Physics
Theory Part 10

Topics: Relativity/ Ray Optics

Course: B.Sc/ Physics

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Relativity

Find the change in energy of a body (electron) whose mass is doubled.

$$E = mc^2 = \gamma m_0 c^2 = \frac{m_0 c^2}{\sqrt{1-\frac{v^2}{c^2}}}$$

now $$m = \gamma m_0 = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

Given $m' = 2m$

$$\Rightarrow 2m_0 = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} \Rightarrow \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} = 2$$

or, $\gamma = 2$.

now $E = \gamma m_0 c^2 = 2 m_0 c^2$

so, if $E = 2 m_0 c^2$ then mass will be doubled

$$E = 2 \times 9.1 \times 10^{-31} \times 3 \times 10^8$$

$$= \boxed{54.6 \times 10^{-23}\ J}$$

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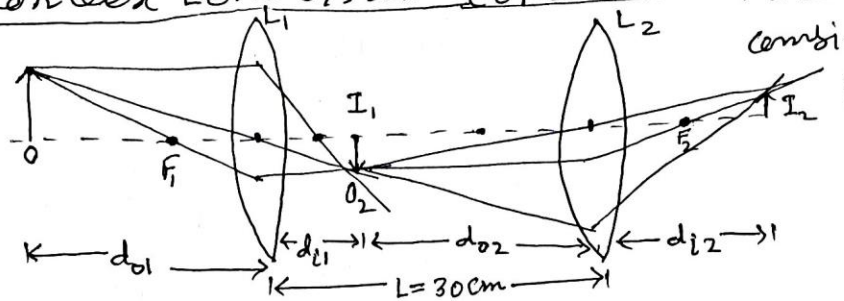
Double Convex Lens system (optical): Find d_{i1}, d_{o2}, d_{i2}, combined magnification, Final Height of the image (h_{i2}).



L = Distance between two lenses = 30 cm, F_1 = Focal Length of 1st Lens.
F_2 = Focal Length of 2nd Lens, d_o = object distance from 1st Lens.
d_{i1} = Image distance from 1st Lens, d_{o2} = " " " 2nd ".
d_{i2} = " " " 2nd ".
h_{i1} = 1st image height, h_{i2} = 2nd image height,
M_1 = Magnification of 1st lens, M_2 = Magnification of 2nd Lens.

(a) for L_1, $\frac{1}{F} = \frac{1}{d_{o1}} + \frac{1}{d_{i1}} \Rightarrow \frac{1}{15} = \frac{1}{40} + \frac{1}{d_{i1}} \Rightarrow 0.066 = 0.025 + \frac{1}{d_{i1}} \Rightarrow$ **$d_{i1} = 24.39$ cm**

(b) Image by 1st Lens is object for the 2nd lens. so for L_2, $d_{o2} = L - d_{i1}$
$= 30 - 24.39$
$= 5.61$ cm

$\frac{1}{F_2} = \frac{1}{d_{o2}} + \frac{1}{d_{i2}} \Rightarrow \frac{1}{5} = \frac{1}{5.61} + \frac{1}{d_{i2}} \Rightarrow$ **$d_{i2} = 33.33$ cm**

Final image located at 33.33cm behind 2nd Lens.

(c) Magnification by 1st lens, $M_1 = -\frac{d_{i1}}{d_{o1}} = -\frac{24.39}{40} = -0.60$

" " 2nd ", $M_2 = -\frac{d_{i2}}{d_{o2}} = -\frac{33.33}{5.61} = -5.94$

Resultant Magnification, $M = M_1 \times M_2 = 0.60 \times 5.94 = 3.56$

in terms of height, $M = \frac{h_{i2}}{h_{o1}} = \frac{h_{i2}}{20} \therefore h_{i2} = 20 \times M$

or, $h_{i2} = 20 \times 3.56 = 71.2$ cm $\therefore$ **$h_{i2} = 71.2$ cm**

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