KABARAK UNIVERSITY

UNIVERSITY EXAMINATIONS

2010/2011 ACADEMIC YEAR

FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE

COURSE CODE: PHYS 111

COURSE TITLE: MECHANICS

STREAM: Y1S1

DAY: THURSDAY

TIME: 9.00 – 11.00 P.M

DATE: 17/12/2010

INSTRUCTIONS:

- *Answer Question **ONE** and any other **TWO** Questions. Question One carries **30marks** while each of the other Two Questions carry 2**0marks**.*
- ***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) State and explain the types of errors in experimental measurements (2mks)
ii) State two ways through which each of errors in (i) above can be minimized (4mks)

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) (2mks)

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

c) i) Differentiate between basic and derived units (2mks)

ii) A satellite moving in a circular orbit in space experience acceleration (a). This acceleration depends only on the speed (V) of the satellite and the radius (r) of its orbit. Use dimensional analysis to determine how the acceleration (a) is related to (V) and (r).

(4mks)

d) An object is thrown vertically upwards to a height of 16m. Find

i). The speed with which it will strike the ground (3mks)

ii). The time taken to return to its original point of projection (2mks)

e) A car of mass 1200kg traveling at 20m/s increases its speed to $50 m/s$ in 10 seconds. Calculate;

i) The change in momentum of the car (3mks)

ii) The force acting on the car to make it increase its speed (2mks)

f) A man repeatedly sketches a spring of spring constant $240 N/m$ so as to increase the strength of his arms. If each time he stretches the spring by 15cm and he does so 40 times in one minute, calculate his power. (3mks)

g) State a situation where a body's velocity is zero yet there is acceleration. (1mk)

QUESTION 2 (20 marks)

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

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? (3mks)

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

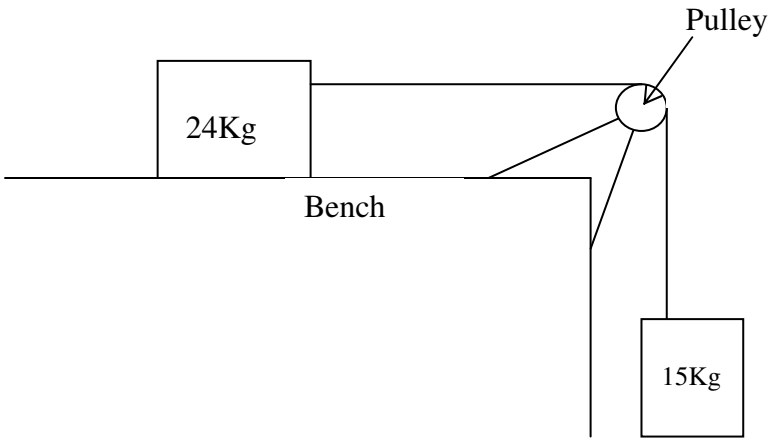
ii) What is the difference between motion at constant velocity and motion at constant acceleration? (2mks)

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 (3mks)

ii). The tension on the string (2mks)

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



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

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 (3mks)

QUESTION 3 (20 marks)

a) State and explain two factors that affect centripetal force (2mks)
b) State the sources of centripetal force in the following situations (2mks)

i). orbital and satellite motion
ii). a car negotiating a round about

c) A pendulum of mass 250g is suspended by an inelastic string of length 1m. The mass is made to rotate in a horizontal circle of radius 0.6m and whose centre is vertically below the point of support. Calculate

i). tension on the string (3mks)
ii). magnitude of component forces (2mks)
iii). the angular speed (3mks)
iv). the period of rotation of the mass (2mks)

d) A mass is projected at $50m/s$ at an angle of 30° to the horizontal. The mass is released 4m above the ground level. Find
i). maximum height reached by the mass (3mks)
ii). The speed with which it will strike the ground. (3mks)

QUESTION 4 (20 marks)

a) Define the following terms (4mks)
i). Displacement
ii). Acceleration
iii). Frame of reference
iv). Free body diagram

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

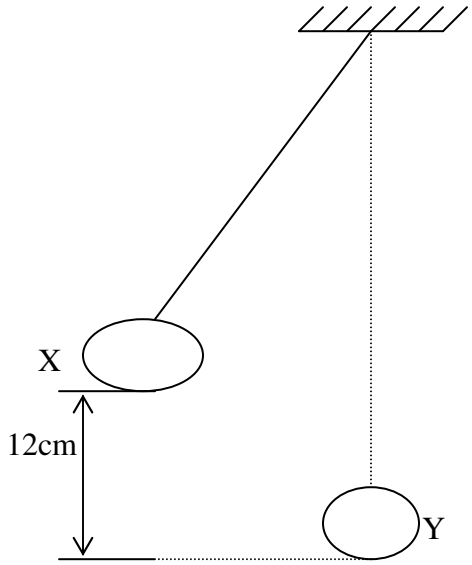
$$s = \frac{v^2 - u^2}{2a}$$ (4mks)

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 covered before stopping (4mks)
ii). the time (t) taken before the car comes to rest (3mks)
iii). the velocities of the car at the time intervals: $0, \frac{t}{4}, \frac{t}{2}, \frac{3t}{4}$ and t (5mks)

QUESTION 5 (20 marks)

a) i) State the law of conservation of energy (1mk)

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



The length of the string is $100cm$ and the bob is momentarily at rest at point X, calculate the velocity of the bob when crossing point Y. (3mks)

b) i) Define friction (1mk)

ii) State and explain two types of friction (2mks)

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

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

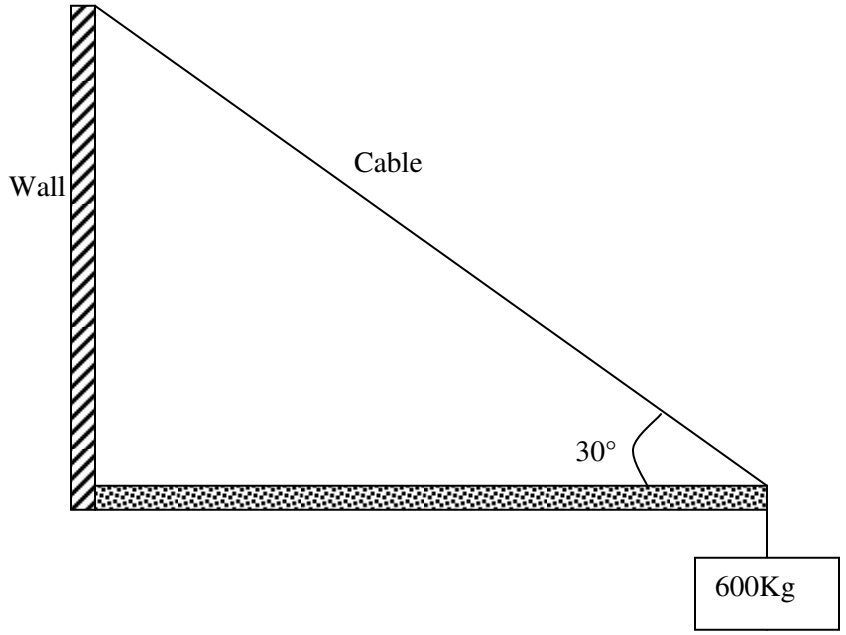
ii). If the force causes the mass to accelerate at $1.5m/s^2$, what would be the frictional force between the mass and the surface (3mks)

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 $210m/s$.

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

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

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 (2mks)

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