

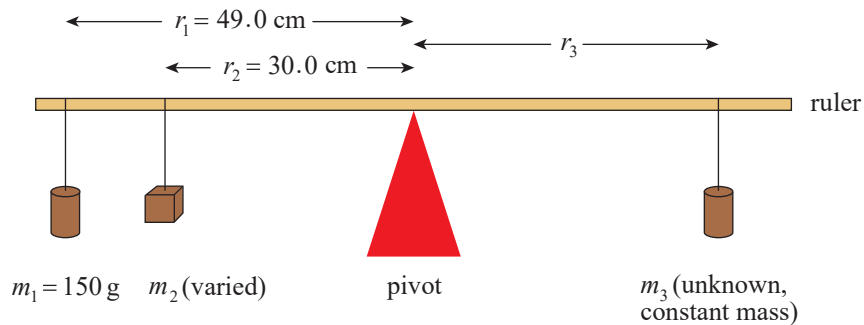
SECTION B

Part 1 (Question 25)

(20 marks)

Answer *all* questions in this part in the spaces provided.

25. A group of students carry out an experiment to determine an unknown, constant mass, m_3 . A metre ruler is set up with a pivot at its midpoint. Three masses, m_1 , m_2 , and m_3 , are hung from the metre ruler, as shown in the diagram below:



The mass $m_1 = 150 \text{ g}$ and its distance from the pivot, $r_1 = 49.0 \text{ cm}$, are held constant throughout the experiment. The mass m_2 is varied but its distance from the pivot, $r_2 = 30.0 \text{ cm}$, is held constant. The distance of the mass m_3 from the pivot, r_3 , is then adjusted so that the ruler is balanced and remains horizontal.

The data recorded in the experiment are shown in the table below:

m_2 (g)	r_3 (cm)			
	Measurement 1	Measurement 2	Measurement 3	Average
50	32.8	32.0	31.2	
75	34.5	37.5	33.0	
100	39.0	36.0	39.0	
125	39.7	40.1	41.2	
150	43.0	45.5	40.5	

You may leave masses in grams and distances in centimetres in answering this question.

- (a) Complete the table above by calculating the average measurement of r_3 for each mass m_2 .
(2 marks)
- (b) On page 17, plot the average measurements of r_3 on the vertical axis versus mass m_2 on the horizontal axis, and draw a line of best fit.
(6 marks)

- (c) (i) State the type of experimental errors that the students have attempted to minimise by averaging a number of measurements of r_3 .

_____ (1 mark)

- (ii) Explain, using the graph you have drawn for part (b) and the data in the table on page 16, whether or not the experimental errors of this type have been reduced.

_____ (2 marks)

- (d) Determine the gradient of your line of best fit. Include the units of the gradient.

_____ (3 marks)

- (e) State the equation of your line of best fit in terms of r_3 and m_2 .

_____ (2 marks)

- (f) The ruler will be balanced when:

$$m_1r_1 + m_2r_2 = m_3r_3.$$

Using this expression and the equation of your line of best fit from part (e), determine the mass m_3 .

_____ (4 marks)