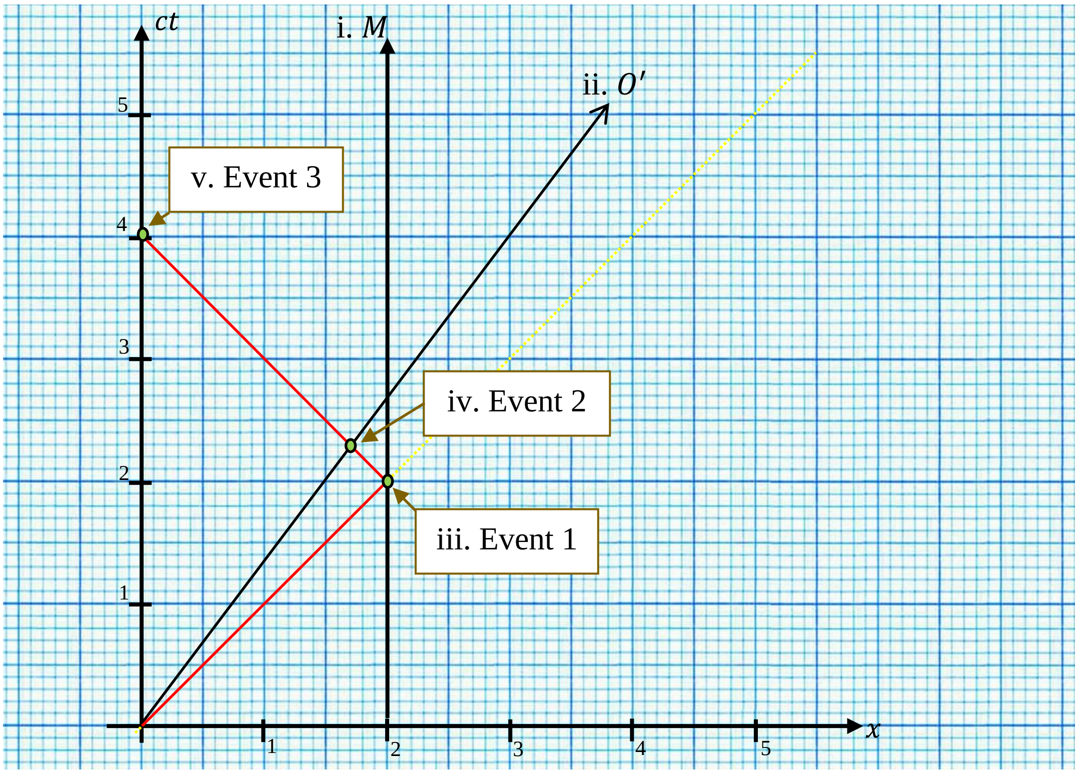
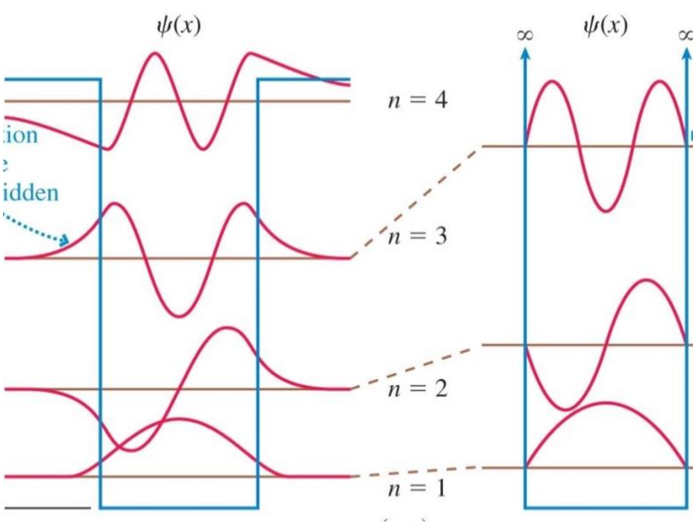
Short Questions

Qn	Answer
1.	$\bar{d} = 1362.7\ m$
2.	$\boldsymbol{v} = \sqrt{7}/_4\ c \cong 1.98 \times 10^8\ ms^{-1}$
3.	$E_{\Delta m} = 17.59\ MeV \cong 2.814 \times 10^{-12}\ J$
4.	$^{228}_{88}$Ra , show decay transformation path.
5.	$t = 210 \times 10^6\ years$
6.	Davisson-Germer & Electron double-slit diffraction experiments.
7.	$E_\mathrm{K} = 0.55\ eV \cong 8.8 \times 10^{-20}\ J$
8.	$\lambda' = 0.4045 \times 10^{-9}\ m = 4.045\ \text{Å}$
9.	$\mathbb{P}_\mathrm{R} = \frac{4}{27}\frac{r^2}{r_0^3}\left(1 - \frac{2}{3}\frac{r}{r_0} + \frac{2}{27}\left[{r}/{r_0}\right]^2\right)^2 \cdot e^{-2r/3r_0}$

Long Questions

Qn	Part	Answer
1.	a.	$p_\mu = 235.6\ MeV$
		$E_\mathrm{K} = 152\ MeV$
	bi-v.	
	bvi.	$x_{Event\ 2} = 1.7\ units$ $ct_{Event\ 2} \cong 2.2\ or\ 2.3\ units$
	bvii.	$x'_{Event\ 2} \cong 0.02\ units$ $ct_{Event\ 2} \cong 1.47\ units$
	bviii.	$ct'_{Event\ 3} \cong 6.05\ units$ $c\Delta t'_{2\to3} \cong 4.58\ units$

<table>
<tr><td>2.</td><td>ai.</td><td>$r'_n = \frac{\epsilon_0 n^2 h^2}{\pi m (\mathbb{Z}e) e}$</td></tr>
<tr><td></td><td>aii.</td><td>$v'_n = \frac{1}{\epsilon_0} \frac{(\mathbb{Z}e)e}{2nh}$</td></tr>
<tr><td></td><td>bi.</td><td>$E_\infty = 54.4\ eV$</td></tr>
<tr><td></td><td>bii.</td><td>$\lambda_{1\to 2} \cong 30\ nm$
$\lambda_{1\to 3} \cong 2.56 \times 10^{-8}\ m = 26\ nm$
$\lambda_{1\to 4} \cong 2.43 \times 10^{-8}\ m = 24\ nm$</td></tr>
<tr><td></td><td>biii.</td><td>6 lines</td></tr>
<tr><td>3.</td><td>a.</td><td>Where $\widehat{H}$ operates on ϕ_{n} and separating the expression of ϕ_{n} from the result.</td></tr>
<tr><td></td><td>bi.</td><td>$Check\ that\ \psi(x,0) is\ normalized.$
<table>
<tr><th>n</th><th>Energies, E_{n}</th><th>Probabilities, $\mathbb{P}_{\mathrm{n}}$</th></tr>
<tr><td>1</td><td>$\frac{\pi^2 \hbar^2}{2ma^2}$</td><td>$\frac{2}{5}$</td></tr>
<tr><td>3</td><td>$9\frac{\pi^2 \hbar^2}{2ma^2}$</td><td>$\frac{1}{2}$</td></tr>
<tr><td>5</td><td>$25\frac{\pi^2 \hbar^2}{2ma^2}$</td><td>$\frac{1}{10}$</td></tr>
</table></td></tr>
<tr><td></td><td>bii.</td><td>$\langle E \rangle = \sum_{\mathrm{n}} \mathbb{P}_{\mathrm{n}} \cdot E_{\mathrm{n}} = 3.7 \frac{\pi^2 \hbar^2}{ma^2}$</td></tr>
<tr><td></td><td>biii.</td><td>Using $\int_0^{a/2} |\psi(x,0)|^2\, \mathrm{d}x$
$\mathbb{P}(0 \le x \le a/2) = 1/2$</td></tr>
<tr><td></td><td>biv.</td><td>$\psi(x,t) = \sqrt{\frac{2}{5}} \cdot \phi_1(x) \cdot e^{-iE_1 t/\hbar} + \sqrt{\frac{1}{2}} \cdot \phi_3(x) \cdot e^{-iE_3 t/\hbar} + \sqrt{\frac{1}{10}} \cdot \phi_5(x) \cdot e^{-iE_5 t/\hbar}$</td></tr>
<tr><td></td><td>c.</td><td>
</td></tr>
<tr><td>4.</td><td></td><td>Using; $p = h/\lambda$
$E^2_{relativistic\ total} = (pc)^2 + (m_0 c^2)^2 = (E_{\mathrm{K}} + m_0 c^2)^2$</td></tr>
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