

- 11 (a) State what is meant by a *photon*.

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

- (b) Indium-123 ( $^{123}_{49}\text{In}$ ) is radioactive.

A nucleus of indium-123 emits a  $\gamma$ -ray photon of energy 1.1 MeV.

Determine, for this  $\gamma$ -radiation,

- (i) the frequency,

frequency = ..... Hz [2]

- (ii) the momentum of a photon.

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

- (c) The indium-123 nucleus is stationary before emission of the  $\gamma$ -ray photon.

Use your answer in (b)(ii) to estimate the recoil speed of the nucleus after emission of the photon.

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

[Total: 7]