Time of completion _____ Cadet _____ Section_____
5 October 2004 Version 2

DEPARTMENT OF PHYSICS
PH203, Physics I
Written Partial Review I

1. Instructions:

   a. Bring only your hand-held calculator, a straight-edge, and pencil(s) into the examination room.

   b. Check your exam for five problems and two bonus problems on nine pages. Write your name and section at the top of each page. Check for the Physics Reference Card provided with the exam.

   c. For calculation problems, **show all work**; partial credit may be given for correct work shown.

   d. Take up to 55 minutes to complete the examination. If you leave early, record your time of completion above.

   e. Bonus problems are optional.

2. An instructor is in the hall.

3. Grading summary (**for instructor use only**):

PROBLEM	WEIGHT	SCORE
1	85	
2	35	
3	70	
4	65	
5	95	
SUBTOTAL	350	
BONUS	20	
TOTAL	350	

_____%

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85 1. One of the primary fusion reactions in a fusion bomb involves deuterium (^{2}H):

$$^2\text{H} + {}^2\text{H} \rightarrow {}^3\text{He} + \text{n}.$$

(50) a. The atomic mass of ^{2}H is 2.014102 u, and the atomic mass of ^{3}He is 3.016029 u. Calculate the energy released by this reaction.

$Q = 3.2695\text{MeV}$

(35) b. A particular bomb design uses 207 kg of deuterium. Calculate the total energy released assuming that 72.6% of the deuterium atoms undergo fusion according to the reaction above.

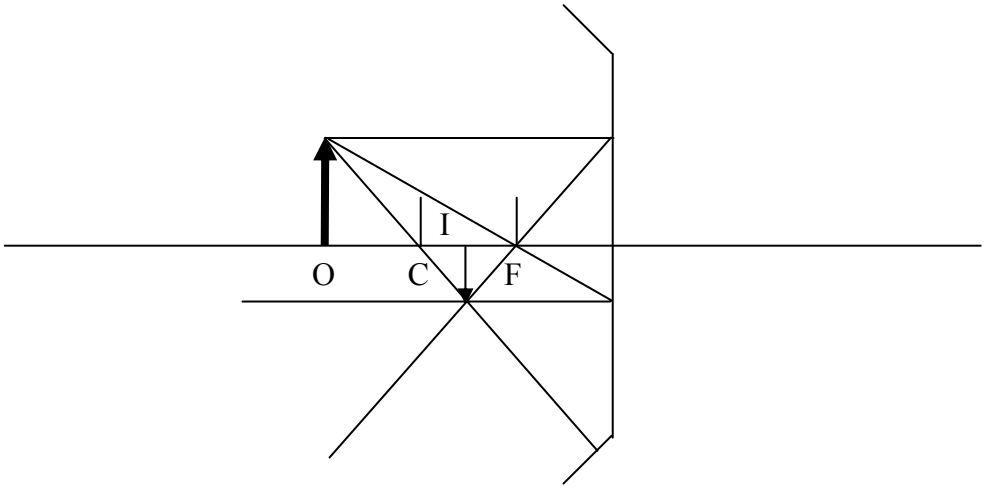
$E_T = 7.35 \times 10^{28}\,\text{MeV}$

35 2. During your AIAD at Lawrence Livermore National Laboratory, you employ a fiber optic cable to transmit laser light across your lab room. The fiber optic cable is composed of two concentric materials. The light travels in the inner material, which has an index of refraction of 2.31. The outer material has an index of refraction of 1.26. Calculate the minimum angle of incidence at which all of the laser light is reflected back into the inner material.

$$\theta_c = 33.1°$$

70 3. Physics Man is building a telescope that uses a large spherical mirror to create an image. He finds what appears to be a suitable mirror while searching through some old demonstration equipment in Bartlett Hall, but he must measure the mirror's focal length. He creates an image with a height that is 0.312 times the object height when the object is placed 194 cm from the mirror.

(20) a. Construct a three-ray diagram to graphically locate the image formed by the mirror. Draw real rays as solid lines and virtual rays as dashed lines. The focal point for the mirror is labeled "F," and the center of curvature "C." **Is the image real or is it virtual? Circle the correct answer.**



(50) c. Calculate the focal length of the mirror.

$f = 46.1\text{cm}$

65 4. While deployed to Iraq, one of your soldiers decides to make a banjo out of some pieces of wood. The only thing he can find for the strings are some pieces of commo wire. The commo wire is 805 m long with a mass of 12.7 kg.

(45) a. Calculate the tension required for a 0.785-m long piece of this wire to play an A note, which has a frequency of 1760 Hz and a wavelength of 0.0872 m.

$$\tau = 372\text{N}$$

(20) b. Calculate the number of nodes on this length of wire while playing an A note.

$$n + 1 = 19$$

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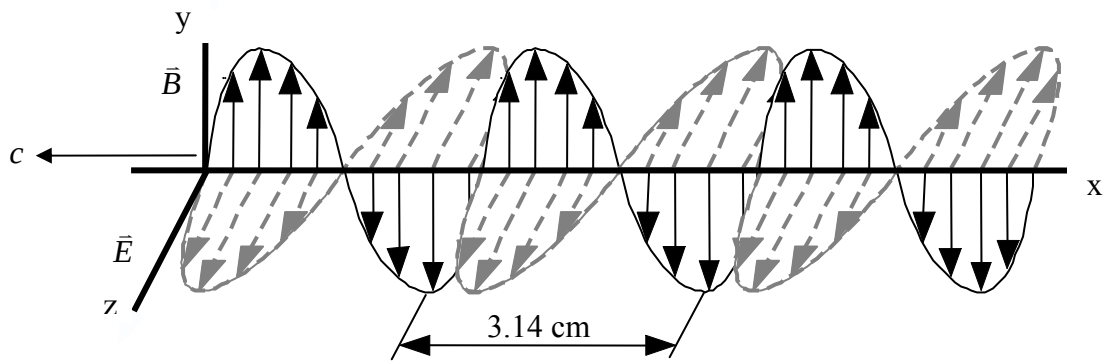
95 5. An electromagnetic wave is graphically depicted below at time $t = T/4$, where T is the period. The wave is polarized parallel to the z axis and propagates in vacuum. The amplitude of the electric field is 14.9 V/m.



(5) a. Label the axis indicating the direction of oscillation of the electric field.
see above

(5) b. Label the axis indicating the direction of oscillation of the magnetic field.
see above

(5) c. Indicate the direction of propagation of the electromagnetic wave.
see above

(55) d. Write the function describing the electric field of the EM wave.
Calculate all constant values.

$$\vec{E} = \left(14.9\,\frac{\text{V}}{\text{m}}\right)\sin\left(\pm 200.\,\frac{\text{rad}}{\text{m}}\,x \pm 6.00\times10^{12}\,\frac{\text{rad}}{\text{s}}\,t - \frac{\pi}{2}\right)\hat{k}$$

(25) e. Write the function describing the magnetic field of the EM wave. Calculate all constant values.

$$\vec{B} = 4.97\times10^{-8}\,\mathrm{T}\sin\left(\pm 200.\frac{\mathrm{rad}}{\mathrm{m}}x \pm 6.00\times10^{12}\,\frac{\mathrm{rad}}{\mathrm{s}}t - \frac{\pi}{2}\right)\hat{j}$$

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10 BONUS1 In problem 1 of this test, the uncertainty in the mass of deuterium is 2 kg, the uncertainty in the percentage fissioning is 0.3%, and the uncertainty in the mass of a neutron is 1×10^{-6} u. Assume that you calculated 122×10^{16} J for the answer to part b.

(5) a. Using the least precise relative uncertainty, calculate the absolute uncertainty associated with the total energy released in part b.

$$\delta E = 1.1 \times 10^{16}\,\text{J}$$

(5) b. Report the total energy released as a confidence interval.

$$(122 \pm 1) \times 10^{16}\,\text{J}$$

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10 BONUS2 A converging lens, with its focal points 10.0 cm from the lens, is located 45.0 cm to the left of a diverging lens with its focal points 15.0 cm from the lens. An object is located 20.0 cm to the left of the system.

a. Calculate the location of the image as viewed from the right side of the system.

final image is 9.38cm left of the diverging lens

b. Calculate the magnification of the image.

$m = -0.3752$