Mecánica Clásica
Tarea 01: Mecánica Newtoniana

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Problema 1 *Equation of motion*

A force:

$$F = -F_0 e^{-x/\lambda},$$

where F_0 and λ are positive constants, acts on a particle that is initially at $x_0 = 0$ and moving with velocity $v_0 > 0$. Determine its velocity $v(x)$ and sketch the three possible graphs of $v(x)$ versus x.

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Problema 2 *Gun's maximum range*

A projectile is fired with a velocity v_0 such that is passes through two points both a distance h above the horizontal. Show that if the gun is adjusted for maximum range, the separation of the points is,

$$d = \frac{v_0}{g}\sqrt{v_0^2 - 4gh}$$

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Problema 3 *Charged particle in an electromagnetic field*

The motion of a charged particle in an electromagnetic field can be obtained from the Lorentz equation for the force on a particle in such a field. If the electric field vector is $\mathbf{E}$ and the magnetic field vector is $\mathbf{B}$, the force on a particle of mass m that carries a charge q and has a velocity $\mathbf{v}$ is given by,

$$\mathbf{F} = q\mathbf{E} + q\mathbf{v} \times \mathbf{B},$$

where it is assumed that $v \ll c$.

a) If there is no electric field and if the particle enters the magnetic field in a direction perpendicular to the lines of magnetic flux, show that the trajectory is a circle with radius

$$r = \frac{mv}{qB} = \frac{v}{\omega_c},$$

where $\omega_c \equiv qB/m$ is the *cyclotron frequency.*

b) Choose the z-axis to lie in the direction of $\mathbf{B}$ and let the plane containing $\mathbf{E}$ and $\mathbf{B}$ be the yz-plane. Thus,

$$\mathbf{B} = B\mathbf{k}, \quad \mathbf{E} = E_y\mathbf{j} + E_z\mathbf{k}.$$

Show that the z-component of the motion is given by

$$z(t) = z_0 + \dot{z}_0 t + \frac{qE_z}{2m}t^2$$

where $z(0) \equiv z_0$ and $\dot{z}(0) \equiv \dot{z}_0$.

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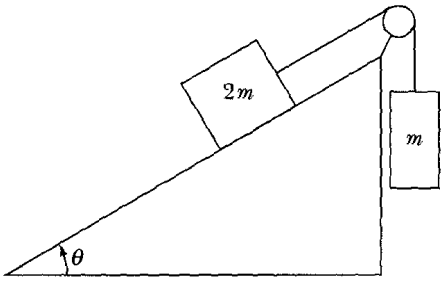
Problema 4 *Connected masses*

Two blocks of unequal mass are connected by a string over a smooth pulley. If the coefficient of kinetic friction is μ_k, what angle θ of the incline allows the masses to move at a constant speed?



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Problema 5 *Falling particle vs air resistance*

A particle is relased from rest ($y = 0$) and falls under the influence of gravity and air resistance. Find the relationship between the velocity v and the distance of falling y when the air resistance is equal to a) αv, and b) βv^2.

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Problema 6 *Elusive force*

The speed of a particle of mass m varies with the distance x as $v(x) = \alpha x^{-n}$. Assume $v(x = 0) = 0$ at $t = 0$.

a) Find the force $F(x)$ responsible.

b) Determine $x(t)$.

c) Determine $F(t)$.

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Problema 7 *Potential analysis*

Consider a particle moving in the region $x > 0$ under the influence of the potential

$$U(x) = U_0 \left(\frac{a}{x} + \frac{x}{a} \right),$$

where $U_0 = 1$ J and $a = 2$ m. Plot the potential, find the equilibrium points, and determine whether they are maxima or minima.

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Problema 8 *Rocket vertical ascent*

Consider a single-stage rocket taking off from Earth on vertical ascent under gravity (no horizontal component), neglecting air resistance, and assuming that the acceleration of gravity is constant with height, find:

a) The velocity equation of motion $v = v(m)$.

b) The hight of the rocket at burnout.

c) How much farther in height will the rocket go after burnout?

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