KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2010/2011

INSTITUTIONAL BASED PROGRAMME (IBP) DECEMBER SESSION

EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE AND BACHELOR OF EDUCATION

SPH 100: MECHANICS I

DATE: FRIDAY, 29TH April 2011 **TIME: 8.00 A.M. – 10.00 A.M.**

INSTRUCTIONS:

1. Answer question one and any other two questions
2. Where necessary take acceleration due to gravity $g = 9.8\ ms^{-2}$

Q1. a) Give the SI units and dimensions of the following physical quantities:
i) Momentum [2marks]
ii) Power [2marks]

b) The period T of a simple pendulum is measured in time units and is given by

$$T = 2\pi\sqrt{\frac{l}{g}}$$

where l is in length of the pendulum and g is the acceleration due to gravity. Show that this equation is dimensionally consistent. [4marks]

c) i) Clearly define instantaneous velocity and instantaneous acceleration [4marks]
ii) The position of a ball tossed vertically upwards is described by the equation

$$y = 7\,t - 4.9\,t^2$$

where y is in meters and t is the time in seconds. Find
1) the initial speed v_o at $t = 0$ [2marks]
2) the velocity at $t = 2$ s [2marks]
3) the acceleration of the ball [2marks]

d) What kind of equilibria are the following ?
i) A simple pendulum bob at its mean position. [1mark]
ii) A stick held vertically on the fingertip by a juggler. [1mark]

e) Cite two examples in which you might think you are doing work but from the point of view of physics you are not doing so. [2 marks]

f) A projectile is launched with an initial velocity V_o at an angle θ with respect to the horizontal. Show that the range R of the projectile is given by

$$R = \frac{V^2{}_o \sin 2\theta}{g}$$

where g is the acceleration due to gravity [5marks]

g) If 8.0J of work must be done to stretch a spring 5.0cm beyond its unstretched length, how much work must be done to stretch the same spring 10.0 cm from its unstretched length? [3marks]

Q2. a) A car of mass 10^3 kg traveling at 20m/s on a horizontal road is brought to rest in a distance of 40m by the action of the brakes. Find

i) The deceleration [2 marks]
ii) The stopping force [2 marks]
iii) The time it takes to come to rest [2 marks]
iv) The work done by that force on the car [2 marks]
v) Show that the work done on the car is equal to the change in its kinetic energy [3 marks]

b) A body of mass m located at position x along a line has potential energy by

$U(x) = b(x^2-a^2)^2$

i) What are the units of a and b ? [2marks]
ii) Derive an expression for the force acting on the body [4marks]
iii) At what values of x is the force zero ? [3marks]

Q3. a) At the sharp corners or bends of the roads, banking is required.

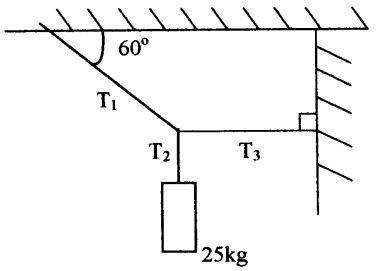
i) Using a diagram explain how the banking helps, to justify you answer [2 marks]
ii) For a block of mass 30 kg on a circular track of radius 10m moving with a speed of 5m/s, what should be the banking angle? [3 marks]

b) A 100 kg wooden crate is at rest on a level store floor. If the coefficients of static friction and kinetic friction are $\mu_s = 0.5$ and $\mu_k = 0.4$ respectively, what is

i) minimum horizontal force needed to start the crate moving ? [2marks]
ii) minimum horizontal force needed to keep the crate motion at constant speed ? [2marks]
iii) What will happen if a horizontal force of 500 N is applied to the crate ? [2marks]

b) i) State the condition for static equilibrium [1mark]

ii) A block of mass 25kg hangs in equilibrium from three cords as shown in figure 5.1. Neglecting the weights of the cords find the tensions T_1, T_2 and T_3 [7marks]



Q4. a). i) State the law of conservation of linear momentum [2 marks]

ii) Show that the law of conservation of momentum is a special case of the Newton's second law, explain your steps clearly. [3 marks]

b) . i) Differentiate between elastic and inelastic collusions [3 marks]

ii) Two ball A and B are involved in a collusion. If B is initially at rest while A was initially moving to the right when it collides with B then both stick and move off with a velocity of 2m/s to the right. Calculate the initial speed of A if its mass is half the mass of B. [4 marks]

c) i) Name two types of error encountered in measurements and give one example of the possible causes of each. [4 marks]

i) If the measured values of certain quantities with absolute error in each are recorded as $A \pm \in_a$ and $B \pm \in_b$ what would be the error in A – B? Justify your answer. [4 marks]

Q5. a) State the three Newton's laws of motion [3 marks]

b) A block of mass 10kg is placed on an inclined plane with slope angle 30° and is connected to a second hanging block that has a mass of 5kg by an inextensible cord passing over a small fixed and frictionless pulley. The coefficient of static friction is 0.45 while that of kinetic friction is 0.35.

i) Draw the free body diagrams for the two masses [2 marks]

ii) Determine the acceleration of the masses. [5 marks]

iii) Determine the tension in the cord [2 marks]

c) i) State the work energy theorem. [2 marks]

ii) A truck and a car having equal kinetic energy are traveling along a straight road. Equal braking forces are applied on them. Determine which one will travel farther before stopping. [3 marks]

d) A man weighing 650N is riding his 15 kg bicycle. What power must he supply to maintain a steady speed of 25km per hour on a level ground ? [3marks]
