Time of completion _____ Cadet _____ Section_____
16 November 2004 Version 2

DEPARTMENT OF PHYSICS
PH203, Physics I
Written Partial Review II

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 three bonus problems on eight 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**):

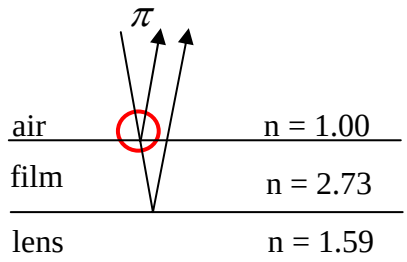
PROBLEM	WEIGHT	SCORE
1	65	
2	85	
3	95	
4	75	
5	30	
SUBTOTAL	350	
BONUS	20	
TOTAL	350	

_____%

Wt. No. Cadet_____

65 1. A night vision device lens has a thin film coating of titanium dioxide on the front to maximize the reflection of infrared light with a wavelength of 1.02 mm. The index of refraction of the lens is 1.59, and the index of refraction of the titanium dioxide is 2.73.

(20) a. Construct a diagram and indicate where phase shifts due to reflection occur in the reflected light.



(45) b. Calculate the minimum film thickness that will maximize reflection.

Ans: $L = 9.34 \times 10^{-5}\,\text{m}$

Wt. No. Cadet_____

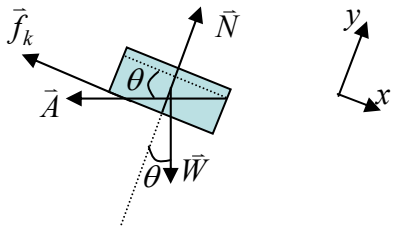
85 2. A 60-mm mortar section is attempting to engage a terrorist group in Fallujah, Iraq. The enemy is located 2.83 km away at an altitude 38.9 m below the muzzle of the mortar. The mortar crew fires the gun at 52.1° above the horizontal. Calculate the velocity required to hit the target, and report that velocity in unit vector notation.

Ans: $\vec{v}_0 = (103\text{m/s})\hat{i} + (133\text{m/s})\hat{j}$

Wt. No. Cadet_____

95 3. You are using a ramp to slide a 90.9-kg crate of TA-50 off of a 5-ton truck in a logistics base in Iraq. In order to slow the crate's descent, you have a soldier stand in front of the crate and apply a constant horizontal force to the crate. The ramp is 31.8° above the horizontal. The coefficient of kinetic friction between the crate and the ramp is 0.493.

(30) a. Construct a free body diagram of the crate on the ramp.



(65) b. Calculate the magnitude of the force that the soldier must apply to let the crate descend at a constant speed.

Ans: $A = 86.7\text{N}$

75 4. A contractor is investigating the ability of magnets to hold a hockey puck-shaped experimental antenna on the turret of a tank. The coefficient of static friction between the magnetized antenna and the turret is 0.756, and the antenna is placed on a horizontal surface of the turret 0.688 m from the axis of rotation. The magnetic force on the antenna is 226 N vertically downward, and the antenna has a mass of 2.33 kg. Calculate the maximum speed at which the antenna can move about the axis of rotation without falling off of the turret.

Ans: $v = 7.45\text{m/s}$

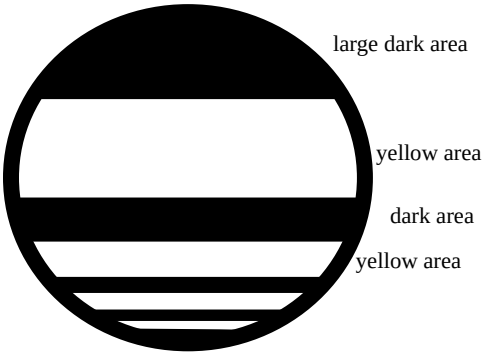
Wt. No. Cadet_____

30 5. Circle the best answer in the following multiple choice questions.

(10) a. The reason there are two slits, rather than one, in a Young's double-slit interference experiment is:

A. to increase the intensity.
B. one slit is for frequency, the other for wavelength.
C. to create a path length difference.
D. one slit is for $\vec{E}$ fields, the other is for $\vec{B}$ fields.
E. so that the small angle approximation holds.

(10) b. Yellow light is viewed by reflection from a thin vertical soap film. Let λ_n be the wavelength of the light in the thin film. Why is there a large dark space at the top of the film?



A. No light is transmitted through this part of the film.
B. The film thickness there is $\lambda_n / 4$.
C. The film there is negligibly thin.
D. The film is too thick in this region for thin film formulas to apply.
E. The reflected light is in the infrared.

(10) c. A visible laser beam is directed onto a spherical pinhead that has approximately the same diameter as the laser beam. A screen is placed on the opposite side of the pinhead from the laser. The light intensity pattern on the screen is best described as:

A. a dark disk
B. a dark disk with bright rings outside of it
C. a dark disk with a bright spot at its center
D. a dark disk with a bright spot at its center and bright rings outside of it
E. a bright disk with bright rings outside of it

Wt. No. Cadet_____

10 BONUS 1 Calculate the period squared, T^2, of the orbit of a satellite using the law of periods (given below). Report the period squared as a confidence interval.

$$T^2 = \frac{4\pi^2 r^3}{G m_E}$$

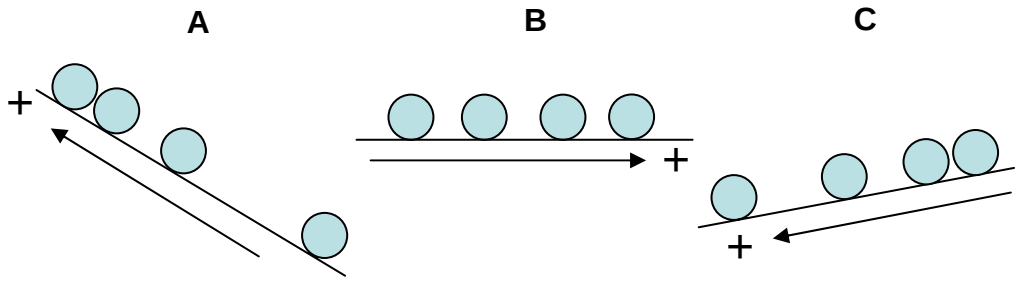
Use the following values:

Orbital radius	(6.41±0.07) x10^6 m
Universal gravitational constant	(6.6726±0.0003) x10^{-11} N·m^2/kg^2
Mass of the Earth	(5.98±0.06) x 10^{24} kg

Ans: $(T^2 \pm \delta T^2) = (2.61 \pm 0.09) \times 10^7 \text{ s}^2$

5 BONUS 2 The following drawings indicate the time sequenced motion of a ball that is acted on by one or more forces. The ball is moving from left to right in each case. Each circle represents the position of the ball at the end of equal intervals of time (stroboscopic picture). A dashed line with an arrowhead on the end indicates the positive direction of the coordinate system for that drawing. Note: Zero is greater than negative, and ties are possible.

Rank each case from the highest to the lowest velocity based on the ball's last velocity.

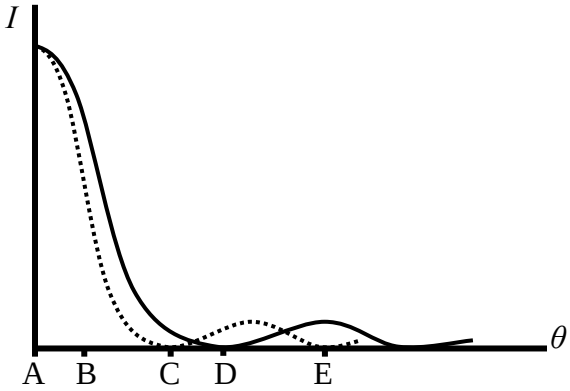


Highest 1___C____ 2___B____ 3___A____ Lowest

Or, all have the same velocity. _____

Wt. No. Cadet_____

5 BONUS 3 Two wavelengths, 800 nm and 600 nm, are used separately in single-slit diffraction experiments. The diagram shows the intensities on a far-away viewing screen as a function of the angle made by the rays with a central axis through the slit. If both wavelengths are then used simultaneously, at which angle is the light on the screen purely 600-nm light?



A.
B.
C.
D.
E.