



UNIVERSITY OF NAIROBI

FIRST SEMESTER EXAMINATIONS 2014/2015

FIRST YEAR EXAMINATIONS FOR THE DEGREES OF
BACHELOR OF SCIENCE IN ENVIRONMENTAL AND BIOSYSTEMS,
ENGINEERING,
BACHELOR OF SCIENCE IN CIVIL ENGINEERING
BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING,
BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING,
AND
BACHELOR OF SCIENCE IN GEOSPATIAL ENGINEERING

FEB 103/FCE 131/FEE 101/FME 111/FGE 175: PHYSICS 1A

DATE: JANUARY 12, 2015

TIME: 8.30 A.M. – 10.30 A.M.

INSTRUCTIONS:

Answer question ONE and any other TWO questions.

QUESTION 1 (Compulsory) – 30 marks

(a) Define the following quantities and stating their S.I. units in each case:

- (i) Displacement
- (ii) Momentum
- (iii) Force
- (iv) Power [8 marks]

(b) (i) State three characteristics of a wave. [3 marks]

- (ii) A body exhibiting simple harmonic motion has a displacement that varies with time represented by equation.

$$x = \sin 0.6\pi t$$

where t is time in seconds and the phase in radians. Calculate the velocity and acceleration of the body at time $t = 2$.

$$(\pi = 3.14) \quad [8 \text{ marks}]$$

(c) (i) Distinguish between heat and temperature. [2 marks]

- (ii) Explain the differences between the following forms of heat transfer: conduction, convection and radiation. [6 marks]

- (d) (i) State Archimede's principle.
(ii) Define Atmospheric pressure
(iii) State Newton's Second Law of Motion. [3 marks]

QUESTION 2 (20 Marks) – Optional

- (a) What do you understand by the following?
- (i) Internal energy
(ii) Specific heat
(iii) Thermal equilibrium [3 marks]
- (b) (i) What is normal body temperature 37.0°C on the Fahrenheit and Kelvin scales? [4 marks]
- (ii) If you have a fever of 101.6°F , by how much has your temperature risen on both Celsius and Kelvin scale? [4 marks]
- (c) (i) Does a thermometer measure its own temperature or the temperature of its surroundings? Explain. [4 marks]
- (ii) The sun radiates energy at the rate $p = 3.9 \times 10^{26} \text{ w}$ and its radius is $7.0 \times 10^8 \text{ m}$. Assuming the sun to be a black body (emissivity = 1). What is its surface temperature? (Also assume the sun to be spherical in shape), $\sigma = 5.67 \times 10^{-8} \text{ w/m}^2 \cdot \text{k}4$). [5 marks]

QUESTION 3 (20 Marks) – Optional

- (a) Water flows along a horizontal pipe of cross section area (C.S.A) of 48 cm^2 which has a constriction of C.S.A. 12 cm^2 at one place. If the speed of the water at the construction is 4 m/s , calculate:
- (i) The speed in the wider section. [1 mark]
- (ii) The pressure in the constriction if the pressure at the wider section is $1.0 \times 10^5 \text{ p.a}$. [2 marks]
- (b) Define the terms:
- (i) Tensile stress. [1 mark]
(ii) Tensile strain [1 mark]
(iii) Young's modulus [1 mark]

- (c) A rubber cord of a catapult has cross sectional area of 2 mm^2 and an initial length of 0.20m . It is stretched to 0.24m to fire a small object of mass 10g . Calculate the initial velocity of the object when it just leaves the catapult. [4 marks]
- (d) A particle of mass m is acted by a constant force until its velocity is v . Show that the kinetic energy of the particle is $\frac{1}{2}mv^2$. [4 marks]
- (e) A train of mass $2 \times 10^5 \text{ kg}$ moves at a constant speed of 20 m/s up a straight incline against a frictional force of $1.28 \times 10^4 \text{ N}$. The incline is such that the train rises vertically 1.0m for every 100m traveled along the incline. Calculate:
- (i) The rate of increase of the potential energy of the train. [3 marks]
- (ii) The necessary power developed by the train. [3 marks]

QUESTION 4 (20 Marks – Optional)

- (a) Explain in non-mathematical terms, the significance of the term moment of inertia. [2 marks]
- (b) Consider a baton of uniform composition, same density everywhere, mass m and length L . Show that:
- (i) The moment of inertia of the baton is generally given by:
- $$I = \frac{1}{3}m(l^2 - 3lh + 3h^2)$$
- where h is the distance from one end of the baton. [6 marks]
- (ii) If $h = \frac{l}{2}$, then the equation for b(i) above reduces to
- $$I = \frac{1}{12}mv^2.$$
- [4 marks]
- (iii) What is the rotational kinetic energy of the baton if its mass and length are 0.5 kg and 0.6m respectively when rotating about an axis through its center at an angular speed of 3 revolutions per second? [4 marks]
- (c) (i) Write an expression for a particle oscillating in Simple Harmonic Motion (S.H.M.). [2 marks]
- (ii) A mass of 2 kg is attached to the end of a helical spring of constant 22 NM^{-1} . The mass is displaced 320mm from its equilibrium position at some instant $t=0$ and released from rest. Determine its period. [2 marks]