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Open Competitive Examination for the Recruitment to the Trainee Grade of the Posts of Inspectors of Measurement Services Devices and Lab Assistant of the Sri Lanka Technological Service of Department of Measurement Units, Standards and Services – 2017 (2018)

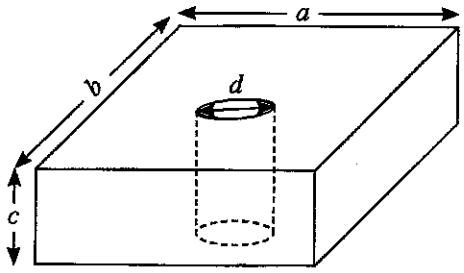
(02) Technological Question Paper

Two hours

Answer **all** questions.

1. As shown in the figure, a wooden paper weight with a cylindrical hole is given to you for the determination of the density of wood.

Approximate measurements of the paper weight are given as follows.



length (a)	= 15 cm
breadth (b)	= 7 cm
thickness (c)	= 8 mm
and	
diameter of the hole (d)	= 3 cm

Following instruments are provided to you which are available at the laboratory.

- meter ruler
- triple beam balance
- vernier calliper
- micrometer screw gauge

(i) Write down the least count (minimum reading) of the following instruments.

(a) meter ruler

(b) micrometer screw gauge

(In the micrometer screw gauge, assume that one thread is 0.5 mm and the circular scale is divided into 50 divisions)

(ii) If 50 vernier divisions is equal to 49 divisions of the main scale (given in mm) of the given vernier calliper, calculate the minimum reading of the vernier calliper.

(iii) Write down the reasonably suitable measuring instrument for the measurements of a, b, c and d.

(iv) What are the precautions you may take to get the above measurements accurately.

(v) Name the other measurement needed to calculate the density of wood and label it as '**W**'.

(vi) Write down an expression to find the volume '**V**' of the wooden paper weight using relevant measurements.

(vii) Write down expression for calculating the density of wood '**d**' using all the measurements you have taken.

(viii) Suppose that you are provided with an odd shaped small piece of wood, a similar size piece of iron, a piece of thread, water and a measuring cylinder. Suggest a method to find the volume of the odd shaped piece of wood, using these objects and equipments.

[*See page two.*

2. In order to find the mass (W) (W~30 g) of a glass stopper in a laboratory using the lever method, you are provided with the following items.

- a known weight of mass W_0 (20 g)
- a meter ruler
- sufficient amount of strings
- a stand with necessary components

(i) A student hangs the meter ruler at the stand using a string attached to its centre mark (50 cm mark). Is this correct? If **not** what is the correct method?

(ii) Draw a rough diagram of the experimental set-up and mark W and W_0.

(iii) If the string is attached to the meter ruler at the point O (hanging point), the distance to the glass stopper from O is l_1 and the distance from O to the point at which the 20 g is attached is l_2, write the relation (equation) between l_1 and l_2 in the form of $y = mx$.

(iv) What is the reason for choosing a weight of mass W_0 = 20 g?

(v) You are given the readings obtained in this experiment in the table shown here. Draw the relevant graph in the given graph paper using the equation, you have written in part (iii) above.

l_1 (cm)	l_2 (cm)
10	8.5
20	18.0
30	28.5
40	37.0
45	41.5
50	45.5

(vi) What is the gradient of the graph drawn?

(vii) Using the gradient of the graph drawn, calculate the mass of the glass stopper.

3. (i) How do you adjust a Travelling microscope for the best performance?

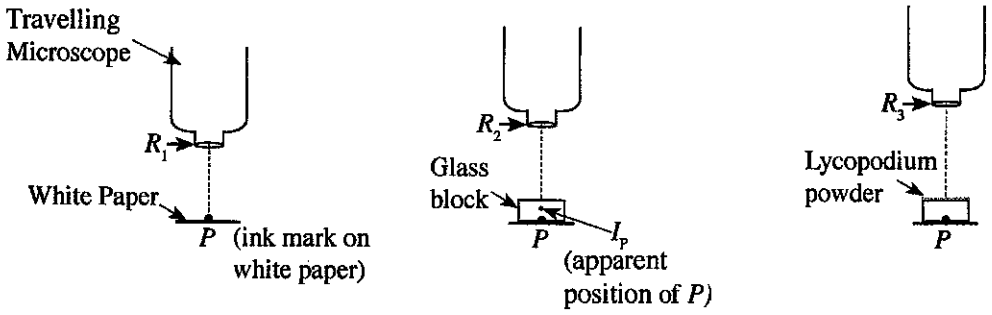
(ii) (a) You are provided with a Travelling microscope, a capillary tube and a suitable stand. Using the diagram of the cross section of the capillary tube shown here, mark two positions (in horizontal directions) at which you take readings in order to determine the diameter of the capillary. Mark them as x_1 and x_2. (Copy the diagram and name.)

(b) Mark the other two possible positions on the same cross-section at which you focus the microscope so that you may calculate another value for the diameter of the capillary tube. (Mark those two points as y_1 and y_2)

(c) Write down an expression for the average diameter of the capillary in terms of x_1, x_2, y_1 and y_2.

[*See page three.*

(iii) In order to determine the refractive index of glass using a Travelling microscope you are provided with a Travelling microscope, a glass block, a white paper and Lycopodium powder. Here you are supposed to determine the refractive index of the glass block by measuring the real thickness and apparent thickness of the block.



According to the above three diagrams,

R_1 – reading of the Travelling microscope focused on the ink mark (P) on the white paper, without the glass block.

R_2 – reading of the Travelling microscope focused on the apparent position of the ink mark (I_P), after the glass block is placed on the ink mark.

R_3 – reading of the Travelling microscope focused on Lycopodium powder spread on the top surface of the glass block.

(a) Obtain an expression for the refractive index of glass in terms of R_1, R_2 and R_3.

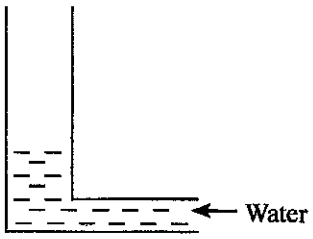
(b) In the experiment, following readings were taken for R_1, R_2 and R_3.

R_1=41.45 mm, R_2=48.82 mm, R_3=63.56 mm.

Calculate the refractive index of glass.

(c) What is the least count of the Travelling microscope used?

4. Figure shows an experimental set–up which can be used to find the speed of sound in air in the laboratory. You are provided with a tuning fork of frequency 180 Hz.



(i) What types of wave forms are produced in the air column above the water level out of transverse or longitudinal and progressive or stationary?

(ii) How do you get the resonance state?

(iii) As shown in the figure, water is filled to a tall vertical tube of cross–sectional area 2.0×10^{-3} m^2 through a narrow tube. At one instant, when the water level in the tube was low, resonance was heard. When an additional amount of water (2.0×10^{-3} m^3) was sent into the tube, the next resonance was heard and that was the **last resonance** heard.

(a) Copy the above figure and draw how you place the tuning fork above the air column.

(b) Draw the wave form corresponding to the first resonance. Draw another diagram corresponding to the second resonance.

(c) Calculate the wavelength of the vibrating air column.

(d) Calculate the speed of the sound in air.

[*See page four.*

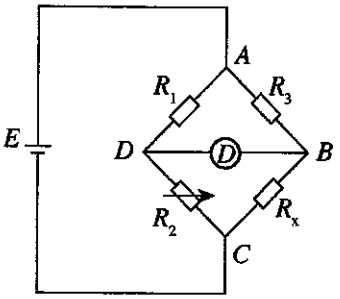
(iv) What are the factors which affect the speed of sound in air?

(v) If you use the following liquids in place of pure water, what would you expect with regard to the accuracy of the measurement of speed of sound in air?

(a) Muddy water

(b) Alcohol

5. (i) A balanced Wheatstone bridge is shown in the figure.

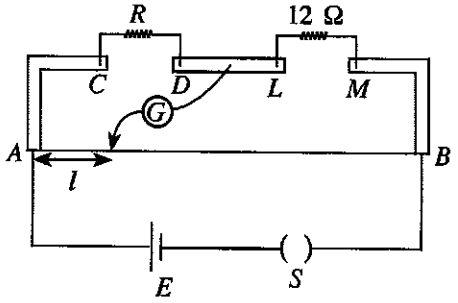


(a) Show that $\frac{R_1}{R_2} = \frac{R_3}{R_x}$

(b) Can we get the balance without changing the resistance values shown in the figure by interchanging the detector (D) and the battery (E)? Explain your answer.

(c) If $R_1 = 20\ \Omega$, $R_2 = 40\ \Omega$, $R_3 = 30\ \Omega$ find R_x.

(ii) In the metre–bridge shown, the null deflection is shown on the galvanometer when $l = 40$ cm.



(a) Find the value of R.

(b) Now, if another resistance S is connected in parallel with the 12 Ω resistor spacing across L and M, the null deflection on the galvanometer is found with $l = 60$ cm. Find the value of S.

(c) If the value of l is too small, the accuracy of finding an unknown resistance is less. Explain why?

(d) What steps would you take to safeguard the galvanometer?

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