MENGO SENIOR SCHOOL
S5 PHYSICS PAPER 1
END OF TERM/YEAR 2001 EXAM
TIME: 2½HOURS.

Instructions:

Attempt ALL Questions
Assume, where necessary:

- Acceleration due to gravity g = 9.81ms^{-2}
- Mass of the earth = 6.0 x 10^{24}kg
- Universal gravitation constant G = 6.67 x 1.0^{-11} Nm2 kg^{-1}
- Radius of the Earth = 6.4 x 10^{3}km

1- a) What is meant by the terms:

(i) terminal velocity (2 marks)

(ii) coefficient of viscosity (1 mark)

b) (i) Draw a velocity time graph for a steel ball bearing dropped contrally in a long column of viscous liquid and label it. (2 marks)

(ii) Derive an expression for the terminal velocity of a steel ball bearing of radius r and density f falling through a liquid of density falling through a liquid of density δ and coefficient of η.

c) The table below give the time of fall of steel spheres of different diameters falling through a liquid of density 1.26 x 10^{3}kgm^{-3}. The density of steel is:

Time/s X10^{-2}	8.36	6.89	5.80	4.93
Diameter/mm	2.0	2.2	2.4	2.6

(i) Calculate the uniform speed Vo of each steel ball. (2 marks)

(ii) Plot a graph of Vo against d^{2}.

(iii) Use the graph in (ii) above to find the viscosity of the liquid.

d) (i) Explain the origin of viscosity in a gas.

(ii) Explain how the coefficient of viscosity of a gas is affected by temperature.

2- a) (i) Define: Surface Tension and Angle of contact. (3 marks)

(ii) Derive an expression for the pressure difference between the inside and outside of an air bubble of radius r in δ liquid of surface tension . (4 marks)

b) A horizontal pipe of radius 2.0cm at one end, gradually increases in size so that its radius is 5cm at the other end. Water is pumped into the smaller end at a velocity of $8.0ms^{-1}$ and pressure of 2×10^5 pa. Find the velocity and pressure of water at the wider end. (4 marks)

c) A U-tube is made from two pieces of glass tubing of internal diameters 2.5mm and 5.0mm respectively. The U-tube contains water of surface tension $6.4 \times 10^{-2}Nm^{-2}$. Assuming that the angle of contact of water with glass is zero, calculate the difference in the levels of water in the two limbs of the U-tube. (4 marks)

d) (i) State Archimede's principle. (1 mark)

(ii) 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 density of the liquid. (4 marks)

3- a) (i) What is young's modulus of elasticity? (1 mark)

(ii) Draw a well labelled graph of stress Vo strain for steel, and briefly explain each of the regions or points on the curve. (5 marks)

b) A mass of 5kg is attached to the end of a vertical wire of length 2m and Diameter 0.82mm, and causes an extension of 0.7mm.

Find: (i) The tensile strain (2 marks)

(ii) The tensile stress (2 marks)

(iii) Young's modulus (2 marks)

c) Distinguish between scalar and vector quantities. Give two examples of each. (3 marks)

d) (i) Define the terms time of flight and range as applied to projectile motion. (2 marks)

(ii) A projectile is fired in air with speed U ms^{-1} at an angle θ to the horizontal.
Find the time of flight of the projectile. (2 marks)

4- a) Define the terms: (i) Acceleration (1 mark)

(ii) Angular velocity (1 mark)

b) (i) A car is moving along a rough circular road of radius r. If the coefficient of friction between the car tyres and the road is μ, derive an expression for the maximum value of the velocity with which the car moves so that it does not skid. (3 marks)

(ii) If the road was banked at an angle θ, What would this velocity in b(i) above be? (3 marks)

c) (i) A mass m is suspended at the end of a vertical spring of constant k. Show that if this mass is given a small downward displacement x, it oscillates with SHM of period $T = 2\pi \sqrt{\frac{e}{g}}$ (4 marks)

(ii) Show that if 2 similar springs each of force constant k are placed vertically in parallel and a mass m attached at the middle of a short connecting horizontal bar, then the period of oscillation T, of the system is given by $T, = \left(\frac{T}{\sqrt{2}}\right)$
where T is as in c(i) above. (3 marks)

d) If the mean density of the earth is 5500kgm^{-3}, find a value for the Acceleration due to gravity at the earths surface. Drive the formula used. (5 marks)

5- a) (i) What is meant by Dimensions of a physical quantity. (1 mark)

(ii) Show that the equation, $V^2 = U^2 + 2ab$,

Where u and v are the initial and final velocities respectively, S is the distance covered and a is the acceleration, is dimensionally correct. (2 marks)

b) (i) By graphical method, derive the relation between the initial velocity u, final velocity v for a particle which acceleration uniformly for a time t with acceleration a. (3 marks)

(ii) A stone is projected upwards from a point 1.95m above the ground with a speed of $20ms^{-1}$. Find the maximum height from the ground reached by the stone.

c) (i) A body of mass M, moving with a velocity u, collides with a body of mass m_2 moving in the same direction with a velocity of u_2. The two bodies undergo elastic collision and they each move with a velocity of $\sqrt{1}$ and $\sqrt{2}$ respectively after collision.

Assuming Newton's experimental law where e is the coefficient of restitution and conservation of linear momomentum.

Show that:

$$\sqrt{1} = \frac{(m_1 - em_2)u_1 + m_2(1 + e)u_2}{}$$

(ii) A ball of mass 10 kg, moving at 8mls impinges directly on a back of mass 8kg moving in the opposite direction at 4mls.

If $e = \frac{1}{3}$, find their velocities after impact.