1. In this experiment, you will determine the constant, α, of the beaker using two methods and the constant, β, of the spring provided. *(40 marks)*

METHOD I

(a) Measure and record the length, l_o, of the spring as shown in Figure **1**

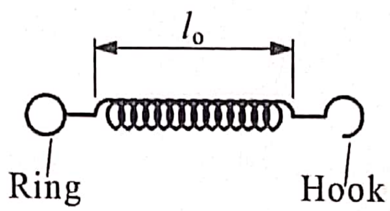

Fig. 1

(b) Suspend a metre rule from the clamp of a retort stand using a piece of thread.

(c) Adjust the position of the loop of the thread along the metre rule until the metre rule balances horizontally.

(d) Read and record the balance point, G.

(e) Tie a loop through one end of the spring.

(f) Suspend the spring from the balanced metre rule at a distance, $d = 17.5$ cm from the zero end of the metre rule.

(g) Suspend a mass labelled, Q, at the other end of the spring and balance the metre rule again as shown in Figure **2**.

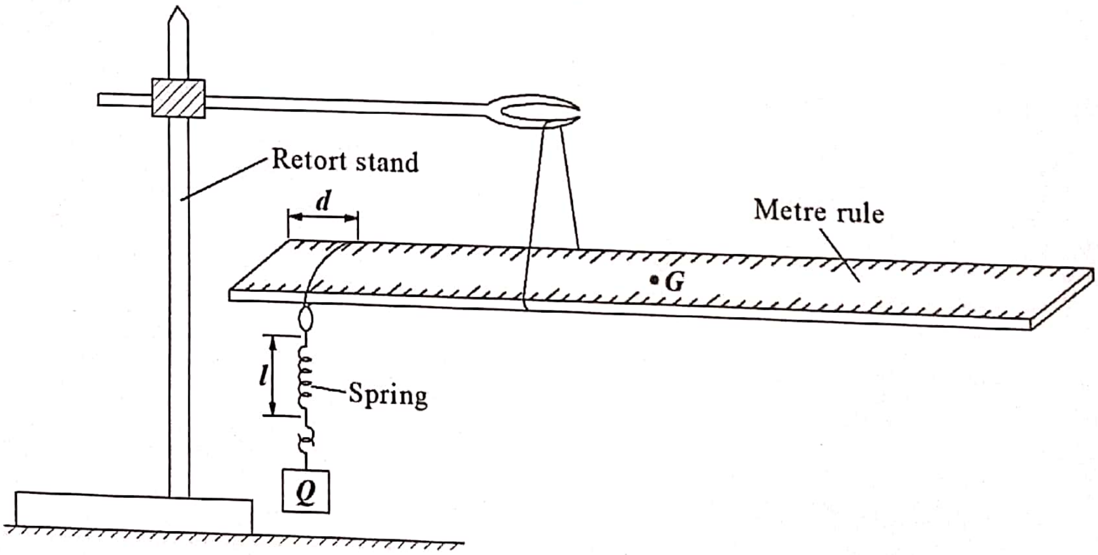

Fig. 2

(h) Measure and record the new length, l, of the spring.

(i) Calculate the value of the extension, e, in metres from the expression, $e = l - l_o$.

(j) Adjust the position of the loop suspending the metre rule to G.

(k) Record the length, l_1, of the spring from point G.

(l) Attach a mass of 50 g to the bottom of the beaker provided using sellotape.

(m) Suspend the beaker from the metre rule as shown in Figure **3**.

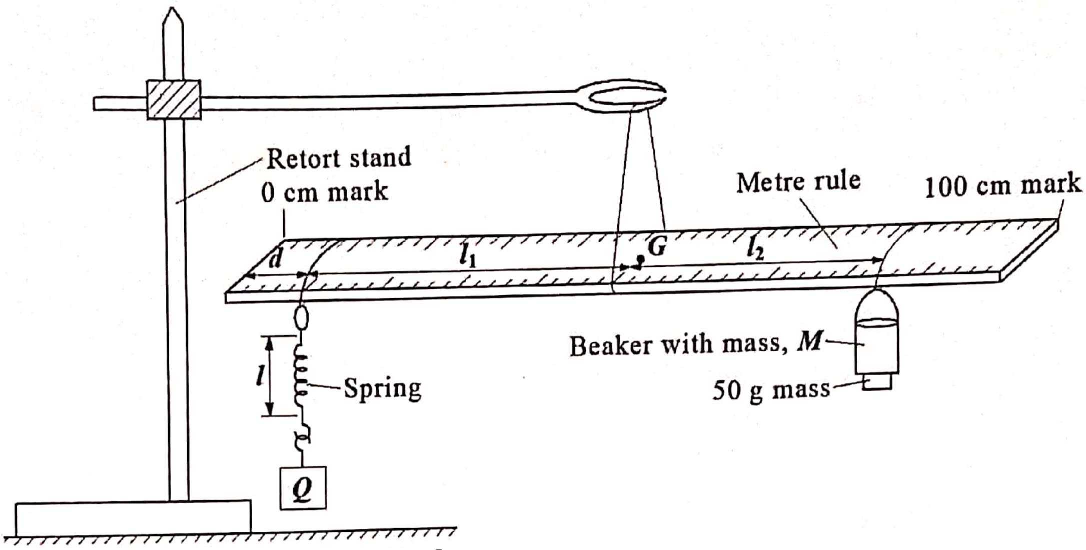

Fig. 3

(n) Place a mass, $M = 0.100$ kg into the beaker.

(o) Adjust the position of the beaker until the metre rule balances horizontally.

(p) Measure and record the balance length l_2.

(q) Repeat procedure (n) to (p) for values of $M = 0.200,\ 0.300,\ 0.400,\ 0.500$ and 0.600 kg.

(r) Tabulate your results including values of $\frac{l_1}{l_2}$ and $y = e^{\frac{l_1}{l_2}}$.

(s) Plot a graph of y against M.

(t) Determine the slope, S, of the graph.

(u) Calculate the value of the constant, β, from the expression;

$$\beta = \frac{g}{S}, \text{ where } g = 9.81 \text{ ms}^{-2}.$$

(v) Read and record the intercept, C, on the y - axis.

(w) Calculate the constant, α_l, from the expression;

$$\alpha_l = \frac{C\beta}{g} - 0.050.$$

DISMANTLE THE SET-UP

 Turn Over

METHOD II

(a) Suspend the half metre rule from the clamp of a retort stand using a piece of thread.

(b) Note the balance point G_1.

(c) Keeping the loop suspending the half metre rule at G_1, suspend mass Q, from the left of G_1 and the beaker from the right of G_1 as shown in Figure **4**.

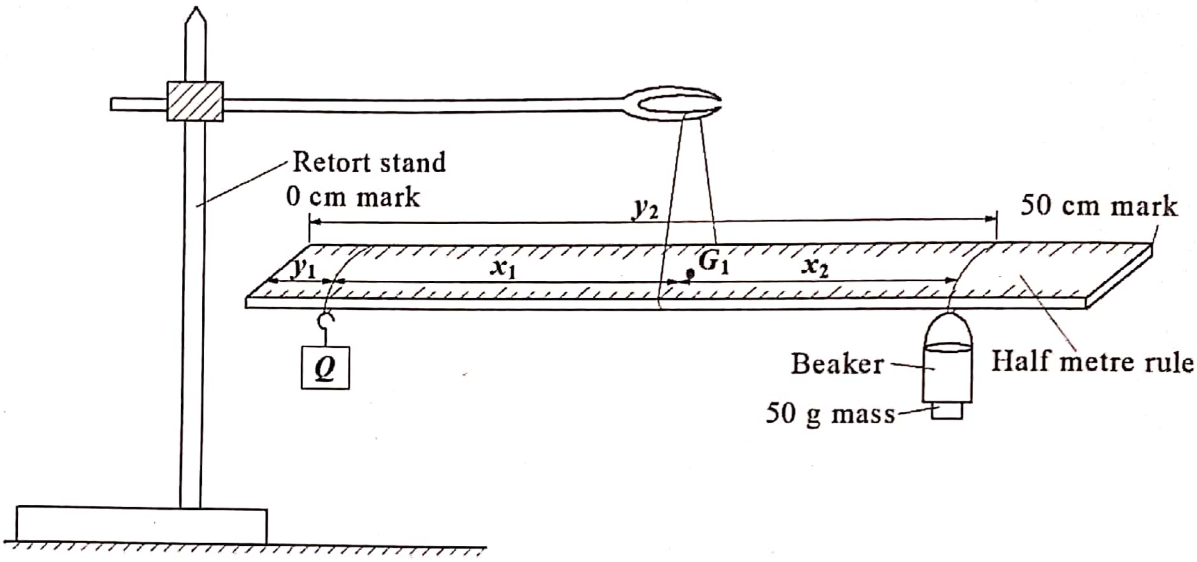

Fig. 4

(d) Adjust the positions of Q and of the beaker until the half metre rule balances horizontally.

(e) Read and record lengths y_1 and y_2 from the zero end of the half metre rule.

(f) Calculate the value of x_1 from the expression $x_1 = G_1 - y_1$ and x_2 from the expression $x_2 = y_2 - G_1$.

(g) Calculate the value of, α_2, from the expression;

$$\alpha_2 = \frac{0.150\,x_1 - 0.050\,x_2}{x_2}.$$

(h) Calculate the value of, α, from the expression;

$$\alpha = \frac{1}{2}(\alpha_1 + \alpha_2).$$

DISMANTLE THE SET-UP

2. In this experiment, you will determine the constant, γ, of the glass block provided using two methods. *(40 marks)*

METHOD I

(a) Fix a plain white sheet of paper on the soft board using drawing pins.

(b) Place the glass block in the middle of the plain sheet of paper with the broadest face upwards and trace its outline *ABCD*.

(c) Remove the glass block.

(d) Mark a point *O* on *AB*, 4.0 cm from *A* and draw a normal at *O*.

(e) Draw a line *QO* such that angle $\alpha = 40^{o}$ as shown in Figure 5.

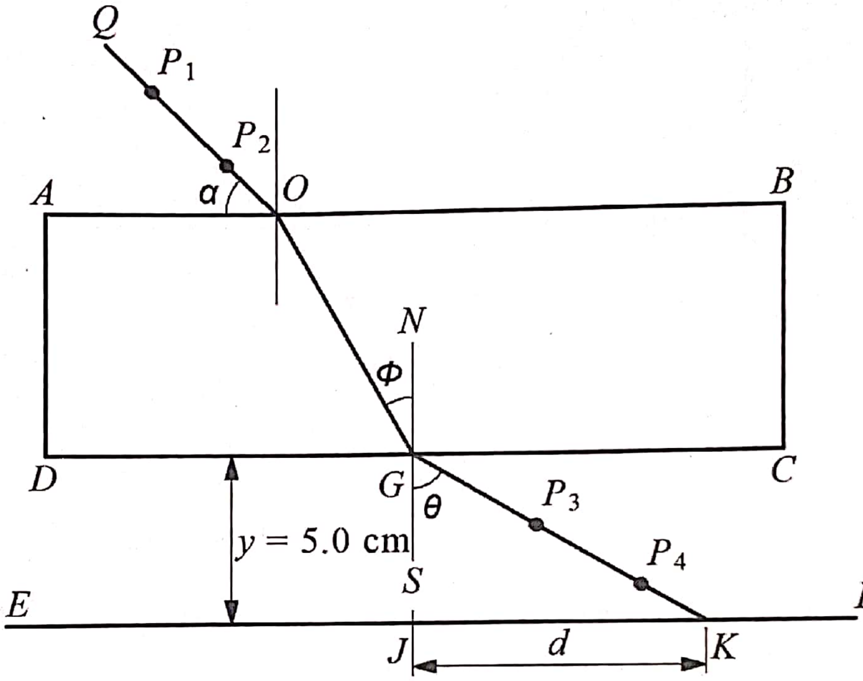

Fig. 5

(f) Draw a line EF =15.0 cm long parallel to *DC*, a distance $y = 5.0$ cm.

(g) Fix two optical pins P_1 and P_2 vertically on the line *QO*.

(h) Replace the glass block on its outline.

(i) While looking through the glass block from side *DC*, fix two optical pins P_3 and P_4 such that they appear to be in line with the images of P_1 and P_2.

(j) Remove the glass block and the pins.

(k) Draw a line through P_3 and P_4 to meet *DC* at *G* and *EF* at *K*.

(l) Join *G* to *O*.

(m) Draw a normal *NS* to *DC* at *G*.

(n) Measure and record angles ϕ and θ, and distance *d*.

(o) Calculate the value of, γ_1 , from the expression; $\gamma_1 = \dfrac{y\sin\phi}{d\cos\theta}$.

Turn Over

METHOD II

(a) Fix a fresh plain white sheet of paper on the soft board using drawing pins.

(b) Place the glass block in the middle of the plain sheet of paper with the broadest face upwards and trace its outline $XYZW$ as shown in Figure **6**.

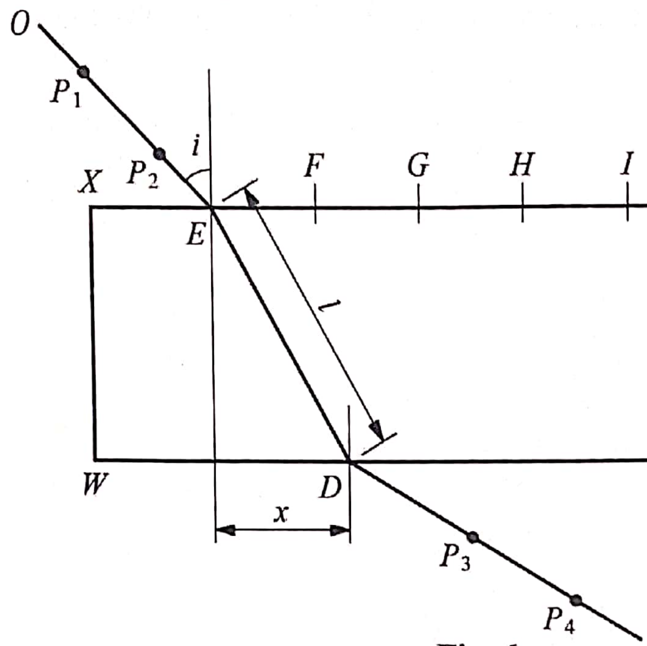

Fig. 6

(c) Remove the glass block.

(d) Mark points E, F, G, H, I and J such that they are 1.5, 3.0, 4.5, 6.0, 7.5 and 9.0 cm respectively from X.

(e) Construct normals to line XY at each of the points E, F, G, H, I and J

(f) Draw lines OE, PF, QG, RH, SI and TJ making angles $i = 45^0$, 40^0, 35^0, 30^0, 25^0 and 20^0 with the normals at E, F, G, H, I and J respectively.

(g) Put back the glass block onto its outline.

(h) Fix two optical pins P_1 and P_2 vertically on the line OE.

(i) While looking through the glass block from side ZW, fix two optical pins P_3 and P_4 such that they appear to be in line with the images of P_1 and P_2.

(j) Remove the glass block and the pins.

(k) Draw a line through P_3 and P_4 to meet ZW at D.

(l) Join D to E.

(m) Measure and record the lengths l and x.

(n) Repeat procedure (h) to (m) for each of the line PF, QG, RH, SI and TJ. (*Ensure that you measure the displacement* x from the *respective* normals.)

(o) Tabulate your results including values of $\frac{1}{\sin^2 i}$ and $\left(\frac{l}{x}\right)^2$.

(p) Plot a graph of $\frac{1}{\sin^2 i}$ against $\left(\frac{l}{x}\right)^2$.

(q) Determine the slope, S, of the graph.

(r) Calculate the value of, γ_2, from the expression $\gamma_2 = \sqrt{S}$.

(s) If the expected value of γ is 0.667, assess the accuracy of the two methods.

HAND IN YOUR TRACINGS TOGETHER WITH YOUR SCRIPT.

3. In this experiment, you will determine the constant, ρ of the bare wire labelled, W, using two methods. *(40 marks)*

METHOD I

(a) Connect the circuit shown in Figure 7

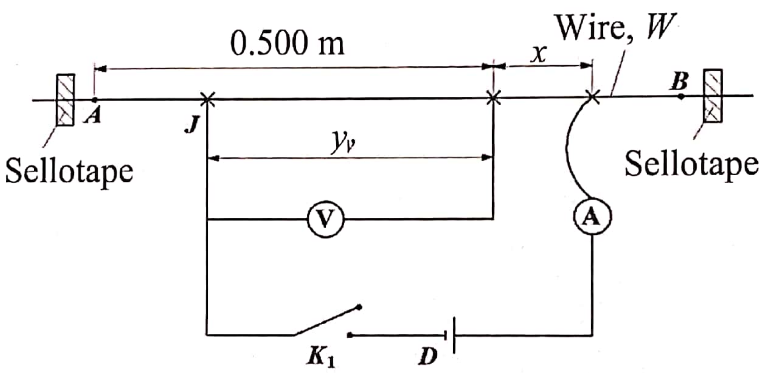

Fig. 7

(b) With switch K_1 open, adjust the length, x on the wire, W, such that $x_1 = 0.250$ m.

(c) Close switch, K_1.

(d) Move the sliding contact, J, until the ammeter reading, $I_1 = 0.26$ A.

(e) Read and record the voltmeter reading, V_1.

(f) Open switch, K_1.

(g) Repeat procedure (b) to (f) for values of $x_2 = 0.500$ m and $I_2 = 0.20$ A.

(h) Read and record the voltmeter reading, V_2.

(i) Calculate the constant, ρ_1, of the wire, W from the expression;

$$\rho_1 = \frac{1}{I_1 I_2 (x_2 - x_1)}\left[(V_1 I_2 - V_2 I_1) - 1.4(I_2 - I_1)\right].$$

Turn Over

METHOD II

(a) Connect the circuit shown in Figure **8**.

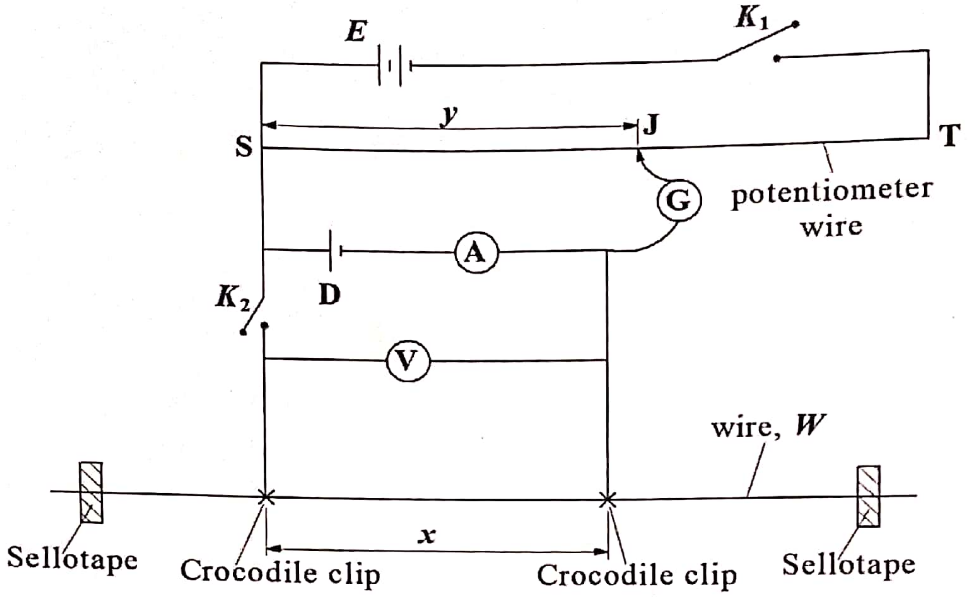

Fig. 8

(b) Close switch K_2 while keeping K_1 open.

(c) Adjust the position of the crocodile clip along the wire, W, until the length, $x = 0.200$ m.

(d) Close switch, K_1, while keeping switch, K_2 closed, adjust the position of the sliding contact, J, along the potentiometer wire ST until the galvanometer, G, shows no deflection.

(e) Read and record the balance length, y in metres.

(f) Read and record the readings, V and I of the voltmeter and ammeter respectively.

(g) Open switches, K_1 and K_2.

(h) Repeat procedure (b) to (g) for values of $x = 0.300,\ 0.400,\ 0.500,\ 0.600$ and 0.700 m.

(i) Tabulate your results including values of $\frac{V}{y}$ and $\frac{Ix}{y}$.

(j) Plot a graph of $\frac{V}{y}$ against $\frac{Ix}{y}$.

(k) Find the slope, ρ_2, of the graph.

(l) If the expected magnitude of the constant, ρ is 4.41, assess the suitability of the two methods in determining the constant.

(m) Find the constant, ρ, of the wire from the expression;

$$2\rho = (\rho_1 + \rho_2).$$

(n) State why step (m) is important.

END