

GENERAL PHYSICS II COURSE BONUS ASSIGNMENT (20 POINT)

Below are three task sets related to black holes, paradoxes, and radiation. Please select one of these sets.

Each set has two tasks. Complete both tasks under the set you selected on at least 5 and no more than 10 plain white A4 sheets of paper (NOT graph paper or pages torn from a notebook) using a fountain pen or ballpoint pen (NOT a pencil).

Due date: Assignments will be collected before the final exam.

Prof.Dr. Hüseyin ÇAVUŞ

i) Black Holes Task Set: Do the following tasks

- 1) The Spaghettification Paradox. Calculate the tidal force difference between their head and feet if they were falling into a stellar-mass black hole. Why is a supermassive black hole actually safer to fall into than a small one?
- 2) Calculate the Schwarzschild Radius (R_s) for the Sun and the Earth. Conceptualize why an observer falling in sees light differently than an observer far away (time dilation basics).

ii) Radiation Model Task Set: Do the following tasks.

- 1) The Inverse Square Law Model. If a point source of Gamma radiation produces a dose of 10 mSv/h at 1 meter, calculate the "Safety Zone" radius required to keep student exposure below the annual background limit.
- 2) Half-Value Layer (HVL) Model. Given a table of HVL values for Aluminum, Concrete, and Lead, model the most cost-effective shield for a laboratory Co-60 source.

iii) Physical Paradoxes Task Set: Do the following tasks.

- 1) The Solar Reconnection Paradox.

According to standard "Frozen-in Flux" theory, magnetic field lines should never break. Yet, we see solar flares happen in minutes. Compare the Lundquist Number (S) for a laboratory plasma versus the solar corona. Have them explain why "fast" reconnection is necessary for life on Earth (shielding from CMEs).

- 2) The Coronal Heating Paradox

Imagine standing near a campfire; as you walk away, you expect to get colder. On the Sun, as you walk away from the "fire" (the surface), you are suddenly blasted with heat that is 200 times hotter than the surface itself.

The Question: How can energy be "pumped" into the corona without violating the laws of thermodynamics, and what is the mechanism that transports this energy?