Cambridge Assessment International Education

Interactive

Interactive Example Candidate Responses
Paper 4 (May/June 2016), Question 13
Cambridge International AS & A Level
Physics 9702

Version 1.0

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13 (a) Explain what is meant by *gamma radiation* (*γ-radiation*).

The emission of gamma particles from a radioactive sample due to spontaneous and random nature. [2]

(b) A source of gamma radiation is placed a fixed distance away from a detector and counter, as illustrated in Fig. 13.1.

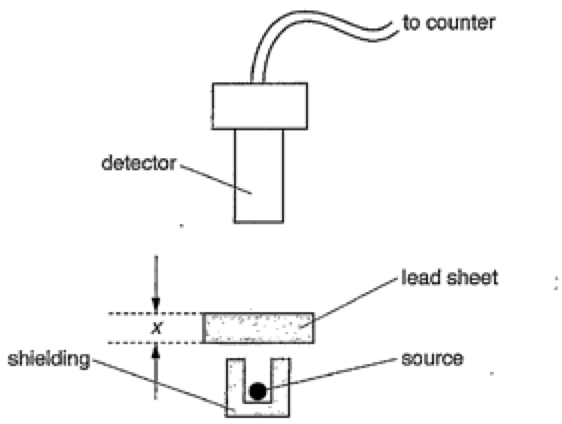

Fig. 13.1

A sheet of lead of thickness x is placed between the source and the detector.
The average count rate C, corrected for background, is recorded. This is repeated for different values of x.
The variation with thickness x of $\ln C$ is shown in Fig. 13.2.

$$C = C_0 e^{-\mu x}$$

$$\ln C = \ln C_0 e^{-\mu x}$$

$$\ln C = -\mu x + \ln C_0$$

Select page

HIGH | MIDDLE | LOW

Your Mark

13(a)

13(b)

13(c)

Q13	Mark scheme		
(a)	(photons of) electromagnetic radiation	M1	
	emitted from nuclei	A1	[2]
(b)	line of best fit drawn	B1	
	recognises μ as given by the gradient of best-fit line **or** $\ln C = \ln C_0 - \mu x$	B1	
	$\mu = 0.061\ mm^{-1}$ (within $\pm 0.004\ mm^{-1}$, 1 mark; within $\pm 0.002\ mm^{-1}$, 2 marks)	A2	[4]
(c)	aluminium is less absorbing (than lead) **or** gradient of graph would be less M1		
	so μ is smaller A1		[2]
			[Total: 8]

EXAMINER COMMENTS

MARK SCHEME

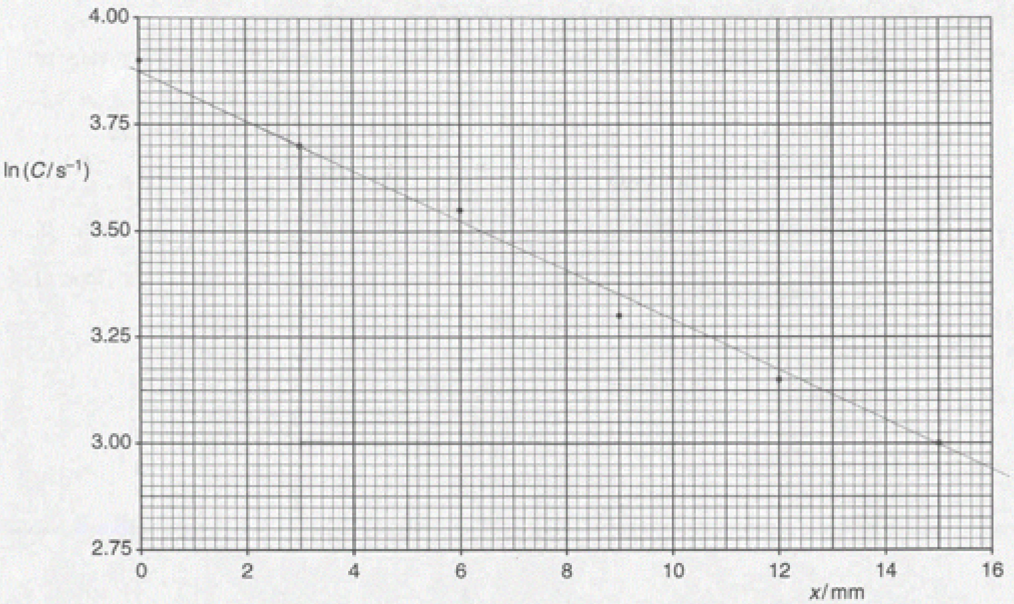

Fig. 13.2

(15, 3)

(3, 3.7)

The absorption of gamma radiation in lead may be represented by the equation

$$C = C_0 e^{-\mu x}$$

where C_0 is the count rate for $x = 0$ and μ is the linear attenuation (absorption) coefficient.

Use Fig. 13.2 to determine the linear attenuation coefficient μ for this gamma radiation in lead.

$C = C_0 e^{-\mu x}$

$\ln C = \ln (C_0 e^{-\mu x})$

$\ln C = \ln C_0 + (-\mu x)$

$\ln C = -\mu x + \ln C_0$

$y = mx + c$

$-\mu =$ gradient.

$m = \dfrac{3.7 - 3}{3 - 15}$ mm

$-\mu = -0.05833$

μ = ~~0.06~~ 0.058 mm⁻¹ [4]

Question 13 continues on the next page.

Select page

HIGH MIDDLE LOW

Your Mark

13(a)

13(b)

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	so μ is smaller A1		**[2]**
			[Total: 8]

EXAMINER COMMENTS

MARK SCHEME

(c) The value of μ calculated in **(b)** is for gamma radiation in lead.

Suggest and explain whether the value of μ for aluminium would be the same, greater or smaller.

Attenuation coefficient would be smaller for Aluminium as the absorption of by Al is lesser than of lead. [2]

[Total: 8]

Select page

HIGH MIDDLE LOW

Your Mark

13(a)

13(b)

13(c)

Q13	Mark scheme		
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	emitted from nuclei	A1	**[2]**
(b)	line of best fit drawn	B1	
	recognises μ as given by the gradient of best-fit line **or** In C = In $C_0 - \mu x$	B1	
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	so μ is smaller A1		**[2]**
			[Total: 8]

EXAMINER COMMENTS

MARK SCHEME

13 (a) Explain what is meant by *gamma radiation* (*γ-radiation*).

It is the electromagnetic wave of the very high frequency range and are released during the decay of a radioactive nucleus. [2]

(b) A source of gamma radiation is placed a fixed distance away from a detector and counter, as illustrated in Fig. 13.1.

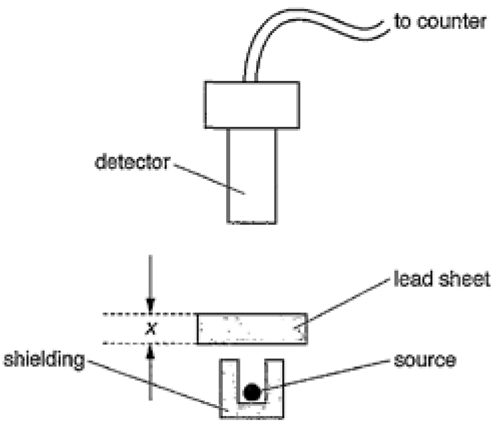

Fig. 13.1

A sheet of lead of thickness *x* is placed between the source and the detector.
The average count rate *C*, corrected for background, is recorded. This is repeated for different values of *x*.
The variation with thickness *x* of ln *C* is shown in Fig. 13.2.

Your Mark

13(a)

13(b)

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EXAMINER COMMENTS

MARK SCHEME

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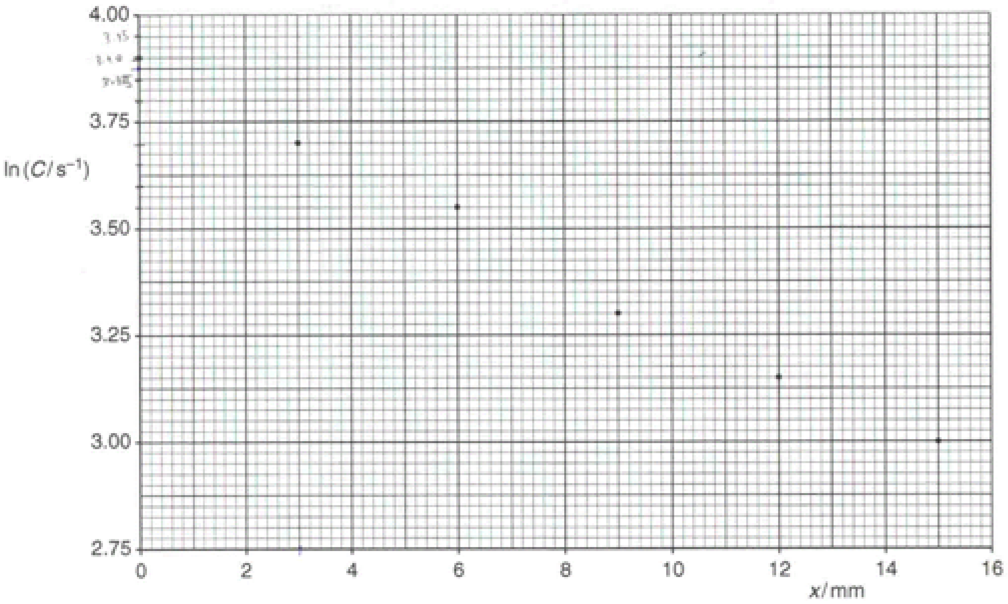

Fig. 13.2

The absorption of gamma radiation in lead may be represented by the equation

$$C = C_0 e^{-\mu x}$$

where C_0 is the count rate for $x = 0$ and μ is the linear attenuation (absorption) coefficient.

Use Fig. 13.2 to determine the linear attenuation coefficient μ for this gamma radiation in lead.

$C_0 = 3.855$, $x = 0$

$C = 3.70$, $x = 3$mm.

$3.70 = 3.855 \times e^{-\mu(3)}$

$0.9598 = e^{-\mu(3)}$

$-0.041 = -\mu(3)$

$\mu = \frac{0.041}{3} =$ ~~0.0136~~ $0.0137 = 1.37 \times 10^{-2}$

$\mu =$ ~~0.0137~~ 1.37×10^{-2} mm^{-1} [4]

Question 13 continues on the next page.

Your Mark

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			[Total: 8]

EXAMINER COMMENTS

MARK SCHEME

(c) The value of μ calculated in (b) is for gamma radiation in lead.

Suggest and explain whether the value of μ for aluminium would be the same, greater or smaller.

It would be lower as aluminium ~~is a~~ absorbs less gamma radiations than lead [2]

[Total: 8]

Select page

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	so μ is smaller A1		**[2]**
			[Total: 8]

EXAMINER COMMENTS

MARK SCHEME

13 (a) Explain what is meant by *gamma radiation* (γ-*radiation*).

radiations of high frequency electromagnetic ~~and~~ waves from nucleus of an unstable atom to attain stability [2]

(b) A source of gamma radiation is placed a fixed distance away from a detector and counter, as illustrated in Fig. 13.1.

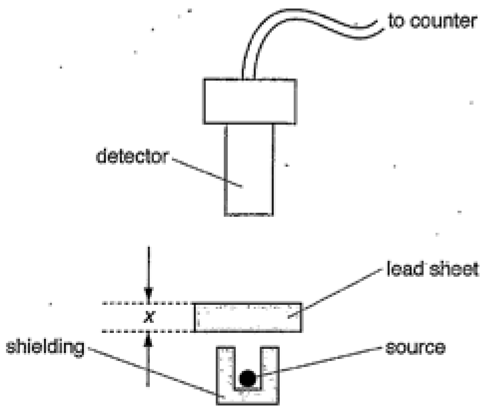

Fig. 13.1

A sheet of lead of thickness *x* is placed between the source and the detector.
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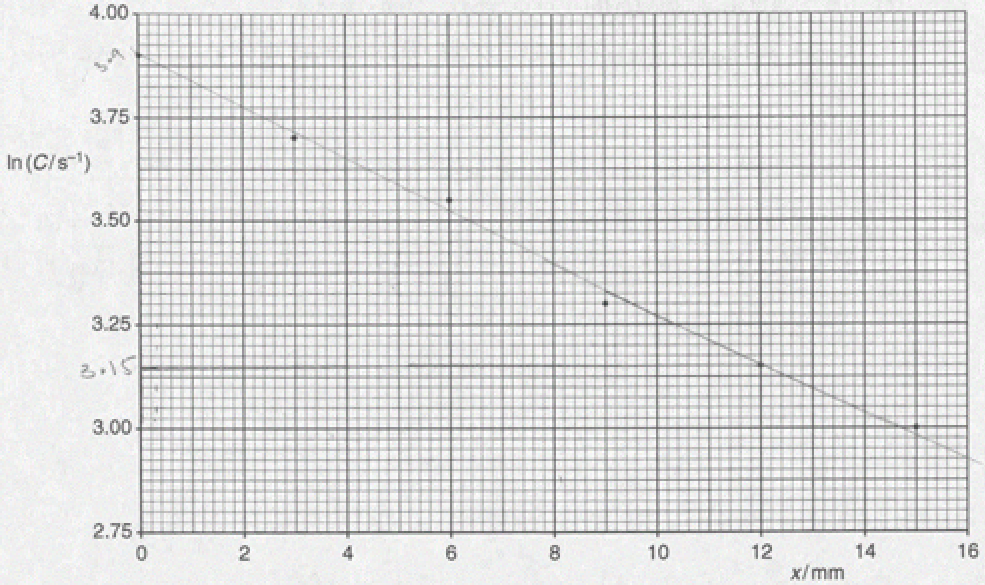

Fig. 13.2

The absorption of gamma radiation in lead may be represented by the equation

$$C = C_0 e^{-\mu x}$$

where C_0 is the count rate for $x = 0$ and μ is the linear attenuation (absorption) coefficient.

Use Fig. 13.2 to determine the linear attenuation coefficient μ for this gamma radiation in lead.

ln C = Co x lne^{-ux}

ln(C/Co) = -ux x lnC₀

= -lnC₀ x x μ

$\frac{3.9 - 3.15}{0 - 12}$

μ = -0.063 mm^{-1} [4]

Question 13 continues on the next page.

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	so μ is smaller A1		[2]
			[Total: 8]

EXAMINER COMMENTS

MARK SCHEME

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(c) The value of μ calculated in **(b)** is for gamma radiation in lead.

Suggest and explain whether the value of μ for aluminium would be the same, greater or smaller.

In aluminium the value will be small as aluminium sheet does not absorb gamma radiation so intensity will not be changed significantly. [2]

[Total: 8]

Your Mark

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13(b)

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EXAMINER COMMENTS

MARK SCHEME

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