Phyx 135-3 (1 pm), Winter 2016 **Name** _____

1a) (7 points) A beam of electrons is directed at two slits which are 4 μm apart. On a fluorescent screen four meters away, they form an interference pattern where the center of the first side-fringe is 0.2 mm from the center of the central bright spot. What is the kinetic energy in eV of the electrons? (You may assume non-relativistic electrons. The electron mass is 9.11×10^{-31} kg.)

1b) (3 points) We *assumed* non-relativistic electrons for part 1a. Using your answer for part 1a, give a *brief* explanation for why this was or was not a good assumption.

2) A passenger aboard a spaceliner is furious that the ship's breakfast buffet has no onion bagels. The spaceliner happens to be close to Earth, so the crew asks an Earth deli to immediately send them an onion bagel by special courier.

2a) (4 points) If the spaceliner is moving towards the Earth at 0.8c and the special courier is moving away from the Earth at 0.85c (they are moving in straight lines towards each other), how fast is the special courier moving relative to the spaceliner?

2b) (6 points) The Earth deli decides that the energy needed to accelerate the onion bagel to a speed of 0.85c must be added to the bill for the spaceliner. Assuming a cost of 12 cents per kilowatt-hour for the electricity, how much will it cost the spaceliner to purchase a 30-g bagel? (One kw-hr = 3,600,000 J.)

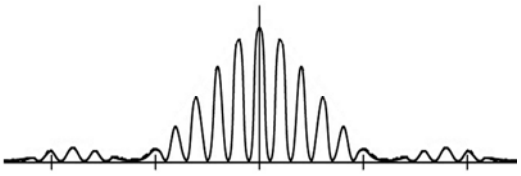
3) (3 points each) Four intensity patterns are shown at right. Match the correct pattern with the relevant description below.

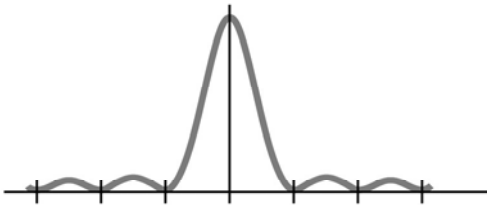
_____ I Light passing through a single narrow slit.

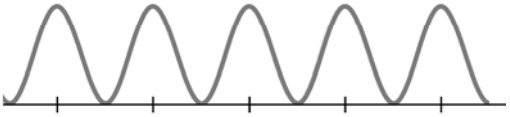
_____ II Light passing through a grating with 10 slits.

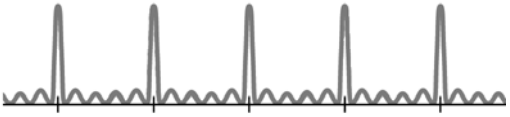
_____ III Two waves (light or sound) of equal frequency and amplitude radiating spherically from two point sources.

_____ IV Monochromatic light passing through two narrow slits set very close together.

A 

B 

C 

D 

4) (10 points) A relativistic radon atom is approaching the Earth at 0.90 c when it emits a γ-ray (towards the Earth) which has an energy of 186 keV in the rest frame of the radon. What is the energy of the γ-ray in the rest frame of the Earth?

5) I am shining three different lasers of three different colors onto a sheet of metal: a blue laser (λ = 420 nm), a green laser (λ = 532 nm), and a red laser (λ = 620 nm). I have noticed that electrons with a kinetic energy of 0.40 eV (only that energy) are being emitted by the metal.

5a) (3 points) Which color of laser is producing the observed electrons? _____

5b) (7 points) What is the work function (in eV) of this particular metal?

6) (8 points) Suppose you have a quantum system with the following wave function:

$\psi(x) = (1.427)\, e^{-x}$ for $0 \leq x \leq 2$,

and $\psi = 0$ everywhere else.

What is the probability that you will find this particle somewhere between x = 0 and x = 1?