Physics 10164 - Exam 4A

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work even if you get the right answer. Clearly indicate your answer with a circle or a box and remember to include correct units and significant figures.

1. (25 pts) According to the pilot on board a spaceship, a constant velocity trip to another star takes 13.4 years, but according to observers on the Earth, the trip takes 71.1 years. Answer all 3 parts with 3 SF.

a) How fast is the ship traveling as a fraction of c?
b) What is the distance to the star (in light years) as measured in Earth's reference frame?
c) What is the distance to the star (in light years) as measured in the pilot's reference frame?

2. (25 pts) An electron is in energy level n = 5 in a neutral Hydrogen atom.

a) What is the maximum possible wavelength of light that can cause this atom to be ionized if the electron is in level n = 5? Answer in nm with 3 SF.

b) What is the shortest possible wavelength that can be emitted from this atom if the electron transitions from the n = 5 level? Answer in nm with 3 SF.

3. (25 pts) A nuclear reactor provides energy using the alpha-decay of Plutonium-239:

$$^{239}Pu \rightarrow {}^{235}U + {}^{4}He$$

The mass of ^{239}Pu is 239.052156 u.
The mass of ^{235}U is 235.043923 u.
The mass of ^{4}He is 4.0020602 u.

A spacecraft is powered by a small nuclear reactor and is expected to have a lifetime of 32 years while consuming an average power of 560 Watts. How many kg of Plutonium is needed for the spacecraft?

4. (25 pts) Cobalt-60 has an atomic mass of about 60 amu and a half-life of 5.27 years. It is a common by-product of an atomic bomb. If a sample is contaminated with 3.4 grams of Cobalt-60, how long (in years) will it take for the radioactivity of the sample to drop below a threshold of 2.5×10^{-6} Ci)? Answer with 2 SF.