MENGO SENIOR SCHOOL
END OF TERM 1 2003 EXAMS
S.6 PHYSICS P510/1
TIME: 2:30 HOURS

INSTRUCTIONS:

-Attempt FIVE questions in this paper
-Assume where necessary
-Acceleration due to gravity = 9.81ms^{-2}
-Radius of the earth = 6.4 x 10^{6} m
-Mass of the earth = 5.97 x 10^{24} kg
-Avogadra's number NA = 6.02 x 10^{23} mol^{-1}
-Density of water = 1000kgm^{-3}
-Gas constant, R = 8.31Jmol^{-1}k^{-1}
-Universal gravitational constant, G=6.67 x 10^{-11} Nm^{2}kg^{-2}
-Surface tension of water = 7.0 x 10^{-2}Nm^{-1}
-Specific Heat capacity of water = 4200J kg^{-1}k^{-1}

SECTION A

1(a)(i) What is meant by Dimension of a physical quantity? (1)

(ii) For stream line flow of a non-viscous, incompressible fluid, the pressure P at a point is related to the height h and velocity v by the equation

$$(p-a) = pg\,(h-b) + \frac{1}{2}p\,(v^2 - d)$$

where a, b, d are constants, p is the density of the Fluid and g is acceleration due to gravity. Given that the equation is dimensionally consistent, find the dimensions of a, b and d. (3)

(b) Define Simple Harmonic Motion. (1)

(c) Sketch the following graphs for a body performing SHM.
(i) Velocity against displacement. (1)
(ii) Displacement against time. (1)

(d) The period of oscillation of a conical pendulum is 2.0s. If the string makes an angle of 60^0 to the vertical at the point of suspension. Calculate the:
(i) Vertical height of the point of suspension above the circle. (3)

(ii) Length of the string (2)

(iii) Velocity of the mass attached to the string. (3)

(e) Give ONE example of oscillatory motion which approximates simple Harmonic motion. (1)

(f) Explain why the acceleration of a ball bearing falling through a liquid decreases continuously until it becomes zero. (4)

2(a)(i) State the Newton's law of gravitaion and deduce the dimensions of the gravitational constant G. (4)

(ii) A body has weight of 10N on earth. What will be the weight of the body on the moon, if the ratio of the moon's radius to the earth's radius is 0.27 and that of the moon's mass to the earth's mass is 1.2 x 10 (4)

(iii) Sketch a graph to show the variation of the acceleration due to gravity with distances from the centre of the earth. (2)

(b) A 10^3kg satellite is launched is a packing orbit about the earth.

(i) Calculate the height of the satellite above the earth's surface. (4)

(ii) Calculate the mechanical energy of the satellite. (3)

(iii) Explain the effect of friction between such a satellite and the atmosphere in which it moves. (3)

3(a)(i) What is meant by VISCOSITY? (1)

(ii) Explain the effect of temperature on the viscosity of a gas. (3)

(iii) Sketch the velocity-time graph for the motion of an oil drop in air. (1)

(iv) Find the terminal velocity of a oil drop of radius 2.5×10^{-6} m which falls through air. Neglect air density.

[Viscosity of air = 1.8×10^{-5}Nsm^{-2}
Density of oil = 900kg/m^3] (4)

(v) Explain why the velocity of a liquid at a wide part of a tube is less than that at a narrow part. (2)

(b)(i) State Archimedes' principle. (1)

(ii) Describe how you would measure the density of an irregular solid which floats in water. (5)

(iii) A hydrometer floats in water with 72% of its volume submerged. The hydrometer floats in another liquid with 80% of its volume submerged. Find the relative density of the liquid. (3)

SECTION B

4(a)(i) Explain why the molar heat capacity of an ideal gas at constant pressure, Cp, differs from the molar heat capacity. Cv. (2)

(ii) Derive the relation Cp- Cv = R, where R is the universal gas constant. (4)

(b) A vessel containing 1.5 x 10^{-3} m^3 of an ideal gas at a pressure of 8.7 x 10^{-2}Pa and temperature 25^0C is compressed isothermally to half its volume and then allowed to expand a diabatically to its original volume.

(i) Calculate the final pressure and temperature of the gas. (Take CP/Cv = 1.41) (7)

(ii) Sketch the work done during the isothermal process. (3)

(c) Use the kinetic theory to account for the increase in pressure of a gas when its temperature is increased at constant volume. (3)

5(a)(i) State the assumptions made in the derivation of the expression $P = \frac{1}{3}pC^2$ for pressure of an ideal gas. (2)

(ii) Use the expression in (a)(i) above to deduce Dolton's law of partial pressure. (3)

(b)(i) What is meat by a saturated vapour? (1)

(iii) Use the kinetic theory to account for the occurrence of saturated vapour pressures. (3)

(d) A column of Nitrogen is trapped in a capillary tube of uniform cross sectional area and closed at one end by a thread of water as shown below:

Water thread

Nitrogen column

The length h is 20.8 cm at 25^0C and 25.2cm at 83.3^0C. Calculate the SVP of water at 83.3^0C if its value at 25^0C is 1.70×10^3 Nm^{-2} Neglect the weight of the water thread and assume that atmospheric pressure remains at 1.01×10^5 Nm^{-2}.

(d(i) Explain the variation of SVP of water with temperature at constant volume, with suitable illustrations. (3)

(ii) Using the same axes, sketch pressure Vs volume graphs for a real gas:
(i) Above the critical temperature.
(ii) At the critical temperature
(iii) Below the critical temperature indicate in your sketch the different phases of the gas. (5)

6(a) Define specific Heat Capacity. (1)

(b) Describe an electrical method for measuring specific heat capacity of a metal. (6)

(c) In a continuous flow calorimeter for measurement of specific heat capacity of a liquid, $3,6 \times 10^{-3}m^3$ of liquid flows through the apparatus in 10 minutes. When electrical energy is supplied to the heating coil at a rate of 44W, a steady difference of 4k is obtained between the temperatures of the out flowing and inflowing liquid. When the rate of flow is increased to $4.8 \times 10^{-3}m^3$ of liquid in 10 minutes, the electrical power required to maintain the temperature difference is 58W. Find the:

(i) Specific Heat Capital of the liquid. (6)
(ii) Rate of loss of heat to the surroundings. (2)
(Density of liquid = $800m^{-3}$)

(d)(i)State any two advantages of continuous flow method over the method of mixtures for the determination of SHC's of liquids. (2)

(ii) Explain why evaporation causes cooling. (3)

END