Option B — Quantum Physics and Nuclear Physics

B1. This question is about models of the hydrogen atom.

(a) Outline how the Bohr model of the hydrogen atom accounts for the spectrum of hydrogen. *[3]*

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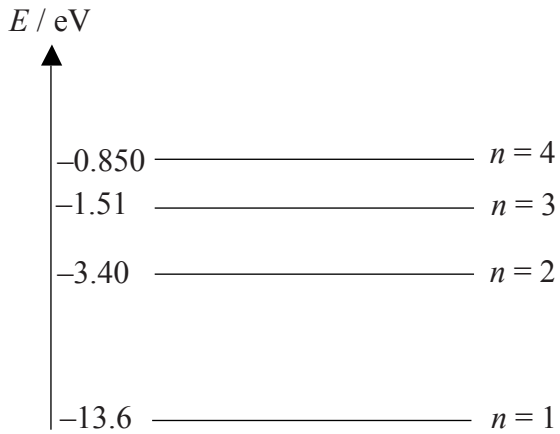
(b) The diagram below shows some of the energy levels of the hydrogen atom.



(i) Outline, by reference to the diagram, what is meant by the term *quantization of energy*. *[1]*

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(ii) Deduce that for the transition from the level $n = 2$ to the level $n = 1$, the wavelength of the photon emitted is 1.22×10^{-7} m. *[2]*

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(iii) Suggest why the lines in the spectrum of atomic hydrogen become closer together as the wavelength of the emitted photons decreases. *[2]*

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(Question B1 continued)

(c) Outline how the concept of matter waves leads to the Schrödinger model of the hydrogen atom. *[4]*

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B2. This question is about nuclear energy levels and radioactive decay.

A thallium nucleus $\left({}^{207}_{81}\mathrm{Tl}\right)$ undergoes decay to form a nucleus of lead-207 $\left({}^{207}_{82}\mathrm{Pb}\right)$.

(a) State the nuclear reaction equation for the decay of thallium-207. *[2]*

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(b) Explain for the decay of thallium-207

(i) why γ-ray photons are also emitted. *[2]*

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(ii) why the particles emitted do not all have the same energy. *[2]*

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(Question B2 continued)

(c) State for the decay of thallium-207 in (a)

(i) the name of the fundamental interaction involved. *[1]*

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(ii) the name of the exchange particle. *[1]*

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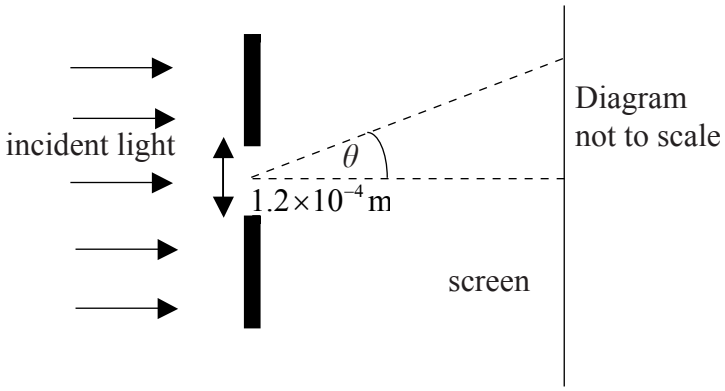
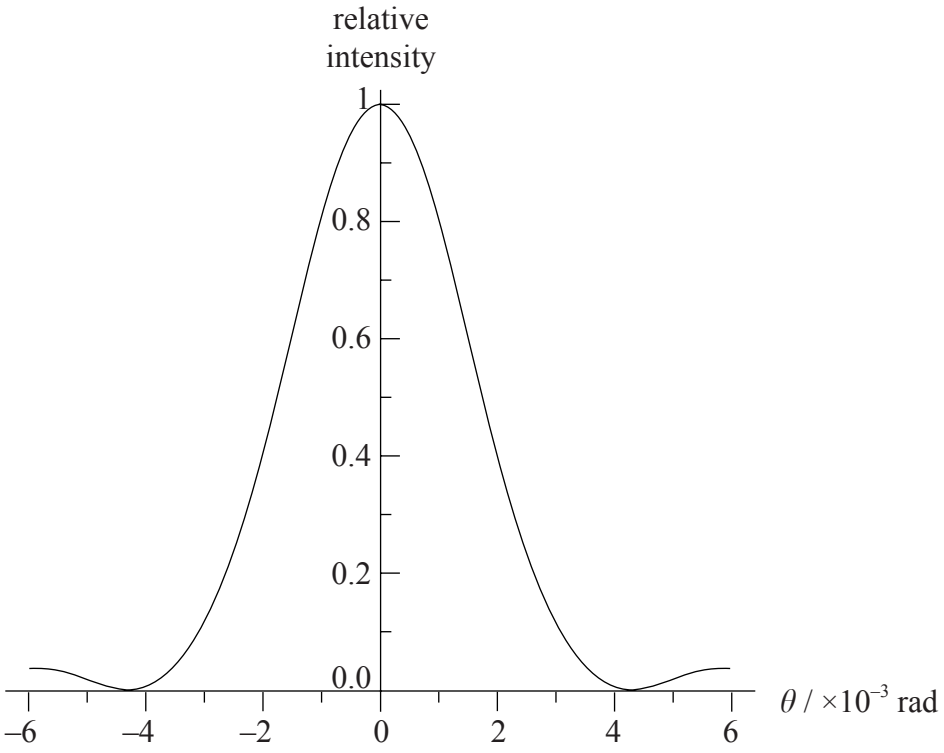
H4. This question is about diffraction.

Monochromatic light is incident on a single slit of width 1.2×10^{-4} m.



The graph shows the variation with angle θ of the intensity of the light on the screen.



(a) Use the graph to estimate the wavelength of the light. *[1]*

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(b) Monochromatic light is incident on two parallel slits. After passing through the slits, the light is incident on a screen. The separation of the slits is approximately twice the slit width. On the axes above draw a graph to show the intensity distribution of the light on the screen. *[2]*