AQA

General Certificate of Education
Advanced Subsidiary Examination
June 2015

Physics   PHY3T/P15/TN

Unit 3   Investigative and Practical Skills in AS Physics

Investigative Skills Assignment (ISA) P

Teachers' Notes   Confidential

The Exams Officer should make two copies of these Teachers' Notes; one copy for the Head of A-level Physics and one for the technician.
These copies can be released to the Head of A-level Physics and the technician at any point following publication but must be kept under secure conditions at all times.
Teachers can have sight of the Teachers' Notes but no further copies should be made.
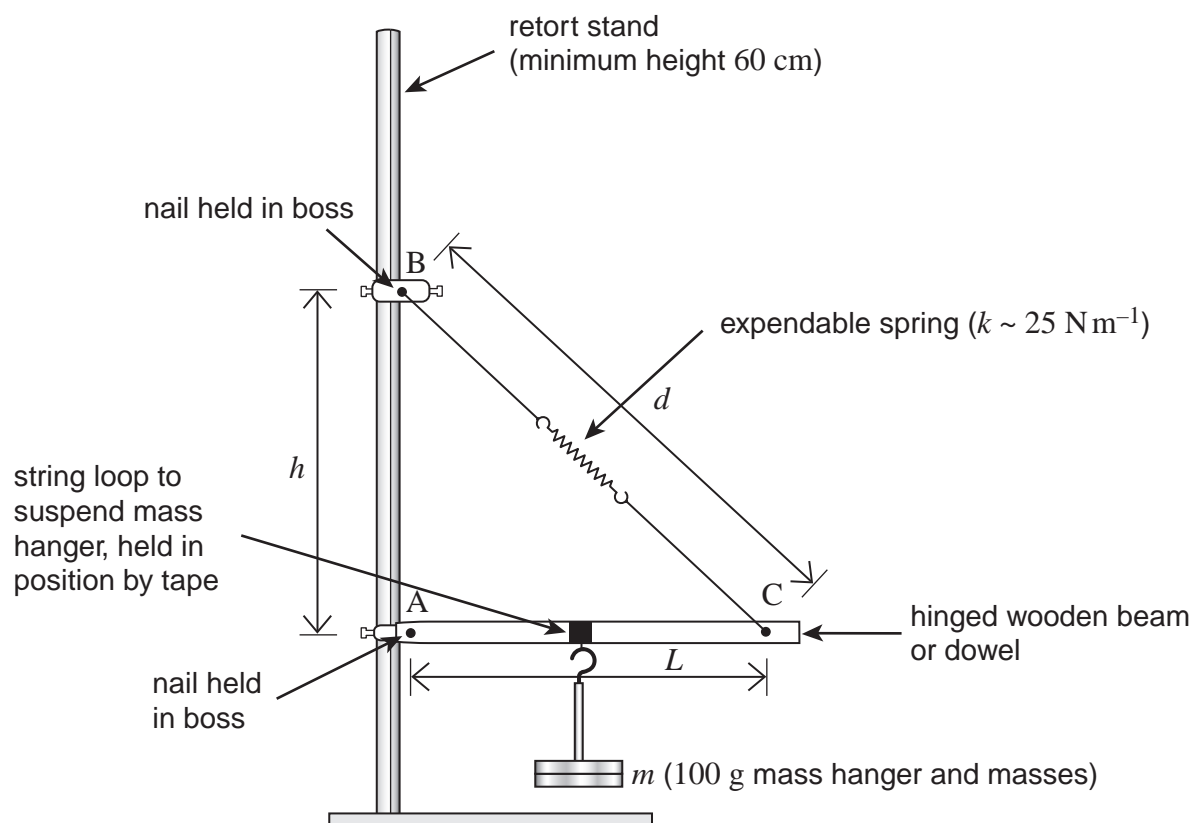
All teacher-assessed marks to be submitted by 15 May.

PHY3T/P15/TN

ISA (P) Forces in Equilibrium

Centre instructions for the investigation

In this ISA candidates will be investigating the equilibrium of forces acting on a hinged beam as shown in **Figure 1**. Candidates will change the mass m and find the corresponding distances h and d required to maintain the beam in horizontal equilibrium.

Figure 1

Apparatus

Centres should ensure that the apparatus provided can be used safely. Each candidate will need:

(a) retort stand, minimum $60\ cm$ height, and two identical bosses
(b) two smooth round nails about 2–$4\ mm$ diameter and $50\ mm$ long
(c) $100\ g$ slotted mass hanger with six additional $100\ g$ slotted masses
(d) expendable spring with spring constant $k \sim 25\ N\,m^{-1}$
(e) string
(f) adhesive tape (to hold string loop for mass hanger in position)
(g) wooden beam, minimum $400\ mm$ long, width 20–$30\ mm$, thickness 3–$5\ mm$ or $400\ mm$ of dowel with diameter 10–$15\ mm$ (alternatively a half-metre ruler could be used but holes will need to be drilled at two points)
(h) metre ruler and set-square
(i) G-clamp or masses to stabilise the retort stand if necessary.

The apparatus should be set up as shown in **Figure 1**.

Drill parallel holes in the wooden beam about 20 mm and 320 mm from one end. The hole at point A should be just large enough to allow the beam to rotate freely when one of the nails is used as a pivot.

The lower boss, corresponding to point A, should be positioned approximately 150 mm above the base of the stand. This height will allow the slotted mass hanger to be suspended on a small loop of string and hang freely when the beam is horizontal. There should be at least 400 mm of retort stand above the position of the lower boss.

Lengths of string should be tied to the circular wire rings at each end of the spring. One of the strings should be attached to the hole drilled at point C on the wooden beam. A loop should be made at the other end of the string such that the overall length of the unstretched spring and the attached strings is exactly equal to the distance L (about 300 mm) between the holes at A and C. In the experiment this loop is attached to the nail in the boss at B.

A loop of string from which to suspend the slotted masses should be added to the wooden beam. To position the loop, arrange the apparatus as shown in **Figure 1**. Hang a mass of 700 g from the loop and adjust the upper boss at B to near its maximum height. Adjust the position of the 700 g mass until the beam is horizontal and tape the string in this position.

Supervisors should decide whether any counterpoise masses are required on the stand base, although this was found to be unnecessary in trials.

The apparatus should be placed ready for the student with the slotted mass hanger and masses removed from the hinged beam. The bosses should be close together on the retort stand at a height of about 150 mm.

Information for centres

Students can be told approximately one week before undertaking Stage 1 of the ISA that they will be investigating the equilibrium of forces.

Note that a 300 mm ruler and protractor **will be required** for the Written Test.
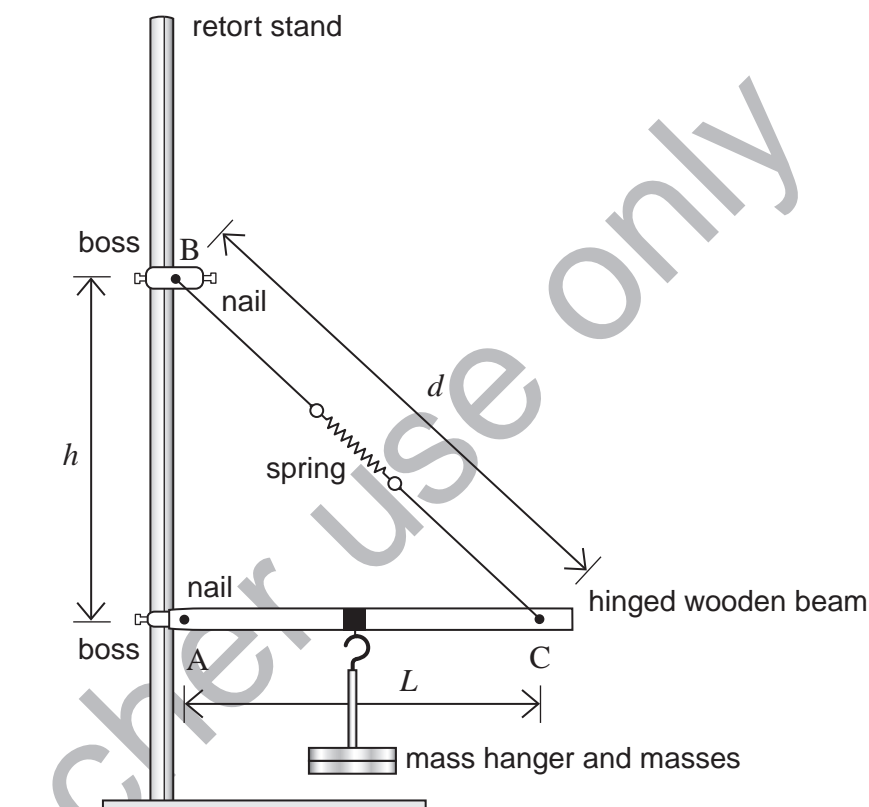
Turn over ▶

Task Sheet

This task is worth 7 marks

You are advised to read through these instructions before beginning your work.

You are going to investigate the equilibrium of forces acting on a wooden beam as shown in Figure 1.

Figure 1

There should not be any masses or mass hanger on the wooden beam at the start of your experiment.

- Measure L, the distance between point A where the beam pivots on the nail, and point C.
- Suspend the $100\ \mathrm{g}$ mass hanger from the string loop on the wooden beam.
- Carefully move the boss at B up or down the retort stand until the wooden beam is approximately horizontal.
- Devise a suitable method to check whether or not the wooden beam is horizontal. Make minor adjustments to the boss at B until the wooden beam is perfectly horizontal.
- Measure and record height h from the nail at point A to the nail in the boss at B as shown in **Figure 1**.
- Measure and record d, the distance BC in **Figure 1**.
- Record m, the value of the total mass of the hanger and any slotted masses.
- Add a $100\ \mathrm{g}$ mass to the mass hanger and repeat the procedure to make the wooden beam horizontal. Measure and record the new values of m, h and d.
- Repeat for five further values of m.
- Take repeat readings of h and d for all values of m.

- Evaluate

$$\left(1 - \frac{L}{d}\right)h$$

  for each value of h and record the values in your table.
  Your table should also include sufficient columns for all repeat readings and mean values.
- Plot a graph of

$$\left(1 - \frac{L}{d}\right)h$$

  on the y axis against m and draw a best fit straight line.

After the investigation

At the end of the investigation, hand in all your written work, including the graph, to the supervisor.

This documentation will be required for Stage 2 of the ISA. Ensure that you have entered your centre details, candidate number and name on all the sheets you have completed.