UNIVERSITY OF NAIROBI

FIRST SEMESTER EXAMINATIONS 2013/2014

FIRST YEAR EXAMINATIONS FOR THE DEGREE OF BACHELOR OF SCIENCE IN ENGINEERING:

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

ENGINEERING PHYSICS 1A

DATE: APRIL 22, 2014 **TIME: 8.30 A.M. – 10.30 A.M.**

INSTRUCTIONS:

THIS PAPER CONSISTS OF **THREE** SECTIONS (A, B & C). ANSWER **AT LEAST ONE** QUESTION FROM **EACH** SECTION

CONSTANTS

Acceleration due to gravity, $g = 10ms^{-2}$

Density of water, $\rho_w = 1000kg\ m^{-3}$

Density of air, $\rho_a = 1.25kgm^{-3}$

Boltzmann constant, $k_B = 1.38 \times 10^{-23}\ jk^{-1}$

Coefficient of linear expansion for copper, $\alpha_{Cu} = 1.7 \times 10^{-5}\ ^oC^{-1}$

Thermal conductivity for copper $\sigma_{Cu} = 397\ Wm^{-1o}C^{-1}$

Young's modulus for steel

Young's modulus for concrete, $= 7 \times 10^9\ Nm^{-2}$

Coefficient of linear expansion for concrete, $= 12 \times 10^{-6}\ ^oC^{-1}$

SECTION A: ANSWER AT LEAST ONE QUESTION FROM THIS SECTION

Question one (20 Marks)

(a) Define the following stating their SI units

(i) Displacement

(ii) Linear momentum

(iii) Weight

(iv) Moment of inertia (8 Marks)

(b) (i) Distinguish between static and kinetic frictional forces (2 Marks)

(ii) Explain why a woman shopping for a cabbage before selecting first decides to lift up and down (3 Marks)

(c) A block of mass m = 100kg is placed on a frictional plane of angle $\theta = 60^{\circ}$

(i) Determine the acceleration of the block after it is released (4 Marks)

(ii) Suppose the block is released from rest at the top of the incline and the distance from the edge of the block to the bottom is d = 10m. How long does it take the front edge of the block to reach the bottom and what is its speed just as it gets there? (3 Marks)

Question Two (20 Marks)

(a) What do you understand by the following terms:

(i) A rigid body

(ii) Escape velocity

(iii) Atmospheric pressure

(iv) Steady fluid flow (4 Marks)

(b) Explain why a ship made of steel floats in sea water yet a small steel ball sinks? (3 Marks)

(c) Derive Bernoulli's equation (8 Marks)

(d) Show that the motion of a mass attached to a spring released after extending it over a distance x is describable by the equation

$$\frac{d^2x}{dt^2} + \omega^2 x = 0$$

Where ω is the angular velocity and t is the time in seconds (5 Marks)

SECTION B: ANSWER AT LEAST ONE QUESTION FROM THIS SECTION

Question Three (20 marks)

(a) From basic principles, show that pressure in liquids is given by P = hgρ with the symbols having their usual meanings (3 Marks)

(b) State the Archimedes principle (1 Mark)

(c) State and explain the four applications of Bernoulli's principle (8 Marks)

(d) Water flows steadily along a horizontal pipe at a volume rate of 8×10^{-2} m^3s^{-1}. If the cross-sectional area of the pipe is 40 cm^2,

(i) Calculate the flow velocity of water. (4 Marks)

(ii) Hence find the total pressure in the pipe if the static pressure in the horizontal pipe is 3×10^4 Pa, assuming water is incompressible, non viscous. (2 Marks)

(iii) What is the new flow velocity if the total pressure is 3.6×10^4 Pa (2 Marks)

Question Four (20 Marks)

(a) Write short notes on the following properties and terminologies
   (i) Stress
   (ii) Strain
   (iii) Hooke's law
   (iv) Young's Modulus
   (v) Bulk modulus (12 Marks)

(b) Let two waves having amplitudes a_1 and a_2 be represented by the equations

$$y_1 = a_1 \sin\frac{2\pi}{\lambda}(vt - x) \quad and$$

$$y_2 = a_2 \sin\left\{\frac{2\pi}{\lambda}(vt - x) + \phi\right\}$$

Where ϕ is the phase difference between the two waves after some time? Determine the resultant displacement of the two waves. (8 Marks)

SECTION C: ANSWER AT LEAST ONE QUESTION FROM THIS SECTION

Question Five (20 Marks)

(a) Explain briefly why the material used in dental fillings should have the same coefficient of thermal expansion as a tooth. What would occur is the coefficients were mismatched? (3 Marks)

(b) A automobile radiator is filled to the brim with water while the engine is cool.
   (i) What happens to the water when the engine is running and the water is heated? (2 Marks)
   (ii) Hence state what should be fitted in the car's cooling system to prevent the loss of water. (1 Mark)

(c) A copper telephone cable has essentially no sag between poles 35 m apart on a cold day when the temperature is -20°C. How much longer is the cable on a hot day when temperature is 35°C? (3 Marks)

(d) A house is fitted inside its walls with an L-shaped hot water pipe which consists of a straight horizontal section 28cm long, an elbow and a straight vertical piece 134 cm long. The two ends of the pipe are held stationary by studs. If the pipe is made of Copper, find the magnitude and direction of the displacement of the pipe elbow when the hot water flow is turned on thus raising the temperature of the pipe from 18 °C to 46.6 °C (5 Marks)

(e) The mass of a hot air balloon and its cargo excluding the air inside is 200 kg. If the air temperature and pressure outside the vessel is 10°C and 101 kPa respectively, to what temperature must the air in the balloon be heated before it lifts off if its volume is 400 m^3? (6 Marks)

Question six (20 marks)

(a) (i) Define heat (2 Marks)

(iii) Clearly distinguish among temperature, heat and internal energy (3 Marks)

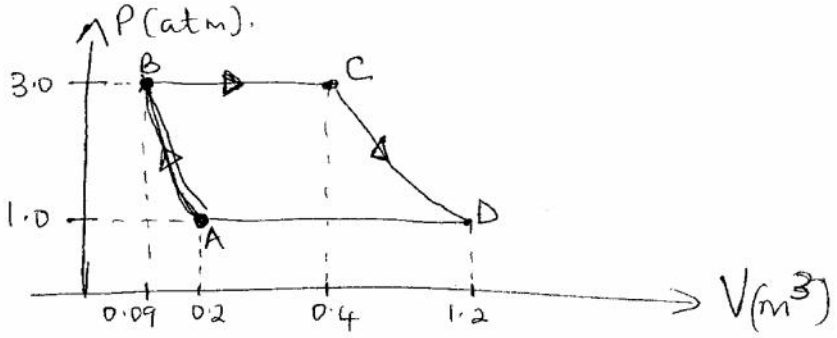
(b) A concrete pavement is laid on a day when the temperature is 20°C in such a way that the ends are unable to move.

(i) What is the stress in the cement on a hot day of 50°C (3Marks)

(ii) Does the concrete fracture? –Explain (1 Mark)

(c) One container is filled with helium gas while another with argon gas. By way of explanation, state which gas molecules have the higher rms speed if both containers are at the same temperature? (2 Marks)

(d) A sample of an ideal gas goes through the process shown in the figure below



From A to B, the process is adiabatic; from B to C, 100kJ of energy enters the system by heat. From C to D, the process is isothermal and finally 150kJ of energy leaves the system by heat (from D to A). Determine the internal energy $E_{int,A}$ and $E_{int,B}$. (9 Marks)