KABARAK UNIVERSITY

UNIVERSITY EXAMINATIONS

2010/2011 ACADEMIC YEAR

FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE

COURSE CODE: PHYS 111

COURSE TITLE: MECHANICS

STREAM: Y1 S1

DAY: SATURDAY

TIME: 2.00 – 4.00 P.M

DATE: 27/11/2010

INSTRUCTIONS

1. Answer Question **ONE** and any other **TWO** Questions. Question One carries **30marks** while each of the other Two Questions carry 2**0marks**.
2. **The following constants may be useful**
   - Universal gravitation constant $G = 6.67 \times 10^{-11} Nm^2 Kg^{-2}$
   - Acceleration due to gravity $g = 9.8 m/s^2$

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QUESTION 1 (30 marks)

a) i) What is error as used in measurements? **(1mark)**

ii) State and differentiate between the types of experimental errors and describe how each can be minimized **(6 marks)**

b) Two measurements y and x are given with their errors as

$y = (3.03 \pm 0.01)mm$, $x = (2.20 \pm 0.02)mm$ and that $z = 3y + 4x$

Calculate:

i). The error in z (∇z) **(2marks)**

ii). The value of z to be reported **(2marks)**

c) i) Distinguish between the following

I. Basic and derived units **(2marks)**

II. Units and dimensional analysis **(2marks)**

ii) If Isaac Newton had considered that force (F) is related to acceleration (a), mass (m) and length (*l*), how would he find a relation between them? **(5 marks)**

d) A student jumps straight upward. He rises for 0.4s and descends in equal times. Calculate;

i). Initial velocity **(2marks)**

ii). Vertical height **(3marks)**

e) i) Give scientific explanation why it is necessary for good highways to have "banked" or slanted curves. **(1mark)**

ii) Calculate the angle of banking (θ) required for a curve of radius 400m so that a vehicle can negotiate at a critical speed of $30m/s$ **(3marks)**

f) State a situation where a body's velocity is zero yet there is acceleration. **(1mark)**

QUESTION 2 (20 marks)

a) i) State Newton's first and second laws of motion **(2marks)**

ii) A horse is urged to pull a wagon. The horse refuses to try citing Newton's third law as its defense. "The pull of me on the wagon is equal but opposite to the pull of the wagon on me. If I can never exert a greater force on the wagon than it exerts on me, how can I ever start the wagon to move?" asks the horse. How would you reply? **(3marks)**

b) i) State two situations where there can be a positive acceleration. **(2marks)**

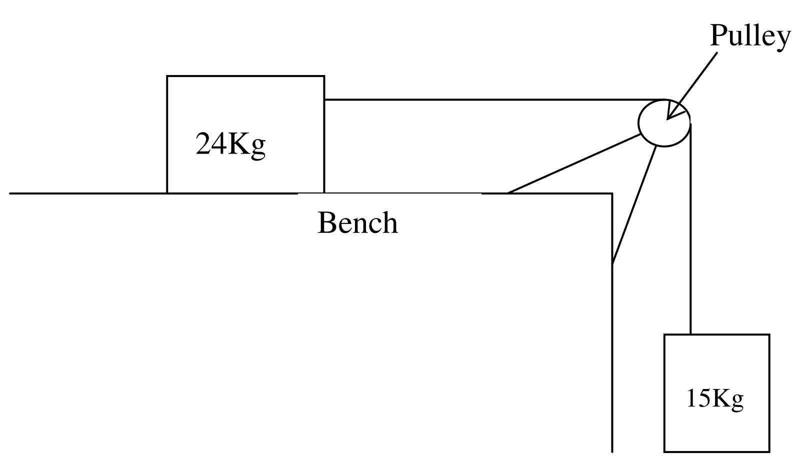
ii) What is the difference between motion at constant velocity and motion at constant acceleration? **(2marks)**

c) The diagram below shows a block of wood of mass 24Kg attached via a pulley to a hanging weight of mass 15Kg. Assuming that there is no friction between the block and the bench, calculate

i). The acceleration of the system **(3marks)**

ii). The tension on the string **(2marks)**

iii). What would be the tension if 24Kg mass was fixed in place? **(2marks)**



c) i) State the law of conservation of linear momentum **(1mark)**

ii) A lorry of mass 1500Kg traveling at 72Km/h collides with a stationary smaller car of mass 900Kg. The impact took 0.4s before the two moves at a uniform velocity for 10s. Calculate common velocity **(3marks)**

QUESTION 3 (20 marks)

a) i) What is a trajectory? **(1mark)**

ii) In a football fracas, a hooligan throws a stone at a velocity of $20m/s$ at an angle of $60°$ to the horizontal. Calculate;

a) the time it takes before the stone strikes the ground **(3marks)**

b) the maximum height reached by the stone **(3marks)**

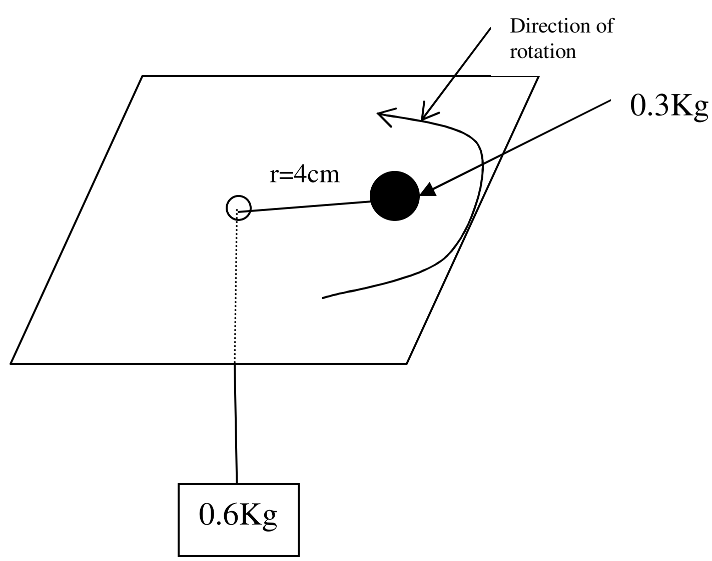
c) the vertical velocity just before it strikes the ground **(3marks)**

b) Show that the range (R) of a projectile having an initial velocity (u) and angle (θ) is given by

$$R = \frac{u^2 \sin 2\theta}{g}$$ **(3marks)**

c) i) State and explain three factors that affect centripetal force. **(3marks)**

ii) The diagram below shows two masses of 0.3Kg and 0.6Kg connected by a string through a hole on a smooth frictionless horizontal surface



The 0.3Kg mass rotates in a horizontal circle of radius 4cm. Calculate the angular velocity (ϖ) of the 0.3Kg mass for the system to be in equilibrium **(4marks)**

QUESTION 4 (20 marks)

a) Define the following terms **(4marks)**

i). Displacement

ii). Acceleration

iii). Frame of reference

iv). Free body diagram

b) Consider an object starting with initial velocity (u) and accelerate constantly at a constant acceleration (a) so as to cover a displacement (s). Show that for this object the displacement (s) is given by

$$s = \frac{v^2 - u_2}{2a}$$ **(4marks)**

c) A driver of a car traveling at a velocity of $40m/s$ suddenly applies brakes and the car achieves a constant deceleration of $5m/s^2$. Calculate,

i). the distance cover before stopping **(4marks)**

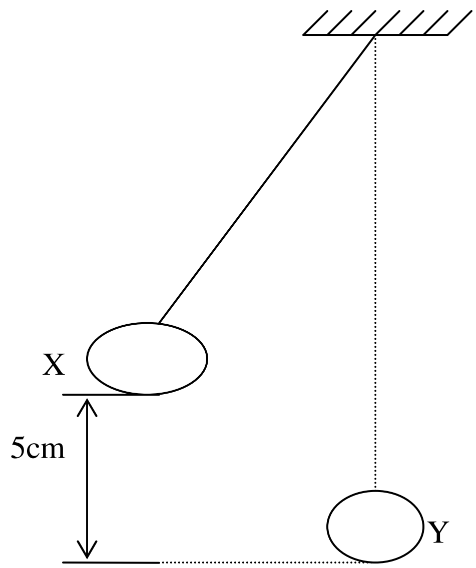
ii). the time (t) taken before the car comes to rest **(3marks)**

iii). the velocities of the car at the time intervals: $0, \frac{t}{4}, \frac{t}{2}, \frac{3t}{4}$ and t **(5marks)**

QUESTION 5 (20 marks)

a) i) State the law of conservation of energy **(1mark)**

ii) The diagram below shows a simple pendulum in oscillation.



The length of the string is $80cm$ and the bob is momentarily at rest at point X, calculate the velocity of the bob when crossing point Y. **(3marks)**

b) i) Define friction **(1mark)**

ii) State and explain two types of friction **(2marks)**

c) A force of 24N acts on a 6Kg mass resting on a smooth surface.

i). What is the acceleration of the mass? **(2marks)**

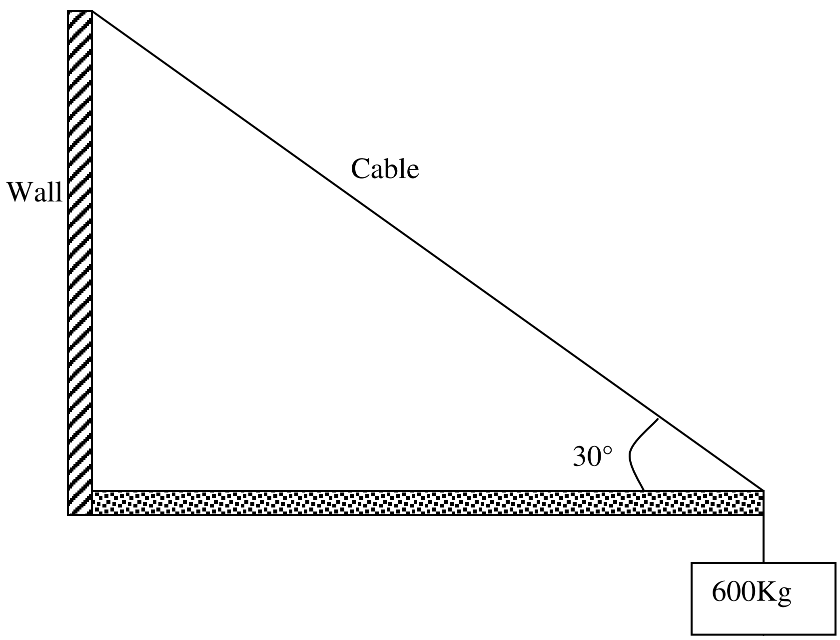
ii). If the force causes the mass to accelerate at $1.5m/s^2$, what would be the frictional force between the mass and the surface **(3marks)**

d) A man is lying at a horizontal distance $d = 120m$ from the foot of a tree. He wishes to shoot a monkey which is hanging on a branch of a tree at a height $H = 24m$ above ground. At the instant the monkey releases the branch and dropped, the man fires the gun with a bullet horizontal speed of $210 m/s$.

i). Explain why the monkey should not have released the branch and dropped if it was to avoid being shot. **(2 marks)**

ii). Determine the time elapsed before the bullet hits the monkey **(2 marks)**

e) A 600Kg mass is suspended from the end of a horizontal beam of length $5m$ as shown.



Assuming that the beam's mass is so small compared to that of the load and thus can be ignored, calculate;

i). The tension on the cable **(2 marks)**

ii). The inward force the beam exerts on the wall **(2 marks)**