MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF EDUCATION (SCIENCE)

SPH 302: STRUCTURE AND PROPERTIES OF MATTER

DATE:25/4/2019 **TIME: 8.30-10.30 AM**

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

The following constants may be useful:

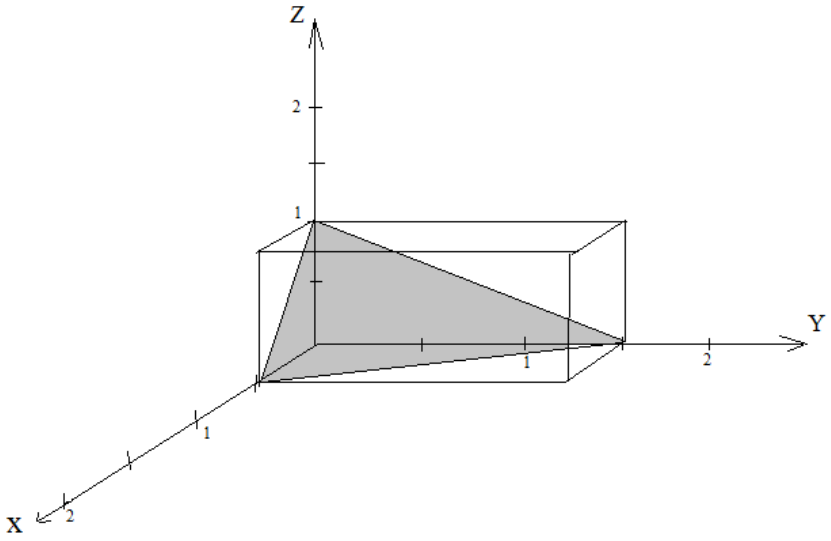
Density of steel, glycerine, air, mercury and blood are 7.7 g/cm^3 , 1.26 g/cm^3, 0.001225 g/cm^3, 13.6 g/cm^3 and 1.050 g/cm^3 respectively. Gravitation acceleration 9.8 m/s^2. Surface tension of water 0.073 N/M, coefficient of thermal conductivity of glass 1.1 W$m^{-1}K^{-1}$, Reynold number of blood flowing in a human artery N_R=3000, viscosity of blood 2.7 x $10^{-3}N.sm^{-2}$, viscosity of air 1.8 x 10^{-3} $N.sm^{-2}$

SECTION A

QUESTION ONE (30 MARKS)

a) In crystals, the axis of symmetry can only be two, three, four or six fold and not 5 or 7 fold. Give a reason why this is so (2 marks)

b) The shaded plane represent a face of a crystal, identify the miller indices of the crystal (4 marks)



c) Distinguish between an ionic and a covalent crystal (2 marks)

d) Derive Bragg's law (2 marks)

e) X-rays with a wavelength of 0.12 nm undergo first order diffraction from a crystal at 68 ^{0} angle of incidence. Calculate the angle at which third order diffraction will occur? (6 marks)

f) Explain how Bernoulli's equation adjusts if a flowing fluid in a pipe

i. Slows down

ii. Is horizontal (4 marks)

g) An alien spherical body falls through still air in the earth's atmosphere with a velocity of 0.5 m/s. The body experiences viscous force of 700 N. Calculate the radius of the body. (6 marks)

h) Define Madelung constant (2 marks)

i) Define the term thermal conduction (2 marks)

SECTION B

QUESTION TWO (20 MARKS)

a) Draw a hexagonal (rhombic) crystal in 2-Dimension (2 marks)

b) Calculate Madelung constant for sodium chloride (6 marks)

c) Consider rate of flow of heat (J/s) in a thin disc of some material of cross sectional area A and thickness δx. Suppose that the hotter section is at a temperature θ and that the colder section is maintained at $\theta - \delta\theta$. Derive an expression for coefficient of thermal conductivity of the material. (6 marks)

d) A glass slab of a thermal insulator with a cross-sectional area of $100cm^2$ is 3.00 cm thick. If the temperature of the hotter side is 300 ℃ and that of the cooler side is 8 ℃, calculate amount of heat that flows through the slab in 1 day? (6 marks)

QUESTION THREE (20 MARKS)

a) At one point in a pipeline, the water's speed is 3.00 m/s and the gauge pressure is 4.0 x $10^4\ pa$ Find the gauge pressure at a second point in the line 11.0 m lower than the first if the pipe diameter at the second point is twice that at the first. (8 marks)

b) Describe an experiment you can perform to determine coefficient of viscosity ɳ using Stoke's law (6 marks)

c) Calculate the terminal velocity of a steel ball bearing 2.00 mm in diameter falling in a glycerine of viscosity 0.150 N.s/m^2 (6 marks)

QUESTION FOUR (20 MARKS)

a) Show that

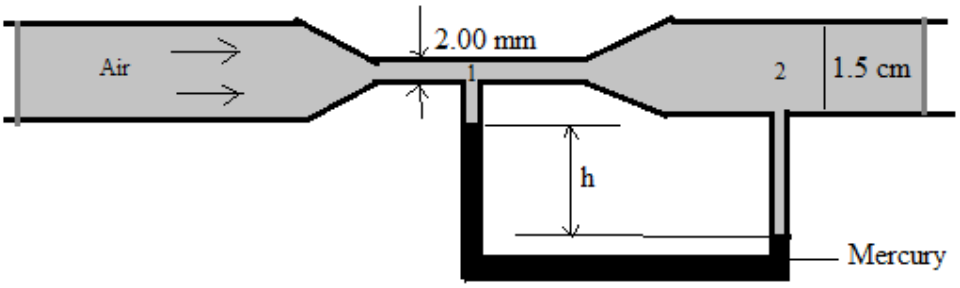
$$V_2 = \sqrt{\frac{2(\Delta P)}{\rho(1-A_2^2/A_1^2)}}$$

where ρ is density of air and other symbols hold their usual meaning. (6 marks)

b) The horizontal circular pipe shown in Figure 1 has a constriction at point 1, of diameter 2.00 mm and a wider section at point 2, of diameter 1.5 cm. If the flow speed of air at the constriction is 9.20x 10^4 m/s, calculate the

i. pressure difference $\Delta P = P_2 - P_1$ between point 1 and 2 (6 marks)

ii. the difference in height h between the mercury columns in the u-tube (3 marks)



c) In an experiment to study blood circulation in a human artery, it was noted that, flow turned turbulent at a speed of 38.5 m/s. Calculate the radius of the artery. (5 marks)

QUESTION FIVE (20 MARKS)

a) Derive Poiseulle's formula using dimensional analysis (6 marks)

b) A fatally wounded patient in a hospital receives IV blood transfusion through a needle of 0.30 mm and length 3 cm. If the required rate of flow is 6.0 x$10^{-8}m^3/s$, how high above the patient, the bottle supplying blood should be placed? (Ignore atmospheric pressure) (7 marks)

c) Suppose God was to create a nano-millipede that could walk on water and which had 1000 legs, each of 1.5 nm in radius. Calculate the greatest possible mass this millipede could possess. (7 marks)