Time of completion _____ Cadet _____ Section_____
4 October 2003 Version 1

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 seven 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 will 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	90	
2	90	
3	50	
4	70	
5	50	
SUBTOTAL	350	
BONUS	20	
TOTAL	350	

_____%

Wt. No. Cadet_____

90 1. Castle Bravo was the largest thermonuclear device that was tested in the atmosphere by the United States. The fusion fuel used in the test was lithium deuteride, with the lithium enriched to 40% ^{6}Li. The first stage of the nuclear fusion process is the fissioning of this fuel in the reaction, $^6\text{Li} + \text{n} \rightarrow {}^3\text{H} + \alpha$. Atomic masses of the reactants are:

^{6}Li:	6.01512 u
n:	1.00866 u
α:	4.00260 u
^{3}H:	3.01605 u

(80) a. Calculate the disintegration energy of this fission reaction.

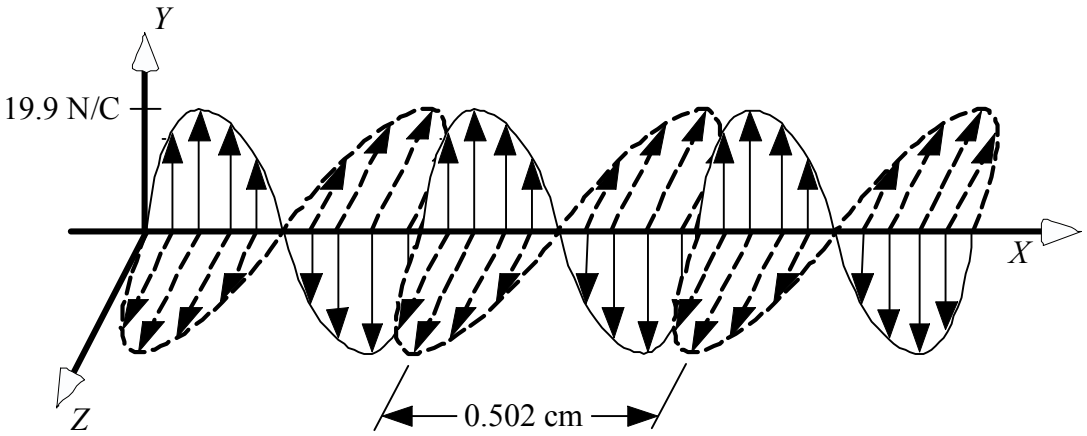
$Q = \underline{\underline{4.78\ \text{MeV}}}_{\text{ANS}}$

(10) b. Circle one statement from each column that best describes α radiation, its ability to penetrate tissue, and its biological effect.

Description	*Ability to Penetrate Tissue*	*Biological Effect*
Photon	Penetrate a few microns	Indirectly ionize living tissue
Electron	Penetrate a few centimeters	May appear as a "sunburn" on the skin
Helium nucleus	Can pass through the body	Very dangerous internal hazard

Wt. No. Cadet_____

90 2. An electromagnetic wave from a high-power microwave weapon system is propagating in free space. At one instant, the electric and magnetic field components are as shown below.



(10) a. Determine the direction of propagation of the wave. Justify your response.

positive x-direction ANS

(20) b. Calculate the magnitude of the magnetic field component of the high-power microwave.

$B_m = 6.64x10^{-8}$ T ANS

2. (cont'd)

(60) c. Write the function that describes the electric field component of the high-power microwave. Calculate all the constants in the function.

$$E = (19.9\ \text{N/C})\sin\left[(1{,}250\ \text{rad/m})x - (3.75x10^{11}\ \text{rad/s})\,t\right]$$ ANS

Wt. No. Cadet_____

50 3. While conducting a clandestine amphibious insertion you spot an enemy mine floating under the surface of the water. In order to alert your soldiers to the danger, you illuminate the mine with your laser designator. To do this you point your laser designator toward the water at an angle of 22.6 degrees above the horizontal surface of the water.

(30) a. Calculate the angle of refraction of your laser beam. The water has an index of refraction of 1.33.

$\theta_2 = \underline{\underline{44.0^o}}_{\text{ANS}}$

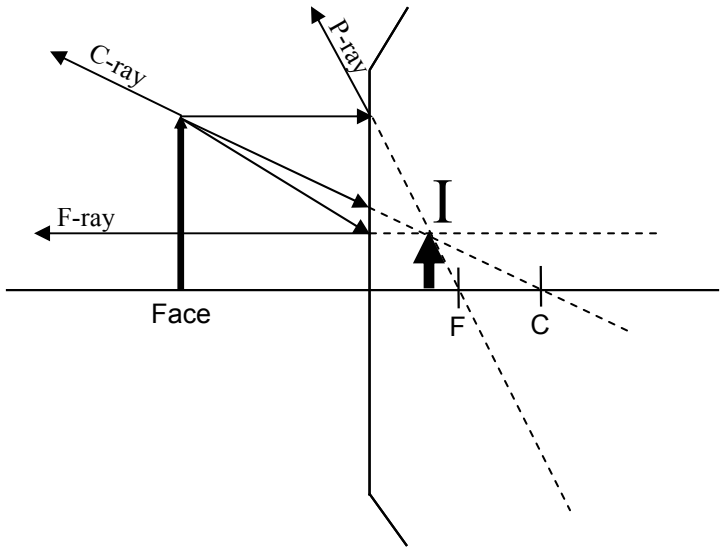
(20) b. Calculate the angle of incidence at which the laser light reflected from the water would be fully polarized.

$\theta_B = \underline{\underline{53.1^o}}_{\text{ANS}}$

Wt. No. Cadet_____

70 4. While inspecting a plebe in your squad, you note the image of your smiling face as you look into the plebe's breast plate.

(20) a. Construct a three-ray diagram, assuming the breast plate is spherically shaped, to locate the image. Draw and label the image on your three-ray diagram.



(25) b. Your face is 25.0 cm from the breast plate, and the breast plate has a radius of curvature of 21.1 cm. Calculate the image distance.

$i = \underline{\underline{-7.42\ \text{cm}}}_{\text{ANS}}$

(25) c. Your face is 22.5 cm high. Calculate the height of the image.

$h' = \underline{\underline{6.68\ \text{cm}}}_{\text{ANS}}$

Wt. No. Cadet_____

50 5. While flying a reconnaissance mission in your OH-58D(I) Kiowa Warrior you spot a thin film of oil on top of the water over which you are flying. The thin film is 401 nm thick with an index of refraction of 1.51 and is illuminated by white light (λ = 400-700 nm) at near normal incidence. Assume the index of refraction of the water is 1.33.

(10) a. Determine the phase difference, **in wavelengths**, due to reflection, between rays of light reflected from the top and bottom of the oil layer.

$$\Delta\phi = \frac{1}{2}\lambda' s$$
ANS

(40) b. Calculate the visible wavelength that will be most strongly reflected.

$$\lambda = 4.84x10^{-7}\ \text{m}$$
ANS

Wt. No. Cadet_____

10 BONUS A typical SR-71 Blackbird reconnaissance mission includes 8.53 hours of flying time at an altitude of 22.4 km. The dose equivalent rate from the natural galactic and solar cosmic radiation (with a RBE factor of 0.815) is equal to 11.4 μSv/hr. Calculate the energy, in joules, absorbed by the 74.8 kg pilot. Assume the total mass of the pilot is exposed to the radiation.

$E = 8.92x10^{-3}$ J
ANS

10 BONUS List and explain the four conditions that must be satisfied in order for a fission bomb to function.

1. A source of neutrons has to exist in the bomb to trigger an explosion.
2. The nuclei making up the bomb has to be fissionable, that is they have to fission when hit by a neutron.
3. Each induced fission has to produce more neutrons than it consumes.
4. The bomb has to use the released neutrons efficiently so that each fission induces an average of more than one subsequent fission.

ANS