UNIVERSITY OF BOTSWANA
Department of Physics

PHY111 2006/2007 END OF SEMESTER 1 EXAMINATIONS Nov. 2006

SHORT QUESTIONS WORKSHEETS (SECTION A)
(please fill in your particulars in the spaces provided)

Name:_____
(Last/Family name) (First/Other names)

ID No.:_____ **Tutorial Group:**_____

QUESTION	For Students: Questions attempted	For Staff use only MARKS	For Staff use only SECTION MARKS
SECTION A			
B1			
B2			
B3			
B4			
B5			
		TOTAL	

SECTION A

A1. A ray of light travelling in a material A strikes the interface between materials A and B at an angle 40.5°. If the angle of refraction in material B is 60.0°, find the ratio $\frac{\eta_A}{\eta_B}$ of the refractive indices of the two materials and hence, determine the speed of light in material B given that the speed of light in material A is 2.13×10^8 m s^{-1}.

A2. An object of height 0.03 m is placed in front of a converging mirror at a distance twice the mirror's radius of curvature. Calculate the size of the image produced after reflection from the mirror. Is the image real or virtual?

A3. For a certain system, the period T of rotation of a cylinder of radius R is given by

$$T = f(R, g) = kR^a g^b$$

where g is the acceleration due to gravity and k is some dimensionless constant. Using the method of dimensional analysis, determine the formula for T.

A4. Determine the centripetal force acting on a spaceship of mass 1000kg moving in a circular orbit around the earth with a constant speed of 7.562 km s^{-1} at an altitude of 600 km above the surface of the earth.

A5. A transverse wave on a string is given by: $y = 0.1 \sin [2\pi(0.01 x - 100 t)]$, where y and x are in meters, and t is in seconds. Determine the amplitude, wavelength, frequency, time-period, and speed of the wave.

UNIVERSITY OF BOTSWANA

2006/2007 END OF SEMESTER 1 EXAMINATIONS

FRONT PAGE

COURSE No.: **PHY111** DURATION: **2** HRS. DATE: **Nov. 2006**

TITLE OF PAPER: **GEOMETRICAL OPTICS, MECHANICS, VIBRATIONS AND WAVES**

SUBJECT: **PHYSICS** TITLE OF EXAMINATION: **BSc./BEd. Level 100**

INSTRUCTIONS:

SECTION A: Answer ALL (FIVE) short questions of Section A within the space provided on the worksheets. At the end of the examination, hand in the Section A worksheets (pages 6 to 9) along with your answer script. Each Section A question carries 5 marks.

SECTION B: Answer ANY THREE (3) questions from section B.
Each question carries 25 marks.

Wherever necessary use the following:

Speed of light in vacuum, $c = 3.0 \times 10^8$ m s^{-1}
Magnitude of acceleration due to gravity, $g = 9.8$ m s^{-2}
Radius of the earth, $R_E = 6.378 \times 10^6$ m

If $x = \sin at$, $\dfrac{dx}{dt} = a\cos at$

If $x = \cos at$, $\dfrac{dx}{dt} = -a\sin at$

No. of Pages

DO NOT OPEN THIS PAPER UNTIL YOU HAVE BEEN TOLD TO DO SO BY THE SUPERVISOR

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SECTION B

Answer any **THREE (3)** questions out of five from this Section

B1. (a) A converging lens of focal length 12.0 cm is located 30.0 cm to the left of a diverging lens of focal length 6.0 cm. A postage stamp is placed 36.0 cm to the left of the converging lens.

(i) Find the final image position of the stamp relative to the diverging lens. **[8 marks]**

(ii) State with reason, the nature of the final image, i.e. is it real or virtual? **[2 marks]**

(iii) Find the overall magnification of the stamp. **[2 marks]**

(b) A ray of light from air is incident on one face of an equiangular glass prism of refractive index 1.5 at an angle of incidence of 30^0.

(i) Draw a labelled diagram to show how the ray would be refracted through the prism, clearly showing the angle of deviation and all angles used in calculating the angle of deviation. **[5 marks]**

(ii) Calculate the angle of deviation of the ray after refraction through the prism. **[8 marks]**

B2. (a) Vectors $\vec{F}$, $\vec{V}$, $\vec{B}$ and $\vec{D}$ are given by $\vec{F} = 4\hat{i} - 20\hat{j} + 12\hat{k}$, $\vec{V} = 2\hat{i} + 4\hat{j} + 6\hat{k}$, $\vec{B} = a\hat{i} + a\hat{j} + c\hat{k}$ and $\vec{D} = -5\hat{i} + \hat{j} + 4\hat{k}$.

(i) Given that $\vec{F}$ is force (in Newtons) and $\vec{D}$ is the displacement (in metres) of the particle resulting from the force, express work done in terms of $\vec{F}$ and $\vec{D}$ and hence determine the work done. **[4 marks]**

(ii) Given that q = 2, $\vec{F} = q\vec{V} \times \vec{B}$, Determine the vector $\vec{B}$, and hence calculate the magnitude of $\vec{B}$. **[13 marks]**

(b) A section of a road has a curve of radius 100 m.

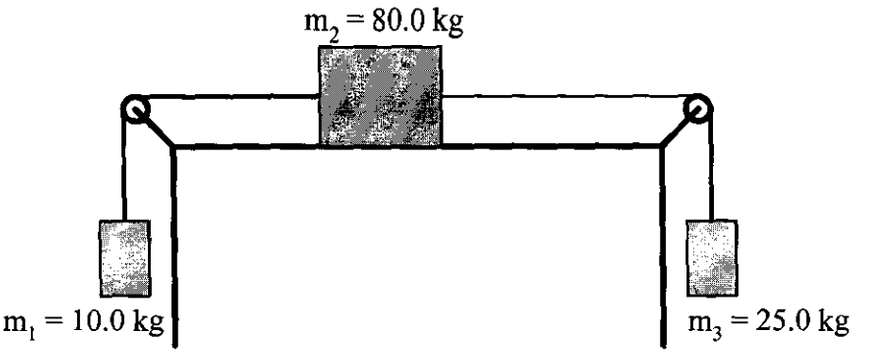
(i) Determine the maximum speed, in km h^{-1}, with which the car will be able to negotiate the curve without skidding if the road is flat and the coefficient of friction between the tyres and the road surface is 0.6. **[5 marks]**

(ii) Determine the banking angle needed to allow the car to negotiate the curve at the speed found in (i) without relying on friction. **[3 marks]**

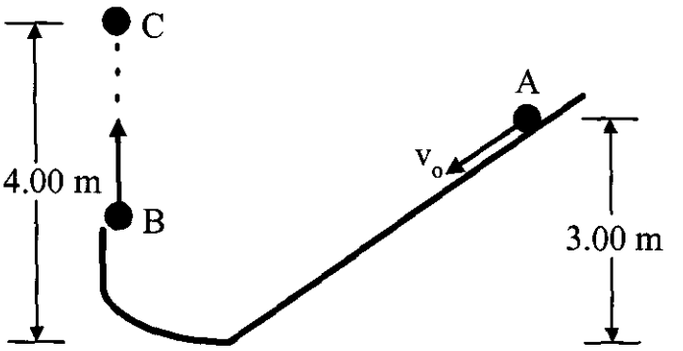
B3. (a) The drawing below shows three objects connected by strings that pass over massless and friction-free pulleys. The coefficient of kinetic friction between the 80 kg block and the surface is 0.1, and the objects move in the clockwise direction. Calculate

(i) the acceleration of the objects. **[11 marks]**

(ii) the tension in each of the two strings. **[4 marks]**



(b) A particle, starting from point A in the drawing below, is projected with velocity v_o down the curved runway. Upon leaving the runway at point B, the particle is traveling straight upward and reaches point C a height of 4.00 m above the floor before falling back down. Ignoring friction and air resistance, determine v_o. **[5 marks]**



(c) The cheetah is one of the fastest accelerating animals, because it can go from rest to 27 m s^{-1} in 4.0 s. If its mass is 110 kg, determine the average power, in watts, developed by the cheetah during the acceleration phase of its motion. **[5 marks]**

B4. (a) A speedboat starts from rest and accelerates at +2.01 m s^{-2} for 7.00 s. At the end of this time, the boat continues for an additional 6.00 s with an acceleration of +0.518 m s^{-2}. Following this, the boat accelerates at -1.49 m s^{-2} for 8.00 s.

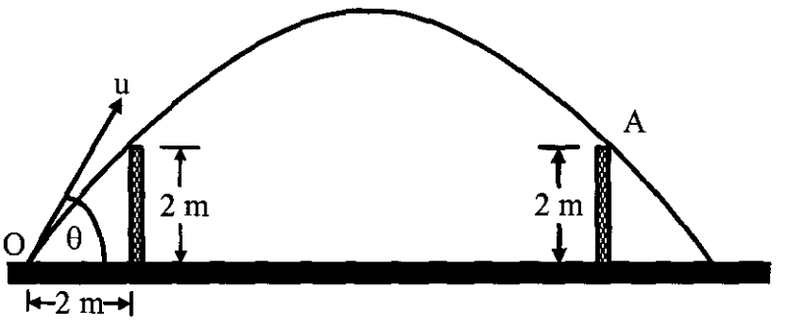
(i) What is the velocity of the boat at t = 21.0 s? **[5 marks]**

(ii) Determine the total displacement of the boat, assuming it moves in a straight line from start to end. **[5 marks]**

(b) The diagram below shows a particle projected with initial speed u from a point O at ground level, at an angle of 55° above the horizontal. It just clears the top of each of two walls that are 2 m high. The first of the two walls is 2 m from O. Determine;

(i) the speed of projection **[8 marks]**

(ii) the distance of the second wall from O **[7 marks]**



B5. (a) Draw a labeled sketch of a freely suspended simple pendulum comprising a point mass m, and a light inextensible string of length l, and displaced by a small angle θ from its equilibrium position. On the diagram show all the forces acting on the mass, and their appropriate components. **[5 marks]**

(b) Derive the equation of motion of the simple pendulum for small oscillations and express it in the following form:

$$\frac{d^2s}{dt^2} + \omega^2 s = 0$$

Where s is the displacement of the pendulum from equilibrium position, and ω is the angular frequency of the pendulum. Write down the expression for the time period of the pendulum directly from the equation of motion. **[10 marks]**

(c) By substitution in the equation of motion, prove that $s = s_o \sin(\omega t + \phi)$ is a solution for the displacement of the simple pendulum as a function of time. Write down another possible solution for the displacement. **[10 marks]**

END OF SECTION B

MAKE SURE YOU

(i) Fill-in all your details on the answer script and on the Section A cover sheet.
(ii) Submit Section A worksheets along with your answer script (i.e. pages 6 to 9).