Instructor: Dr. A. M. Wolfe (phone: 47435)
Text: Gravitation: Hartle
Homework no. 3
Due: Thurs. Feb . 15

1

Your are in a freely falling elevator containing a light source located a height h above the floor which is a square with sides of length l. Compute the trajectory of a photon emitted in the horizontal direction by the source. Assume the photon is a classical particle obeying Newtonian physics.

Comment on your result within the context of the Equivalence Principle.

2

Two steel balls separated by a horizontal distance Δx_0 are dropped from a height h from the floor of an elevator. Compute the change in horizontal separation by the time the balls fall to the floor if

(a) the elevator rests at the surface of the earth.
(b) the elevator is in empty space and is accerating at a rate g.

For numerical results let $g = 10 m/s^2$, h=5 m, Δx_0= 1m, and the radius of the earth R=6.4×10^6 m. Again phrase your answers in the context of the equivalence principle.

3

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4

The light emitted by some quasars is redshifted such that the light frequency observed on earth is 3 times smaller than the light frequency emitted by the quasar. Assume the light is emitted at a radius r surrounding a black hole of mass M=10^8 $M_\odot$, (where $M_\odot$, the solar mass=2×10^{33}g. Use the Schwarschild metric to compute r and then compare your result to the Schwarzchild radius of the black hole. Today we know that the redshift is caused by the expansion of the Universe and not by the gravitational field of the black hole.

5 Provide a one page outline of the topic for your term paper.