ELIZADE UNIVERSITY

ILARA-MOKIN

ONDO STATE

FACULTY: Basic and Applied Sciences

DEPARTMENT: Physical and Chemical Sciences

SECOND SEMESTER EXAMINATIONS

2013/2014 ACADEMIC SESSION

COURSE CODE: PHY 106

COURSE TITLE: General Physics III

DURATION: 2 hours

TOTAL MARKS: 80

HOD's SIGNATURE

Matriculation Number: _____

INSTRUCTIONS:

1. Fill your personal details in the space provided above and on the cover page of the exam booklet.
2. Answer questions in the exam booklet provided.
3. This question paper consists of 5 pages (including this page): check whether all pages are included.
4. Where necessary, use $g = 9.8\ \mathrm{m\ s^{-2}}$ for the magnitude of free-fall (gravitational) acceleration.
5. Hand in this question paper together with your exam booklet at the end of the examination.
6. You may make use of the equations displayed on the next page.
7. Answer ALL questions.

EQUATIONS

$$P_2 = P_1 + \rho g h \qquad F_B = \rho g V \qquad \rho_1 A_1 v_1 = \rho_2 A_2 v_2$$

$$P_1 + \frac{1}{2}\rho(v_1)^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho(v_2)^2 + \rho g h_2 \qquad \frac{\Delta V}{\Delta t} = \frac{\pi \Delta P r^4}{8 \eta L}$$

$$F_D = 6 \pi \eta r v \qquad \frac{F}{A} = Y\frac{\Delta L}{L} \qquad \theta \text{ (in radians)} = \frac{s}{r}$$

$$\omega = \frac{\theta}{t} \qquad v = r\omega \qquad f = \frac{1}{T}$$

$$a_r = \frac{v^2}{r} \qquad \omega = 2\pi f = \sqrt{\frac{k}{m}} \qquad F_s = -kx$$

$$x = A\cos(\omega t) \qquad v = -A\omega \sin(\omega t) \qquad a = -A\omega^2 \cos(\omega t)$$

$$x_{cm} = \frac{\sum_i m_i x_i}{\sum_i m_i} \qquad \tau = \pm F d_\perp \qquad I = \sum_i m_i (r_i)^2$$

Question 1 (11 marks)

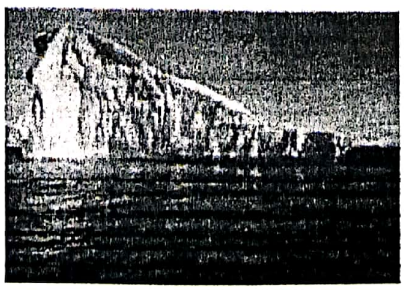
(a) Use Newton's Laws to derive a formula which relates pressures at different depths in a static fluid: draw a labeled sketch where relevant. [6]

(b) Draw a rough labeled sketch of a mercury barometer. Use physics arguments to explain how this device works and how you would use this device to measure value of atmospheric pressure in Ilara-Mokin. [5]

Question 2 (10 marks)

(a) Explain in words and in mathematical form what is meant by Archimedes' Principle. [4]

(b) Assume that the density of seawater is 1.030×10^3 kg/m^3 and the density of ice is 9.17×10^2 kg/m^3. Draw a labeled diagram showing all the forces acting on an iceberg and use Newton's laws to determine what fraction of an iceberg's volume is beneath the surface of the seawater. [6]



Question 4 (11 marks)

(a) A wire of length 5.00 m with a cross-sectional area of $0.100\ cm^2$ stretches by 6.50 mm when a load 1.00 kN hangs from it. Determine the Young's modulus of the wire. [4]

(b) Draw a rough graph of tensile stress versus tensile strain for a ductile material. Label the graph and indicate the following points: elastic limit, proportional limit, breaking point, ultimate strength. [5]

(c) Explain in words the difference between the proportional limit and the elastic limit of a ductile material. [2]

Question 5 (16 marks)

(a) Explain in mathematically and in words what is meant by Hooke's law for an ideal spring. [3]

(b) Explain what is meant by the concept of simple harmonic motion and also explain under what conditions an object undergoes simple harmonic motion. [2]

(c) An object of mass $m = 1.0\ kg$ is attached to a massless horizontal spring (with a spring constant of $1200\ N/m$) which is stretched through a maximum distance of 5.0 cm from its equilibrium position. The object is released at time $t = 0.0\ s$ and undergoes simple harmonic motion. Answer the following questions and motivate each step of your reasoning:

(i) Determine the maximum speed of the oscillating object. [4]

(ii) Determine the frequency of the simple harmonic motion. [2]

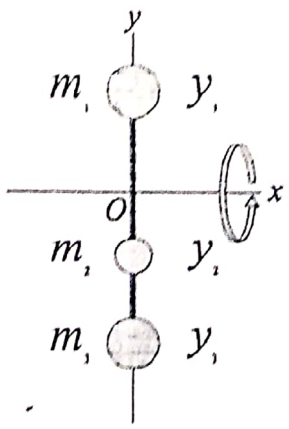
(iii) Write an expression for the position of the oscillating object as a function of time. [2]

(iv) Determine the position of the object at time $t = 2.0\ s$. [2]

(v) Will the period of oscillation increase or decrease if the amplitude is doubled? [1]

Question 6 (17 marks)

(a) Three point particles with masses, $m_1 = 4.0\ kg$, $m_2 = 2.0\ kg$ and $m_3 = 3.0\ kg$ are connected by rigid rods of negligible (very small) mass lying along the y-axis as indicated in the accompanying sketch,. and the y-coordinate of each particle is $y_1 = 3.0\ m$, $y_2 = -2.0\ m$ and $y_3 = -4.0\ m$ respectively. The system rotates around the x-axis with a constant angular speed of $2.0\ rad/s$. Determine the center-of-mass position this rotating system of three particles. [3]



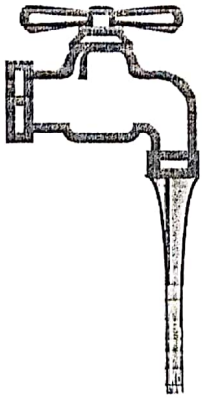
Question 3 (15 marks)

(a) Write down Bernoulli's equation and define all symbols used. [3]

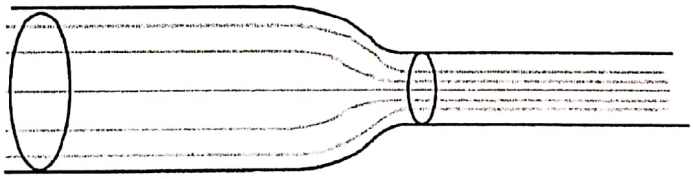
(b) Use dimensional arguments to explain the physical meaning of the continuity equation for incompressible fluids, namely: [3]

$$A_1 v_1 = A_2 v_2$$

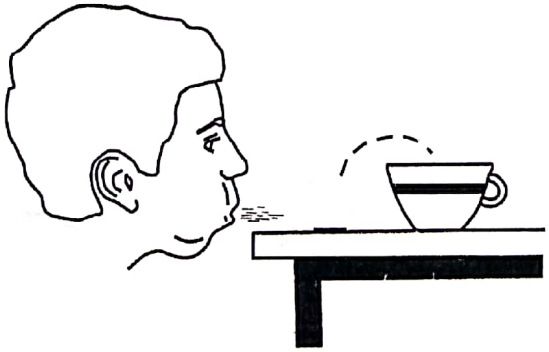
(c) When water flows from a tap, the stream becomes narrower as the water moves further away from the tap: see the accompanying sketch. Use physics arguments to explain this phenomenon. [3]



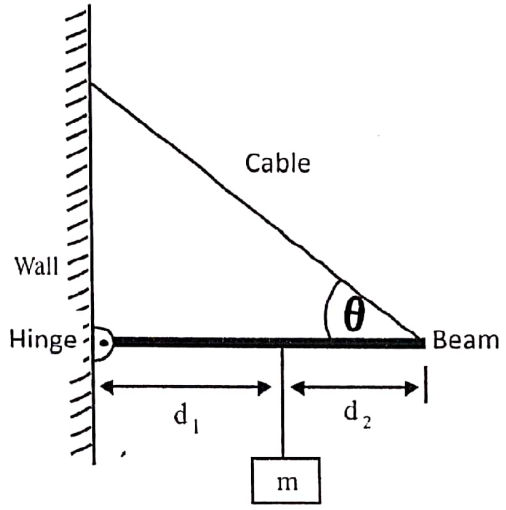
(d) It is often stated that Bernoulli's equation tells us that if the speed of a fluid increases, then the pressure in the fluid decreases. Show how the latter statement follows by applying Bernoulli's equation AND the continuity equation to the flow of water in the horizontal pipe system shown in the figure below. [4]



(e) With a some effort, it is possible to blow a strong gust of air just above a coin on a table so that it "jumps" into a cup as shown in the accompanying figure. Use physics arguments to explain why the coin moves from the table into the cup. [2]



(b) Consider a horizontal beam of uniform density and mass $m_b = 5.0$ kg of which one end is connected via a hinge to a wall, and the other end is supported by cable as shown in the underlying figure. The cable makes an angle of $\theta = 45^o$ with the horizontal. An object of mass $m = 3.0$ kg is suspended from the beam by means of a rope as shown in the sketch. The small mass of the rope can be neglected. Assume that $d_1 = 4.0$ m and $d_2 = 2.0$ m. Answer the following questions:



(i) Draw a labeled diagram showing all the forces acting on the beam. [4]

(ii) Explain in words and in mathematical form what is meant by the concept of static equilibrium. [3]

(iii) Determine the tension T in the cable. [7]

END OF EXAMINATION