KABARAK UNIVERSITY

UNIVERSITY EXAMINATIONS

2010/2011 ACADEMIC YEAR

FOR THE CERTIFICATE OF PRE-UNIVERSITY PHYSICS

COURSE CODE: PPHYS 021

COURSE TITLE: MECHANICS AND WAVES

STREAM: SEMESTER TWO

DAY: TUESDAY

TIME: 2.00 – 4.00 P.M

DATE: 14/12/2010

INSTRUCTIONS:

- *Answer Question **ONE** and any other **TWO** Questions. Question One carries **30marks** while each of the other Two Questions carry **20marks**.*
- ***The following constants may be useful***
  - Acceleration due to gravity $g = 9.8 m/s^2$
  - Universal gravitation constant $G = 6.67 \times 10^{-11} NM^2 Kg^{-2}$
  - Radius of Earth $R_e = 6.4 \times 10^6 m$

PLEASE TURN OVER

QUESTION 1 (30 marks)

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

i). Velocity
ii). Displacement
iii). Frame of reference
iv). Free body diagram

b) A force of 24N acts on an 8Kg 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 $2.5m/s^2$, what would be the frictional force between the mass and the surface **(3mks)**

c) An object is thrown vertically upwards to a height of 12m. 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)**

d) A car of mass 1200kg traveling at 20m/s increases its speed to $45m/s$ 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)**

e) A man repeatedly sketches a spring so as to increase the strength of his arms. If each time he stretches the spring by 15cm using an average force of 400N, and he does so 40 times in one minute, calculate his power. **(3mks)**

f) i) Differentiate between transverse and longitudinal waves **(2mks)**

ii) A wave of wavelength 20cm has a speed of $25m/s$ Calculate the frequency of the source producing the wave **(3mks)**

iii) The refractive index 1.33. If the speed of light in air is $3\times10^8 m/s$, calculate the speed of light in water. **(3mks)**

QUESTION 2 (20 marks)

a) i) Differentiate between instantaneous and average velocity. **(2mks)**

ii) A student measured the time taken for a freely falling body to pass two points. The body passes the points at initial time $t_i = 0.127s$ and final time $t_f = 0.501s$. Calculate the average velocity of the body **(4mks)**

b) i) Differentiate between vector and scalar quantity and state one example of each. **(4mks)**

ii) Swimmer covers $100m$ in a $50m$ swimming pool in 50 seconds by swimming from one end to the other and back. Calculate;

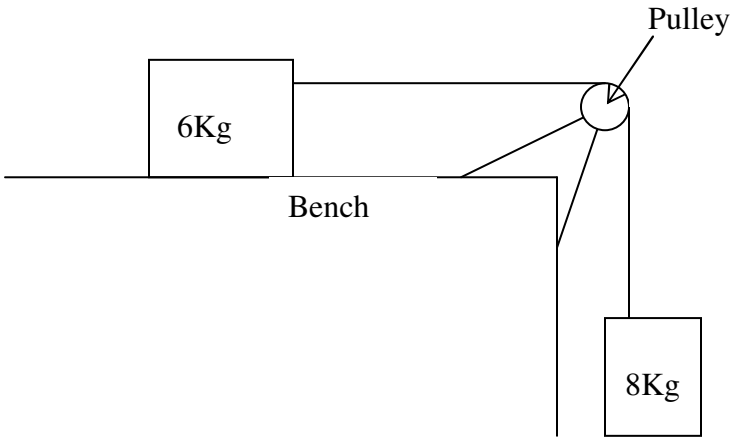
i). average speed **(2mks)**

ii). average velocity **(2mks)**

c) The diagram below shows a block of wood of mass 3Kg attached via a pulley to a hanging weight of mass 4Kg. Assuming that there is no friction between the block and the bench, calculate

i). The acceleration of the system **(4mks)**

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



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 200g is suspended by an inelastic string of length 0.5m. The mass is made to rotate in a horizontal circle of radius 0.3m 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 5Kg mass is placed on an inclined plane at an angle of 30° to the horizontal. If the frictional force between the two surfaces is 8N, calculate,

i). The acceleration of the mass? **(4mks)**

ii). Calculate the coefficient of dynamic friction (μ_k) between the mass and the plane **(2mks)**

QUESTION 4 (20 marks)

a) i) State Kepler's first and second laws of planetary motion. **(2mks)**

ii) Show that Kepler's third law is given by

$$T^2 = \frac{4\pi^2}{GM_s} R^3 \quad \textbf{(5mks)}$$

Where the symbols have there usual meanings

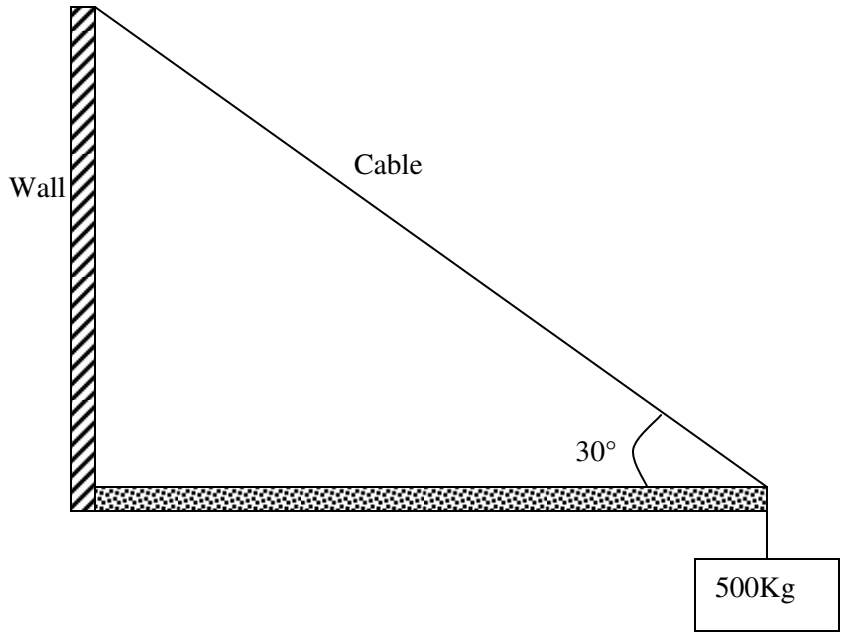
b) i) Define escape velocity of a body. **(1mk)**

ii) A satellite is at the height of $500Km$ above the surface of the Earth. Find the speed of this satellite given that the mass of the Earth is $6.0\times10^{-24}\,Kg$ and its radius is $6.4\times10^{6}\,m$. **(3mks)**

c) i) What is equilibrium? **(1mk)**

ii) State two conditions of translational equilibrium **(2mks)**

e) A 500Kg 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 **(4mks)**

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

QUESTION 5 (20 marks)

a) Define the following as used with waves **(4mks)**

i). Period
ii). Compression
iii). Rarefaction
iv). Wavelength

b) State Huygen's Principle and use it to derive Snell's law of refraction **(4mks)**

c) i) State the principle of superposition **(1mk)**
ii) State two conditions for interference **(2mks)**

d) Define the following terms as used with waves **(2mks)**

i). Natural frequency
ii). Resonance

e) i) State two differences between traveling waves and standing waves **(2mks)**
ii) A wire fixed at both ends of length 50cm and mass 20g is stretched by a tensional force of 20N. The wire is made to vibrate and produces a series of harmonic modes. Calculate

i). The speed of the wave produced along the wire **(3mks)**
ii). The frequency of the second and third harmonic **(2mks)**