KABARAK UNIVERSITY

UNIVERSITY EXAMINATIONS

2009/2010 ACADEMIC YEAR

FOR THE CERTIFICATE OF PRE-UNIVERSITY PHYSICS

COURSE CODE: PPHYS 021

COURSE TITLE: MECHANICS AND WAVES

STREAM: SEMESTER TWO

DAY: WEDNESDAY

TIME: 9.00 – 11.00 A.M.

DATE: 11/08/2010

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

(b) An object is thrown vertically upwards to a height of 8m. 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)

(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 car of mass 1200kg traveling at 20m/s increases its speed to $50m/s^2$ 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 of spring constant $240N/m$ 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)

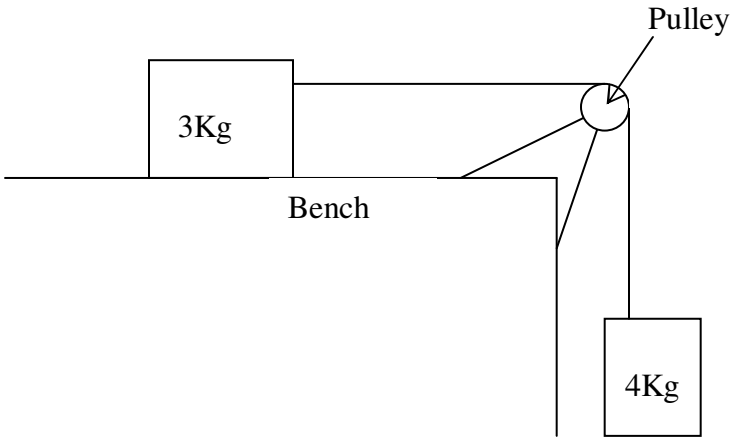
(f) i) Differentiate between transverse and longitudinal waves (2mks)
ii) A wave of wavelength 5cm has a speed of $0.5m/s$ Calculate the frequency of the source producing the wave (3mks)
iii) The refractive index for a ray of light traveling from glass to air is 0.67. If the speed of light in air is $3\times10^8 m/s$, calculate the speed of light in glass. (3mks)

QUESTION 2 (20 marks)

(a) State Newton's second law of motion. (1mk)

(b) 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 (3mks)
ii). The tension on the string (2mks)



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

(d) 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

i). common velocity (3mks)

ii). Distance moved after impact (2mks)

iii). force of impulse (3mks)

iv). kinetic energy before and after collision, account for energy difference if any (3mks)

(e) A hunter fired a monkey of mass 100g hanging on a loose branch. If the mass of the bullet used is 20g and the speed at which it strikes the monkey is $200m/s$, calculate the height rose by the monkey after impact assuming that the bullet got embedded in its body and that the weight of the branch can be ignored. (2mks)

QUESTION 3 (20 marks)

(a) Define angular velocity and show that it is given by $\varpi = \frac{V}{r}$ (2mks)

(b) State the sources of centripetal force in the following situations (2mks)

i). orbital and satellite motion

ii). electrons around the nucleus of an atom

(c) A pendulum of mass 400g is suspended by an inelastic string of length 1m. The mass is made to rotate in a horizontal circle of radius 0.8m 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) State Newton's law of universal gravitation (1mk)

(b) Define gravitational field strength (I) and show that

$$I = \frac{GM}{r^2}$$ (3mks)

(c) Show that escape velocity on the Earth surface is given by

$V_{esc} = \sqrt{2gR_e}$, hence find the approximate escape velocity for a body to leave the Earth surface (3mks)

(d) i) What is equilibrium? (1mk)

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

(e) A uniform metre rule is balanced at 10cm mark by a 2.5N placed at 0cm mark. Find the weight of the rule. (3mks)

(f) A block of mass 0.8Kg is resting on an inclined plane. When the angle of the slope was increased to 40°, the block starts to slide down

i). determine the coefficient of static friction (2mks)

ii). when the angle was gradually reduced to 30° the block slides with a constant speed, determine the coefficient of dynamic friction (2mks)

iii). Find the acceleration of the block when the angle is 75° (3mks)

QUESTION 5 (20 marks)

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

i). Frequency

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). Doppler Effect

ii). Resonance

(e) i) State two differences between traveling waves and standing waves (2mks)

ii) A stretched spring of length 50cm fixed at both ends is made to vibrate and produces a series of harmonic modes of fundamental frequency $f_0 = 200Hz$.

Calculate

i). Frequency of the second and third harmonic (2mks)

ii). Wavelength of the second and third harmonic (3mks)