Time of completion __________ Cadet ________________________ Section________
15 November 2003 Version 1

DEPARTMENT OF PHYSICS
PH203, Physics I
Written Partial Review II

1. Instructions:

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

   b. Check your exam for four problems and one bonus problem 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 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	75	
2	100	
3	100	
4	75	
SUBTOTAL	350	
BONUS	20	
TOTAL	350	

________%

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75 1. As your platoon reaches the crest of a sand dune, you spot two enemy T-72 tanks 7740 m away, through your binoculars, that were recently engaged by friendly forces. The tanks, glowing bright orange (wavelength of 612 nm) from the emitted radiation, are separated by a distance of 3.31 m.

(60) a. Calculate the minimum diameter of the circular aperture of your binoculars, if the two tanks are to be distinguishable.

$d = \underline{\underline{0.00175\text{ m}}}_{\text{ANS}}$

(15) b. Suppose two observers viewed the tanks independently. One looks through a circular aperture with the diameter you calculated in part a. The other looks through a single slit of width equal to the diameter calculated in part a. Can one observer resolve the tanks more clearly than the other? If so, which one? Justify your response.

$\underline{\underline{\text{yes}}}_{\text{ANS}}$

$$\theta_R = 1.22\frac{\lambda}{d} \quad (1)$$

$$\underline{\underline{a \sin\theta = m\lambda \quad (2)}}_{\text{ANS}}$$

assume small angle approximation for eq (2), and solve for θ

$$\theta = \frac{m\lambda}{a}$$

Rayleigh's criterion for resolvability occurs when m=1

$$\theta_R = \frac{\lambda}{a} \quad (3)$$

θ_R is smaller using eq (3) as compared to eq (1), which means that the ability to resolve two objects improves if the circular aperture was replaced by a single-slit of equal width.

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100 2. Cadet Anthony Zurisko, ace field goal kicker on the Army team, is brought into the game against Navy with two seconds left in the 4th quarter. Army is behind by two points and the holder spots the ball exactly 50.2 m from the goal posts. Cadet Zurisko kicks the football with an initial velocity of 23.5 m/s at an angle of 53.7° above the horizontal. Assume that the football travels directly toward the goal posts and neglect air resistance.

(20) a. Calculate the horizontal and vertical components of the initial velocity.

$v_{xo} = \underline{\underline{13.9 \text{ m/s}}}_{\text{ANS}}$

$v_{yo} = \underline{\underline{18.9 \text{ m/s}}}_{\text{ANS}}$

(50) b. The crossbar of the goal posts is 2.99 m above the ground. Calculate whether the football clears the cross bar.

$h = \underline{\underline{4.54 \text{ m}}}_{\text{ANS}} \longrightarrow$ yes, it clears the cross bar

2. (cont'd)

(30) c. Calculate the velocity of the football 2.39 s after it is kicked. Report your result using the magnitude and direction notation.

$|\vec{v}| = \underline{\underline{14.6 \text{ m/s}}}_{\text{ANS}}$

$\theta = -\underline{\underline{17.9^o \text{ with respect to the } \hat{i} \text{ direction}}}_{\text{ANS}}$

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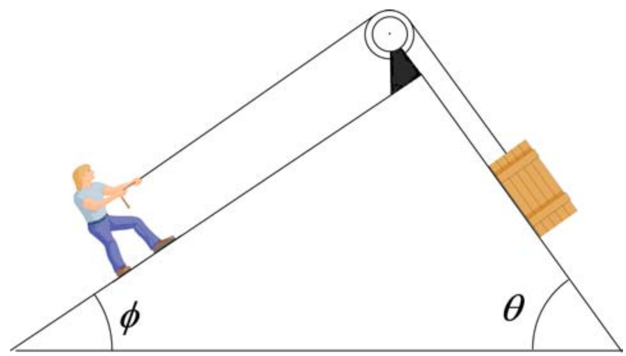
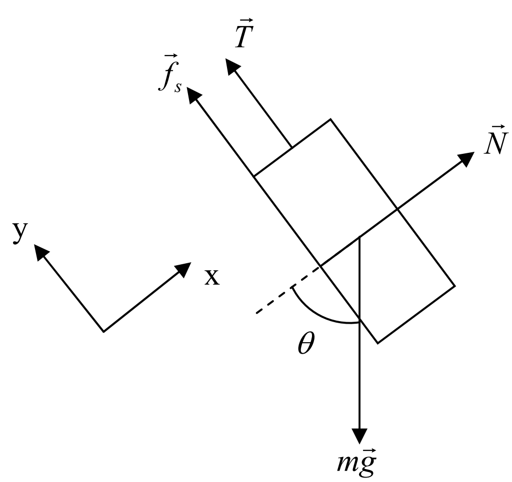
100 3. An off duty soldier is involved in a strong-man competition. In one of the events, depicted below, the soldier is required to prevent the crate from sliding as long as possible. The soldier and the crate are connected with an ideal cord that passes over an ideal pulley. The soldier has a mass of 118 kg and the crate has a mass of 237 kg. The angle $\phi = 30.2^{o}$ and $\theta = 59.8^{o}$. The coefficient of static friction between the crate and the incline is 0.385.



(20) a. Using only the information provided above, the force of static friction acting on the crate (circle all that are correct)

1. could be directed down the plane.
2. could be directed up the plane.
3. could be larger than the weight of the crate.
4. has a maximum magnitude less than the magnitude of the kinetic friction force would be if the crate were sliding up the ramp.

(20) b. Draw a free-body diagram of the external forces acting on the crate. Assume the soldier is providing the minimum amount of force to keep the crate from sliding down the incline.



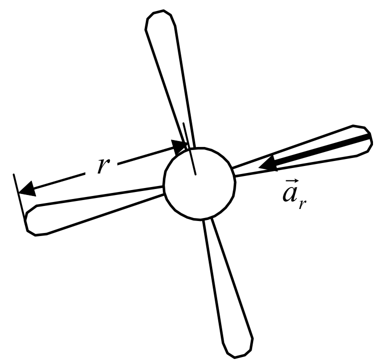
3. (cont'd)

(60) c. Calculate the minimum force the soldier must exert on the rope to keep the crate from sliding down the incline.

$T = \underline{\underline{1560\ \text{N}}}_{\text{ANS}}$

75 4. The tips (outer edges) of the propeller blades of the P-51 Mustang rotating at a constant speed take 0.0713 s to complete one revolution. This corresponds to a centripetal acceleration of 11,800 m/s^2.

(15) a. In the figure below draw and label the direction of the centripetal acceleration vector at the outer edge of one of the propeller blades.



(60) b. Calculate the length of one of the propeller blades, r.

$r = \underline{\underline{1.52\ \text{m}}}_{\text{ANS}}$

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20	BONUS	A rocket with mass 3.52×10^3 kg is fired from rest at an angle of 60.3° above the horizontal. The motor creates a force (thrust) on the rocket of 6.14×10^4 N at a constant angle of 60.3° to the horizontal for 49.2 s and then cuts out. Neglect the mass of fuel consumed, and neglect air resistance. Assume that the acceleration due to gravity remains constant throughout the rocket's flight.
(10)		a. Calculate the altitude of the rocket when the motor cuts out.

$H = \underline{\underline{6480\ \text{m}}}_{\text{ANS}}$

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BONUS (cont'd)

(10) b. Calculate the total horizontal distance from the firing point to the impact point with the ground. Assume the impact point and the firing point are along the same horizontal plane.

$R = \underline{\underline{41.1\,\text{km}}}_{\text{ANS}}$