# Solución EBAU Murcia. Julio 2023

**CUESTIONES**

**C1** Las velocidades de escape del planeta ($P$) y la Tierra ($T$) son, respectivamente

$$v_P = \sqrt{2G\frac{M_P}{R_P}} \quad , \quad v_T = \sqrt{2G\frac{M_T}{R_T}},$$

y como la densidad es igual

$$\rho = \frac{M_P}{\frac{4}{3}\pi R_P^3} = \frac{M_T}{\frac{4}{3}\pi R_T^3} \rightarrow \frac{M_P}{M_T} = \frac{R_P^3}{R_T^3}$$

Por tanto:

$$\frac{v_P}{v_T} = \sqrt{\frac{M_P}{M_T}\frac{R_T}{R_P}} = \sqrt{\frac{R_P^3}{R_T^3}\frac{R_T}{R_P}} = \frac{R_P}{R_T} = 2$$

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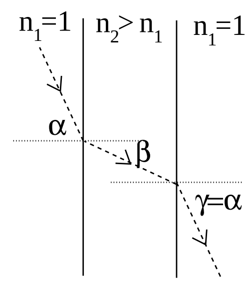
**C2** Aplicando la Ley de Snell a las dos interfases:




$n_1 \text{sen}(\alpha) = n_2 \text{sen}(\beta) = n_1 \text{sen}(\gamma)$

$\Rightarrow \text{sen}(\alpha) = \text{sen}(\gamma) \Rightarrow \gamma = \alpha$

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**C3** El protón siente la fuerza de Lorentz $\vec{F} = q\vec{v} \times \vec{B}$ que es perpendicular a $\vec{v}$. Por tanto no realiza trabajo ya que $\vec{v}$ es paralelo a $d\vec{r}$ y entonces $\vec{F} \cdot d\vec{r} = 0$, por lo que no varía su energía cinética y por tanto tampoco el módulo de la velocidad.

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**C4** $E_\gamma = hf = h\frac{c}{\lambda} \Rightarrow \lambda = \frac{hc}{E_\gamma} = \frac{6.63\cdot 10^{-34} \times 3\cdot 10^8}{3 \times 1.6\cdot 10^{-19}} = 4.14 \cdot 10^{-7}\, m = 0.414\, \mu m$

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**P1 a)** $$|\vec{g}| = G\frac{M_T}{(R_T+h)^2} = 6.67 \cdot 10^{-11}\frac{6 \cdot 10^{24}}{((6371+1450)\cdot 1000)^2} = 6.54\, m/s$$

**b)**

$$T = \sqrt{\frac{4\pi^2}{GM_T}(R_T+h)^3} = \sqrt{\frac{4\pi^2}{6.67\cdot 10^{-11} \times 6 \cdot 10^{24}}((6371+1450)\cdot 1000)^3} = 6870\, s$$

Número de vueltas en 2 años: $\frac{2 \times 365 \times 24 \times 3600\, s}{6870\, s/vuelta} = 9181\, vueltas$

**c)** $1 \equiv$ superficie, $2 \equiv$ órbita:

$$E_1 = E_{c_1} + E_{p_1} =\sim 0 - \frac{GM_T m}{R_T} = -\frac{6.67\cdot 10^{-11} \times 6 \cdot 10^{24} \times 25}{6371 \times 1000} = -1.57 \cdot 10^9\, J$$

$$E_2 = E_{c_2} + E_{p_2} = \frac{1}{2}mv^2 - \frac{GM_T m}{(R_T+h)} = -\frac{GM_T m}{2(R_T+h)} = -6.40 \cdot 10^8\, J$$

$\Delta E = E_2 - E_1 = 9.3 \cdot 10^8\, J = 930\, MJ$

**P2 a)** $$\beta = 10\log\left(\frac{I}{I_o}\right) \rightarrow I = I_o 10^{\beta/10} = 10^{-12}\times 10^{130/10} = 10\,W/m^2$$

$$I = \frac{P}{4\pi d^2} \Rightarrow P = 4\pi I d^2 = 4\pi\times 10\times 100^2 = 1.26\cdot 10^6\,W = 1.26\,MW$$

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**b)** $120\,dB \Rightarrow I = 1\,W/m^2 \quad \rightarrow \quad d = \sqrt{\frac{P}{4\pi I}} = \sqrt{\frac{1.26\cdot 10^6}{4\pi\times 1}} = 317\,m$

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**c)** $\lambda = \frac{c}{f} = \frac{3\cdot 10^8}{125\cdot 10^6} = 2.4\,m \quad ; \quad E_\gamma = hf = 6.63\cdot 10^{-34}\times 125\cdot 10^6 = 8.3\cdot 10^{-26}\,J$

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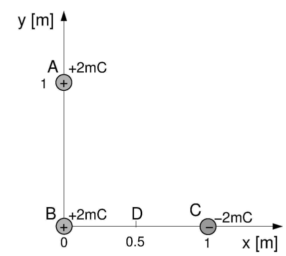
**P3 a)** $(q\equiv 2\,mC),\, k\equiv 1/(4\pi\epsilon_o)$:




$$E_P = E_{P_{AB}} + E_{P_{AC}} + E_{P_{BC}} = kq^2\left(\frac{1}{r_{AB}} - \frac{1}{r_{AC}} - \frac{1}{r_{BC}}\right)$$

$$= kq^2\left(\frac{1}{1} - \frac{1}{\sqrt{2}} - \frac{1}{1}\right) = 9\cdot 10^9\times(2\cdot 10^{-3})^2\times\frac{(-1)}{\sqrt{2}} = -2.55\cdot 10^4\,J$$

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**b)** $$W_{ext} = \Delta E_P = E_{P_D} - E_{P_A} = 0 - \left(E_{P_{AB}} + E_{P_{AC}}\right) = kq^2\left(\frac{1}{1} - \frac{1}{\sqrt{2}}\right) = 1.05\cdot 10^4\,J$$

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**c)** $$\vec{F}_A = \vec{F}_{BA} + \vec{F}_{CA} = kq^2\left(\frac{\vec{u}_{BA}}{r_{BA}^2} - \frac{\vec{u}_{CA}}{r_{CA}^2}\right) = kq^2\left(\frac{(0,1)}{1^2} - \frac{(-1,1)/\sqrt{2})}{(\sqrt{2})^2}\right) =$$

$$= kq^2(2^{-3/2}, 1-2^{-3/2}) = kq^2(0.35, 0.65) = (12600, 23400)\,N$$

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**P4 a)**

$$f = \frac{c}{\lambda} = \frac{3\cdot 10^8}{750\cdot 10^{-9}} = 4\cdot 10^{14}\,Hz \quad \text{(rojo)} \quad ; \quad f = \frac{3\cdot 10^8}{400\cdot 10^{-9}} = 7.5\cdot 10^{14}\,Hz \quad \text{(violeta)}$$

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**b)** Aplicando la ecuación de las lentes delgadas:

$P = \frac{1}{s'} - \frac{1}{s} \Rightarrow P = \frac{1}{110} - \frac{1}{-11} = 0.1\,cm^{-1} = 10\,m^{-1} = 10\,D$

Por otro lado, $P = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

Lente simétrica $(R\equiv R_2 = -R_1) \rightarrow P = (n-1)\frac{2}{R} \Rightarrow R = (n-1)\frac{2}{P} = (1.7-1)\frac{2}{0.1} = 14\,cm$

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**c)** La potencia para la luz violeta es

$$P = (n-1)\frac{2}{R} = (1.8-1)\frac{2}{14} = 0.114\,cm^{-1}$$

Luego

$$P = \frac{1}{s'} - \frac{1}{s} \Rightarrow s' = \frac{1}{P + \frac{1}{s}} = \frac{1}{0.114 + \frac{1}{-11}} = 43\,cm$$