long wavelength X-rays) do not pass through the body B1 [1] [Total: 8]

(ii) Suggest the reason for this filtering.

They ^{lack} energy to penetrate through body skin they
only increase the dose they don't put in image. [1]
take

[Total: 8]

Your
Mark

12(a)(i)

12(a)(ii)

12(a)(iii)

12(b)(i)

12(b)(iii)

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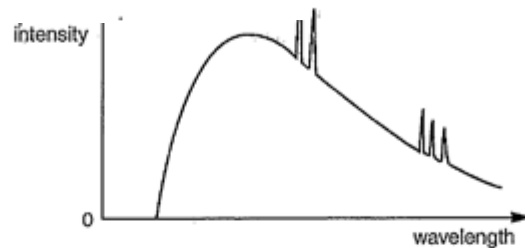


Fig. 12.1

(a) Explain why there is

(i) a continuous distribution of wavelengths,

Electrons have various velocities.
High wavelength X ray beams are due to low energy electrons.

[3]

(ii) a sharp cut-off at short wavelength,

Electrons would have an energy value more than one specific value. (threshold ~~was~~ frequency)

[2]

(iii) a series of peaks superimposed on the continuous distribution of wavelengths.

When a series of electrons hit the metal target and ~~is~~ more than one photon is emitted from the similar wavelength electrons.

[1]

(b) In the X-ray imaging of body structures, longer wavelength photons are frequently filtered out of the X-ray beam.

(i) State how this filtering is achieved.

By keeping a thin Aluminium sheet between the body and beam.

[1]

Your
Mark

12(a)(i)

12(a)(ii)

12(a)(iii)

12(b)(i)

12(b)(iii)

Q12	Mark scheme
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(b)(ii)	(long wavelength X-rays) do not pass through the body B1 [1] [Total: 8]

(ii) Suggest the reason for this filtering.

It absorbs high wavelength X ray beams
which would be absorbed by the body. [1]
and not contribute to the image. [Total: 8]

Your
Mark

12(a)(i)

12(a)(ii)

12(a)(iii)

12(b)(i)

12(b)(iii)

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