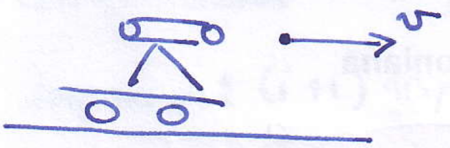
PROBLEMA #1



(a)

M = masa inicial (plataforma + balas)

m = masa de una bala

v = velocidad de la bala

$$(M-m)\,v_x + m v = \underbrace{0}_{\text{momentum inicial}}$$

$$v_x = -\frac{m}{M-m}\,v = -\frac{m}{M}\left(1-\frac{m}{M}\right)^{-1} v$$

$$v_x \approx -\frac{m}{M}\left(1+\frac{m}{M}\right) v$$

$$\epsilon = \frac{m}{M} = \frac{10^{-2}}{10^{3}} = \cancel{10^{-6}}\ 10^{-5} \qquad \boxed{v_x = -2\times 10^{-3}\ \mathrm{m/s}} \qquad (2\ \text{ptos})$$

(b) Sea M_i la masa de la plataforma + balas después de (i+1)ésimo disparo

$$M_i = M - i m = M(1 - i\epsilon)$$

Sea v_i la velocidad de la plataforma después del i-ésimo disparo momentum de ~~l sistema~~ la plataforma es $M_i v_i$, la bala sale disparada con velocidad v respecto a la plataforma

después del $(i+1)$ disparo el momentum es

$$-M_{i+1} v_{i+1} + m(v - v_i) = -M_i v_i$$

y obtenemos la recurrencia

$$\boxed{v_{i+1} = \frac{M_i}{M_{i+1}} v_i + \frac{m}{M_i}(v - v_i)} \qquad (1.\ \text{pto})$$

desde que sale la primera bala hasta que la plataforma alcanza 2 m/s ~~obt~~ siempre se cumple que $v - v_i \approx v$!

Además $$\frac{M_i}{M_{i+1}} = \frac{M(1 - i\epsilon)}{M(1-(i+1)\epsilon)} \approx 1 - i\epsilon + (i+1)\epsilon = 1 + \epsilon$$

$$\boxed{v_{i+1} = (1+\epsilon) v_i + \epsilon v}$$

$$v_2 = (1+\epsilon) v_1 + \epsilon v$$

$$v_3 = (1+\epsilon)^2 v_1 + (1+\epsilon)\epsilon v + \epsilon v \approx (1 + 2\epsilon) v_1 + 2\epsilon v$$

$$v_4 = (1+3\epsilon) v_1 + 3\epsilon v$$

$$\vdots$$

3

$$\boxed{v_{N+1} = (1 + N\epsilon)v_1 + N\epsilon v}$$

$$v_{N+1} \cong (N+1)\epsilon v$$

y obtenemos $(N+1)\epsilon v = 2$ m/s

$$N+1 \approx 10^5 \frac{2}{200} = 10^3$$

$N \approx 10^3$ balas (3 ptos)

a razón de 10/s tenemos 100 segundos

ALTERNATIVA

$$(M - m)\, v_x + m v = 0$$

$$m (v - v_x) + M v_x = 0$$

$$m = \frac{-M \overset{-2}{v_x}}{\underset{200}{v} - \underset{-2}{v_x}} = M \left(\frac{2}{200-2} \right)$$

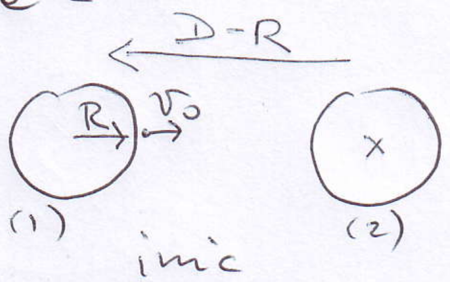
$$= M \left(\frac{1}{100-1} \right)$$

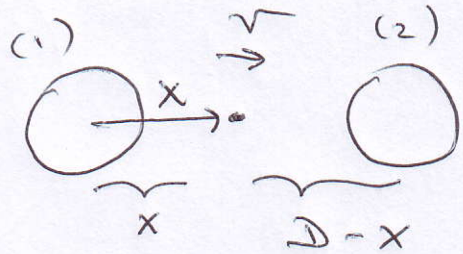
$$\boxed{m \simeq \frac{M}{100}} = \frac{1000}{100} = \underline{10 \text{ kg}}.$$

$$\frac{10 \text{ kg}}{0{,}01 \text{ kg}} \Rightarrow 1000 \text{ balas}.$$

100 segundos

Problema 2





Cons. de energía $E = K + U_1 + U_2$ [1 pto]

inic) $E = \frac{1}{2} m v_0^2 - G\frac{Mm}{R} - G\frac{Mm}{D-R}$ [1 pto]

viaje) $E = \frac{1}{2} m v^2 - G\frac{Mm}{x} - G\frac{Mm}{D-x}$ [1 pto]

Igualar: $\frac{1}{2}\cancel{m} v_0^2 - GM\cancel{m}\left(\underbrace{\frac{1}{R} + \frac{1}{D-R}}_{\frac{D}{R(D-R)}}\right) = \frac{1}{2}\cancel{m} v^2 - GM\cancel{m}\left(\underbrace{\frac{1}{x} - \frac{1}{D-x}}_{\frac{D}{x(D-x)}}\right)$

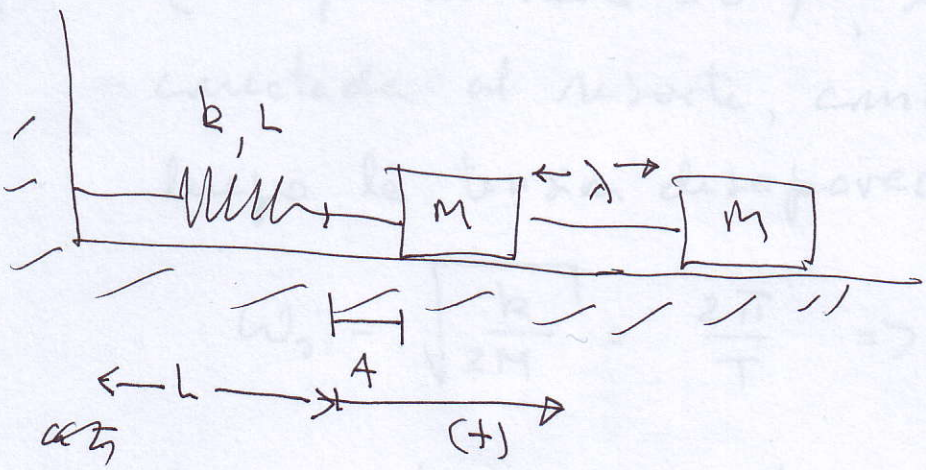
Despejar: $v_0^2 = v^2 + 2GM\left(\frac{D}{R(D-R)} - \underbrace{\frac{D}{x(D-x)}}\right)$ ← máximo en el punto medio $x = D/2$

Velc. mínima cuando $\left.\begin{matrix} v = 0 \\ x = D/2 \end{matrix}\right\} \rightarrow$ 2 pto.

$$v_0^2 = 2GM\left(\frac{D}{R(D-R)} - \frac{4}{D}\right)$$

algebra 1 pto.

Problema #3 (OSC. ARMÓNICO) NZ



a.- Veamos: DCL de la 1era masa

2ptos

1) $-kA + T = Ma$

2) $-T = Ma$

La aceleración debe ser la misma en ambas masas o se corta la cuerda.

1) + 2) $\Rightarrow$ $-kA = 2Ma$

$$a = -\left(\frac{k}{2M}\right) \cdot A = -\omega_0^2 A.$$

$$\Rightarrow -T = +M \cdot a = -M \frac{k}{2M} A = -\frac{kA}{2}.$$

(Conviene decirle a los Est. que resuelvan haciendo un DCL. Si no todos pondrán $T = kA$.!)

b.- Al pasar el resorte por el pto ~~xxxx~~ neutro (desplazamiento = 0), la primera masa, conectada al resorte, comienza a frenarse luego la tensión desaparece.

1 pto.

$$\omega_0 = \sqrt{\frac{k}{2M}} = \frac{2\pi}{T} \Rightarrow T = \frac{1}{2\pi}\sqrt{\frac{2M}{k}}$$

Como esto corresponde a $1/4$ del período

$$\Rightarrow \tau_0 = \frac{1}{4} T = \frac{1}{8\pi}\sqrt{\frac{2M}{k}}$$ //

c) Al desconectarse las masas, el período de la masa ligada al resorte es

2 ptos

$$T' = \frac{1}{2\pi}\sqrt{\frac{M}{k}}$$

puesto que la masa del sistema es M (no 2M).

$$\tau' = \frac{1}{4} T' = \frac{1}{8\pi}\sqrt{\frac{M}{k}}$$

En este instante el resorte alcanza su máxima compresión y esté instantáneamente en reposo.

$$\frac{\lambda}{\tau'} = 8\pi\lambda\sqrt{\frac{k}{M}}$$

La velocidad del sistema es

Energía potencial inicial

$$\frac{1}{2} k A^2 = \frac{1}{2}(2M) v_0^2$$

Energía Cinética para el largo natural del resorte

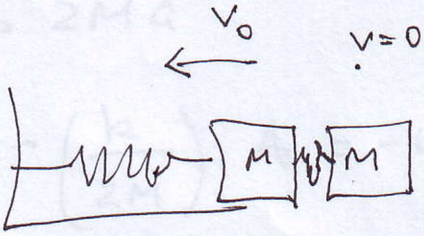
$$\Rightarrow v_0^2 = \frac{1}{2M} k A^2 = \omega_0^2 A^2$$

$$v_0 = \frac{\lambda}{\tau'} = 8\pi\lambda\sqrt{\frac{k}{M}}$$

$$\sqrt{\frac{k}{2M}}\, A = 8\pi\lambda\sqrt{\frac{k}{M}} \Rightarrow \boxed{\lambda = \frac{A}{\sqrt{2}\cdot 8\pi}}$$

d: Como son masas iguales una queda en reposo y la otra adquiere la velocidad de la incidente $\Rightarrow$

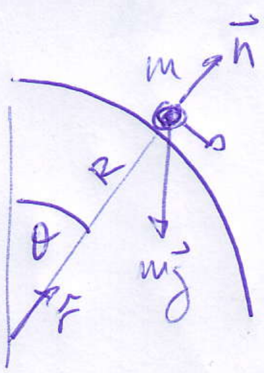
$\frac{1}{2}$ pto



e: La masa sigue comprimiendo al resorte hacia la izquierda. Retorna y choca con la masa en reposo, Ahora aquella atada al resorte se queda inmóvil por un instante y luego sigue a la otra masa. Cuando alcanza el largo natural comienza a frenar a la otra mas

$\frac{1}{2}$ pto

Problema 4:



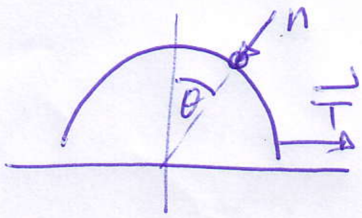
Aplicando Newton para la masa m

$$\vec{n} + m\vec{g} = m\vec{a}$$

Considerando solo la parte radial

$$n = mg\cos\theta - m\frac{v^2}{R} \quad (1)$$

2 ptos

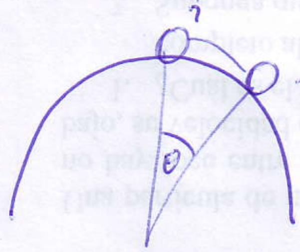


aplicando Newton para la semiesfera

$$T = n\sin\theta \quad (2)$$

1 pto

Por conservación de la energía



$$mgR = m\frac{v^2}{2} + mgR\cos\theta$$

$$v^2 = 2gR(1-\cos\theta) \quad (3)$$

1 pto

Así (1)(2)(3)

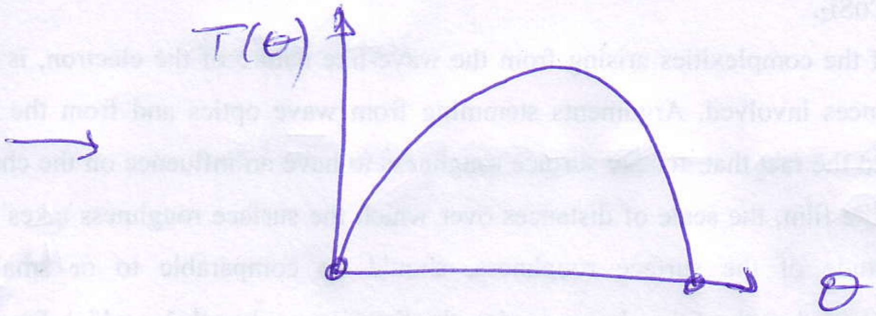
$$T(\theta) = mg\sin\theta(3\cos\theta - 2)$$

1 pto

la tensión presenta dos polos:

$\sin\theta = 0$

y $3\cos\theta = 2$



1pto

for the FS conductivity diverges as ln(ξ/t), implying that when the conductivity of the film is limited only by electron-surface scattering, there is no dissipation, an unphysical result that is a consequence of the omission of quantum effects in the classical theory. To overcome these shortcomings, a number of transport theories were published during the last two decades [4-14]. Some of these theories succeeded in quantitatively describing the experimental resistivity data in ultra thin films of CoSi₂.

One of the complexities arising from the wave-like nature of the electron, is related to the scale of distances involved. Arguments stemming from wave optics and from the wave-particle duality point to the fact that for the surface roughness to have an influence on the charge transport properties of the film, the scale of distances over which the surface roughness takes place and the typical amplitude of the surface roughness should be comparable to or smaller than the characteristic wave length of the charge carrier, the Fermi wave length λ_F, which for several metals is in the range of nanometers. The invention of the Scanning Tunneling Microscope (STM) has made possible the direct measurement of surface roughness within the scale set by λ_F.

The goal of theoretical research performed since the eighties, has been to build a formalism that would permit the prediction of the increase in resistivity due to "size effects" from first principles, from the information contained in the roughness profile characterizing the rough surface. A significant step towards this goal was the theory of Sheng, Xing and Wang (SXW) [14], that unifies the quantum transport theories then available, applicable to different special cases, with the classical FS formalism. SXW abandoned the model in which the motion of electrons is described via the classical BTE. They calculated instead the Green's function describing electrons confined within two potential barriers described by randomly rough surfaces. SXW computed the dissipative part of the electron self-energy due to electron-surface scattering in the presence of a rough surface using Dyson's equation, and proceeded to calculate the conductivity of the film using the Kubo transport formalism. However, in their treatment SXW modeled the surface roughness by a white-noise surface profile, assuming that the Fourier transform of the height-height autocorrelation function (ACF) that on the average characterizes the surface, is a constant independent of the in-plane momentum. This white-noise approximation severely limits the predictive power of the SXW formalism.

Our research on size effects from the beginning involved theoretical work combined with experiments performed within the group. In Ref. 15 we proposed a modified version of SXW theory