\[
\cdot \frac{dp}{dx} (i) \gamma = a
\]

(c) The physical vector of the particle relative to the galaxies that it is passing.

(b) The expression for the spacetime metric to relate \( \frac{dx}{dt} \) to \( \frac{dx}{d\tau} \).

(1) The vector equations for the geodesic equation of motion (Eq. 6.39) for one of the coordinates.

(a) Show that the above equation implies

\[
\frac{d\phi}{d\phi} \cdot \frac{d^2\phi}{d\phi} = \frac{d^2\phi}{d\phi} = 0
\]

Notes on the Schwarzschild metric

(a) Use the expression for the spacetime metric to relate \( \frac{dx}{dt} \) to \( \frac{dx}{d\tau} \).

(b) Use the geodesic equation of motion (Eq. 6.38) for one of the coordinates.

(c) Show that the above equation implies

\[
\frac{d\phi}{d\phi} \cdot \frac{d^2\phi}{d\phi} = \frac{d^2\phi}{d\phi} = 0
\]

(d) The vector equations for the geodesic equation of motion (Eq. 6.39) for one of the coordinates.

(1) The vector equation for the geodesic equation of motion (Eq. 6.39) for one of the coordinates.

(a) Use the metric to find the proper time interval \( \Delta \tau \).

(b) Use the geodesic equation of motion (Eq. 6.38) for one of the coordinates.

(c) Show that the above equation implies

\[
\frac{d\phi}{d\phi} \cdot \frac{d^2\phi}{d\phi} = \frac{d^2\phi}{d\phi} = 0
\]

(d) The vector equations for the geodesic equation of motion (Eq. 6.39) for one of the coordinates.

(1) The vector equation for the geodesic equation of motion (Eq. 6.39) for one of the coordinates.
Show that the momentum of the particle, defined relativistically by

\[ p = m v \sqrt{1 - \frac{v^2}{c^2}} \]

falls off as \( \frac{1}{R} \) (t). (This implies, by the way, that the wavelength of light is redshifted.)

**Problem 3: Metric of a Static Gravitational Field**

In this problem we will consider the metric

\[ ds^2 = -\left(c^2 + 2 \phi(\vec{x})\right) dt^2 + 3 \sum_{i=1}^{3} (dx_i)^2, \]

which describes a static gravitational field. Here \( \phi(\vec{x}) \) is the function of the spatial variables \( \vec{x} \equiv (x_1, x_2, x_3) \), and not on the time coordinate \( t \). The first computation can be carried out by the usual coordinate methods. Let us use the notation (\( x \equiv (x_1, x_2, x_3) \)). The function \( \phi(\vec{x}) \) depends only on the spatial variables \( \vec{x} \), and not on the time coordinate \( t \).

(a) Suppose that a radio transmitter, located at \( \vec{x}_e \), emits a series of evenly spaced pulses. The pulses are separated by a proper time interval \( \Delta T_e \), measured by a clock at the same location. What is the coordinate time interval \( \Delta t_e \) between the emission of the pulses? (I.e., \( \Delta t_e \) is the difference between the time coordinate \( t \) at the emission of one pulse and the time coordinate \( \dot{\vec{x}} \) at the emission of the next pulse.)

(b) The pulses are received by an observer at \( \vec{x}_r \), who measures the time of arrival of each pulse. What is the coordinate time interval \( \Delta t_r \) between the reception of successive pulses?

(c) The observer uses his own clocks to measure the proper time interval \( \Delta T_r \) between the reception of successive pulses. Find this time interval, and also the redshift \( z \), defined by

\[ 1 + \frac{1}{z} = \frac{\Delta T_r}{\Delta T_e} \]

In this problem we will consider the metric

\[ ds^2 = -\left(c^2 + 2 \phi(\vec{x})\right) dt^2 + 3 \sum_{i=1}^{3} (dx_i)^2. \]

When repeated, calculate an explicit expression for

\[ \frac{\partial^2 x_i}{\partial \tau^2}, \]

valid for \( i, j = 1, 2, 3 \). (It is acceptable to leave quantities such as \( \partial \tau / \partial \tau \) or \( \partial x_i / \partial \tau \) in the answer.)

In this problem we will consider the metric

\[ ds^2 = -\left(c^2 + 2 \phi(\vec{x})\right) dt^2 + 3 \sum_{i=1}^{3} (dx_i)^2. \]

When repeated, calculate an explicit expression for

\[ \frac{\partial^2 x_i}{\partial \tau^2}, \]

valid for \( i, j = 1, 2, 3 \). (It is acceptable to leave quantities such as \( \partial \tau / \partial \tau \) or \( \partial x_i / \partial \tau \) in the answer.)