PAPER II PART A - STRUCTURED ESSAY

1. The apparatus used for determination of young`s modulus (Y) of a material in the form of a wire in a laboratory consists of two identical vertical wires of the same material fastened to a rigid support. The wires carry a main scale (S) a vernier scale (V), a fixed load (W_0) and a scale pan (P).

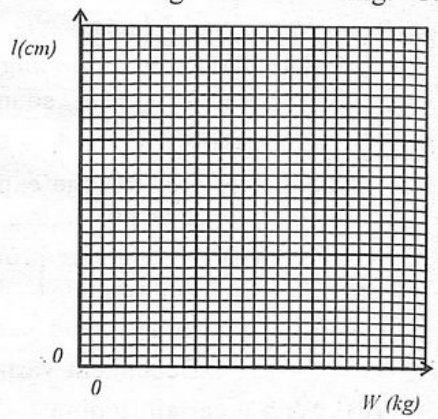
   (a) Draw a labelled diagram of this apparatus in the space provided. 7cm available

   (b) What is the purpose of having **two** wires in this set - up . *(2 lines)*

   (c) In this experiment it is necessary to take readings while loading and unloading. Give reasons. *(2 lines)*

   (d) In such an experiment following measurements were taken by a student.

Load (kg)	Average scale reading (cm) loading and unloading
1.0	1.236
1.5	1.246
2.0	1.256
2.5	1.266
3.0	1.276



   (i) Use the above set of readings to plot a graph of effective load (W) vs the corresponding increase in the length of the wire (l),and find the gradient m.

   m = ...

   (ii) What other additional measurements would yourequire to calculateY for the material. State appropriate measuring instruments for the above measurements.

   Measurement Instrument

   (a) ..... . α (say) .....

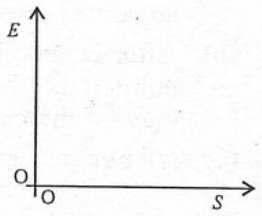
   (b) ..... β (say) .....

   (iii) In measuring one of the quantities mentioned in (ii) above a particular procedure has to be followed in order to obtain an accurate value. State this procedure. ***(two lines)***

   (iv) Write down an expressionfor the young`s modulus (Y) of the material used in this experiment interms of the gradient (m) of the graph and the measurements α and β.

   Y = ...

   (e) Young`s modulus of steel is approximately twice that of aluminium. Draw rough sketches of the stress (S) - strain (E) curves for aluminium and steel onthe diagram given.



2. The method of mixtures is used in the laboratory to find the specific heat capacity of lead in the form of lead shots. One of the major items used in this experiment is the calorimeter.

   (a) Make a list of other important apparatus used in this experiment. *(two lines)*

   (b) Statethe processes by which the heat is lost in the calorimeter. *(two lines)*

   (c) Outline briefly the methods adopted to minimize the heat loss from the calorimeter due to each of the above processes. *(5 lines)*

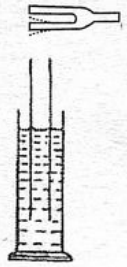
   (d) What is the main reason to select a fixed temperature such as the boiling point of water as the initial temperature of lead shots? *(two lines)*

   (e) State precautions that you would take when tranaferring lead shots to the calorimtter. *(3 lines)*

(f) In what way does the use of lead shots instead of large pieces of lead affect the value of the final temperature of the mixture ? Explain your answer. *(two lines)*

(g) Cooling correction is important if the method of mixtures is used to determine the specific heat capacity of an insulating material such as rubber. Explain why. *(two lines)*

3. An experimental set-up used in the laboratory to determine the speed of sound in air by resonating air columns is shown inthe figure.



(a) Briefly describe the procedure that you would adopt to obtain the fundamental note of vibration of the air column with this set-up.
(3 lines)

(b) If the corresponding length of the air column measured in (a) is l and the wavelength of sound waves in air is λ, write down the relationship between l and λ. (neglect the end correction of the tube.) *(one line)*

(c) (i) Rewrite the expression in (b) interms of l, speed of sound in air V, and the frequency n of the tuning fork. *(one line)*

(ii) If you are provided with several tuning forks of known frequencies and asked to determine V by plotting a graph state the quantities that you would plot

Independent variable .....

Dependent variable : .....

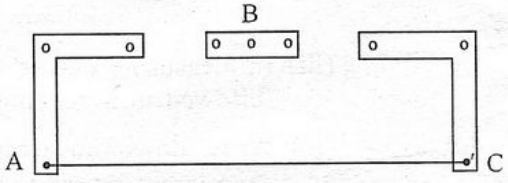
(d) With a certain tuning fork the value of l was observed to be 35 cm. If the length of the tube is 75 cm, explain whether it is possible to find another position of the tube in water where resonance is produced with the same tuning fork. *(two lines)*

(e) If the room temperature is increased, would you expect l to be greater than, equal to or less than 35cm. ? Give reasons for your answer. *(two lines)*

(f) If alcohol is used instead of water in this experiment, would you expect the same value for V as measured in (C) (ii) ? Explain the answer. *(two lines)*

(g) For accurate calculations an end correction has to be introduced only to the open end fo the tube and not to the closed end, Explain why. *(3 lines)*

4. The diagram shows a slide-wire metre bridge . You are provided with a resistance box R, a coil of unknown resistance X, a slider S, a sensitive galvanometer G, a cell E, a key K, and some connecting wires.



(a) Draw, on the given diagram, the circuit you would use to determine the resistance X using the apparatus provided.

(b) After connecting the circuit with a suitable value in R, and while attempting to find the balance point it is observed that the galvanometer deflections are always in the same direction. what may be the cause for this ? *(two lines)*

(c) (i) For accurate determination of the unknown resistance what value in R is more suitable? *(one line)*

(ii) Give the reason for your answer. *(two lines)*

(d) in this type of experiment, while finding the balance point it is not advisable to slide S over the wire or press hard on the wire; Give the man reason for this. *(two lines)*

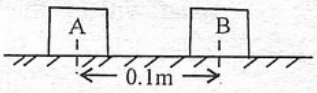
(e) In all metre bridge experiments, for the same values of X and R two balance lengths are usually obtained by having X and R interchanged in positions. Explain why. *(3 lines)*

(f) In these experiments, it is advisable to use an additional resistance box R' with the galvanometer. state the purpose of R' *(two lines)*

(g) For measuring or comparing low resistances which are less than 1Ω , a potentiometer is more suitable than a metre bridge Explain why. *(4 lines)*

PAPER II PART B - ESSAY

1. Answer **either** part (a) or part (b).



(a) State Newton`s law of universal gravitation.

Two identical blocks A and B of mass 100 kg each are placed on a light rough horizontal surface in a region where there are no other objects except the earth which exerts an attractive force on A and B in the vertically downward direction.The centres of gravity of the blocks are 0.1m apart as shown in the figure and the coefficient of static frietion of the horizontal surface is 0.1.

(i) Taking the universal gravitational constant (G) to be equal to 6.67×10^{-11} Nm^2 kg^{-2} find the magnitude of the gravitational force acting on B due to A. Indicate the direction of this force on B.

(ii) Does the block B move towards A due to the gravitational force mentioned in (i) ? Explain your answer.

(iii) Is there a frictional force acting on B ? If so, what is its magnitude ?

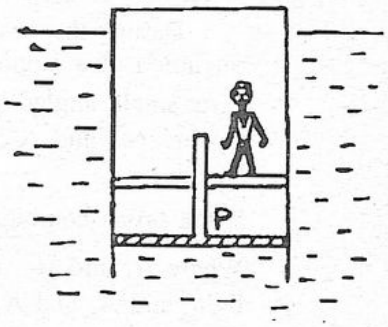
(iv) Calculate the minimum mass that the block A should have in order to set the block B in motion.

(b) Define surface tension, Describe briefly a laboratory method to determine the surface tension of water using capillary rise.

A glass tube of internal radius 12 mm, wall thickness 0.4 mm, and open at both ends, is suspended vertically from a sensitive spring balance; A beaker containing a liquid is now brought slowly so that the surface of the liquid just touches the lower end of the suspended glass tube. What happens to the reading of the balance ? Explain your answer. The beaker of liquid is then raised until the original reading is seen again on the balance. If the depth of immersion of the tube is 3.67 cm, calculate the surface tension of the liquid assuming that the angle of contact of the liquid with glass is zero. Density of liquid is 1 000 kg m^{-3}.

2. State Archimede's principle.

A large thin walled cylindrical vessel fitted with a mechanically operated pistion (P) at its open end as shown in the figure, is used to send a person to the sea bed to collect specimens. The water level inside the vessel can be adjusted by raising or lowering the piston. The air pressure inside the vessel is always maintained at the atmospheric pressure by means of an internal air pumping system.



(i) When the vessel is put into the sea the volume of air trapped inside the vessel is found to be $2m^3$ and the vessel is found to float with 1/10th of this air volume above the sea level as shown in the figure. Find the mass of the vessel and its contents. (Density of water = 1 000 kg m^{-3})

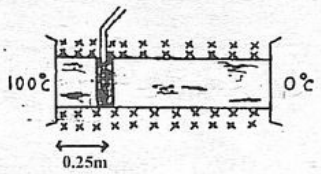
(ii) If the area of cross section of the piston is 0.75 m^2, find at least by howmuch the water level inside the vessel be raised in order ot make it sink.

(iii) When the specimens were stored in the vessel at the sea bed it was found that at least 0.05 m^3 of water had to be removed from the vessel to lift off. Calculatc the mass of the specimens collected.

(iv) If the sea is 500 m deep how much minimum work has to be done on the piston in order to move the vessel up to the surface ? Neglect viscous effects.

3. "When an immersion heater is switched on without inserting it in water it will burn out soon. but when it is in water it works normally" . Explain this statement.

What will be the maximum temperature attained by the surface of the heater when it is used to boil water?



One end of a uniform lagged steel bar, 1 m long and area of cross section 0.01 m^2 is kept at 100^0C and the other end at 0^0C as shown in the figure.

A thin slot is cut across the bar 0.25 m away from the 100^0C end, and a 200 W flat electrical heating element is inserted into the slot as shown in the figure. The slot is then filled with mercury to ensure a good thermal contact between the heating element and the bar. When the heating element is switched on and the system has attained the steady condition calculate the surface temperature of the element. Assume that mercury is a perfect conductor of heat. (Thermal conductivity of steel = 50 J m^{-1} s^{-1} k^{-1}.)

4. Describe briefly the wet-and-dry bulb hygrometer and discuss how you would use it to find the relative humidity of the atmosphere. State precautions, if any, that have to be taken in order to obtain an accurate value for the relative humidity.

Temperature °C	Mass (g) of water vapour required to saturate 1 m^3 of air
24	21.54
22	19.22
20	17.42
18	15.22
16	13.50

Temperature °C	Mass (g) of water vapour required to saturate 1 m^3 of air
14	11.96
12	10.57
10	9.33
08	8.21
06	7.22

On a day when the relative humidity of the atmosphere is 80% a certain room of capacity 48 m^3 was isolated from the rest of the atmosphere and its relative humidity was reduced to 50% by means of a machine which absorbs water vapour from air without changing its temperature. Once the room had attained the 50% humidity level it was found that the machins had collected 430 g of water from the air inside the room. Use the above data and the table to calculate

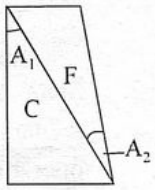
(i) the dew point of the room to the nearest degree.

(ii) absolute humidity of the atmosphere outside the room.

5. Answer **either** part (a) or part (b)

(a) What do you mean by dispersion of light ?

Define the dispersive power of a prism. Write down an expression for the deviation of a monochromatic ray of light refracted through a small angled prism.



Two small angled prisms, made of crown (C) and flint (F) glasses of dispersive powers ω_1 and ω_2 respectively, for the yellow colour, are placed as shown in the figure.

If the prism combination is achromatic, show that, $\omega_1 (\mu_1 - 1) A_1 + \omega_2 (\mu_2 - 1) A_2 = 0$

Where μ_1 and μ_2 are the refractive indicies of crown glass and flint glass respectively, for yellow light, and A_1 and A_2 are the respective refracting angles of the prisms.

A flint glass prism is to be combined with a crown glass prism of refracting angle 10^0 so that the combination is achromatic between the red and blue light.what should be the angle of the fint glass prism.

Refractive index of flint glass for blue light = 1.6691

Refractive index of flint glass for red light = 1.6501

Refractive index of crown glass for blue light = 1.5232

Refractive index of crown glass for red light = 1.5146

(b) A compound microscope in normal adjustment is used to view a point object situated off the axis. Draw the paths of two light rays from the object to the eye through the microscope.

Define the magnifying power of a microscope and explain why a compound microscope is usually employed rather than a single lens, when a large magnifying power is required.

The desired overall magnifying power of a compound microscope is 140. The objective itself has a magnifying power of 12 Find the required focal length of the eye piece assuming that the final image will be formed 25 cm from the eye. Derive any formula you may use.

In a certain experiment it is necessary to place a cross- wire in the compound microscope. Show

on a diagram where this would be located. Assume that the final image is formed at infinity in this case.

6. Write down expressions for transverse and longitudinal wave speeds along a stretched wire show that the expression for longitudinal wave speed is dimensionally correct.

A heavy wire is hung freely and vertically from a fixed support. Transverse and longitudional waves are sent up along the wire, separatcly from its lower end. Will these waves have constant speeds along the wire? Explain your answer.

A uniform steel wire of area of cross section $1.2\text{x}10^{-6}$ m^2 is stretched horizontally. What should be the tension of the wire such that the speed of transverse wave along the wire is same as that of longitudinal wave? Explain why this condition cannot be achieved practically.

Young`s modulus of steel $= 2\text{x}10^{11}$ Nm^{-2} Density of steel $= 7.8\text{x}10^{3}$ kg m^{-3}

7. Answer **either** part (a) or part (b)

(a) Define the lerm "resistivity" of a conducting material.

A d c generator supplies a voltage of 240 V to a resistive load of 120Ω situated 1 km away from the generator.

(i) If the resistive load is connected to the generator by means of copper wires having diameter of 0.5 mm calculate the voltage of the d c gencrator. (Resistivity of copper $= 1.7\text{x}10^{-8}$ Ωm)

(ii) What is the power dissipated in the wires ?

(iii) If the d c generator can provide only 241 V how would you supply the above mentioned voltage (i.e. 240 V) to the resistive load using the wires of same material?

(iv) In long distance power transmission why it is advantageous to use an alternating high voltage ?

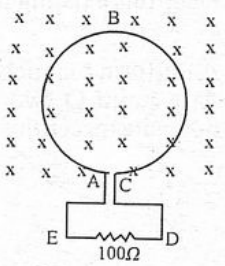
(b) Draw a clear labelled diagram showing the essential features of a moving coli galvanometer. Explain how a steady defiection is produced when a steady current is passed through such a galvanometer.

A galvanometer with a resistance of 39.8 Ω is fitted with a shunt resistance of 0.2 Ω to function as an ammeter with a full scate deflection of 10 A. What is the actual current through the galvanometer when is shows a full seale defiection ?

This galvanometer is now to be used as a voltmeter with two different ranges having full scale deffections of 3V and 15 V respectively. what resistances should be used and how shoul they be fitted to achieve this ?

8. State the laws of electromagnetic induction.

As shown in the figure a thin rigid wire is formed into a circular loop ABC and placed perpendicular to a uniform magnetic field which is directed into the plane of the paper. The loop is connected to a resistance of 100 Ω using thin connecting wires. The radius of the loop is 7 cm and the, magnetic flux density of the field **decreases** with time at a constant rate of 10^{-2} T s^{-1}



(i) Neglecting the effect of connecting wires, calculate the magnitude of the e.m.f. induced in the loop.

(ii) Assuming that the resistances of the loop and connecting wires are hegligible, find the magnitude of the current thuough 100Ω .

(iii) What is the direction of the current through 100 Ω resistor? (from D to E or E to D)?Explain clearly how you arrived at the answer.

(iv) When the current flows through the loop a tension is developed in the wire, Explain how this arises and calculate this tension at the instant when the magnitude of the magnetic flux density, threading the loop is 0.1 T.