

























































12 (a) State what is meant by a *photon*.

.....  
.....  
..... [2]

(b) A stationary nucleus of samarium-157 ( $^{157}_{62}\text{Sm}$ ) emits a gamma-ray ( $\gamma$ -ray) photon of energy 0.57 MeV.

Determine, for one  $\gamma$ -ray photon:

(i) its wavelength

wavelength = ..... m [2]

(ii) its momentum.

momentum = ..... N s [2]

- (c) (i) Using your answer to (b)(ii), determine the speed of the samarium-157 nucleus after emission of the photon.

speed = .....  $\text{ms}^{-1}$  [2]

- (ii) By reference to your answer in (c)(i), explain quantitatively why the speed of the samarium-157 nucleus may be assumed to be negligible compared with the speed of the photon.

.....  
..... [1]

[Total: 9]

## BLANK PAGE

---

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at [www.cambridgeinternational.org](http://www.cambridgeinternational.org) after the live examination series.

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.