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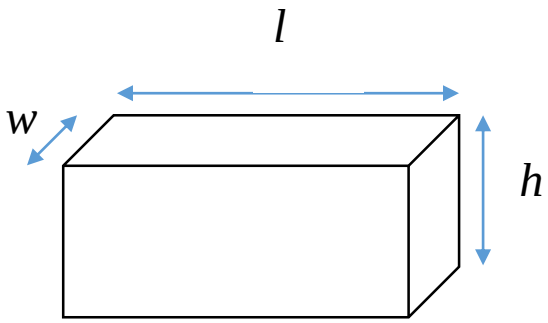
Answers to 2015 O level Physics 5064 Paper 3

In the 2015 Pure Physics practical examination, there were 2 experiments where each experiment was allocated 45 minutes.

First Experiment

Candidates were asked to measure the dimensions of a wooden block.



The measurements that we got were:

l: 12.4 cm

w: 6.9 cm

h: 4.9 cm

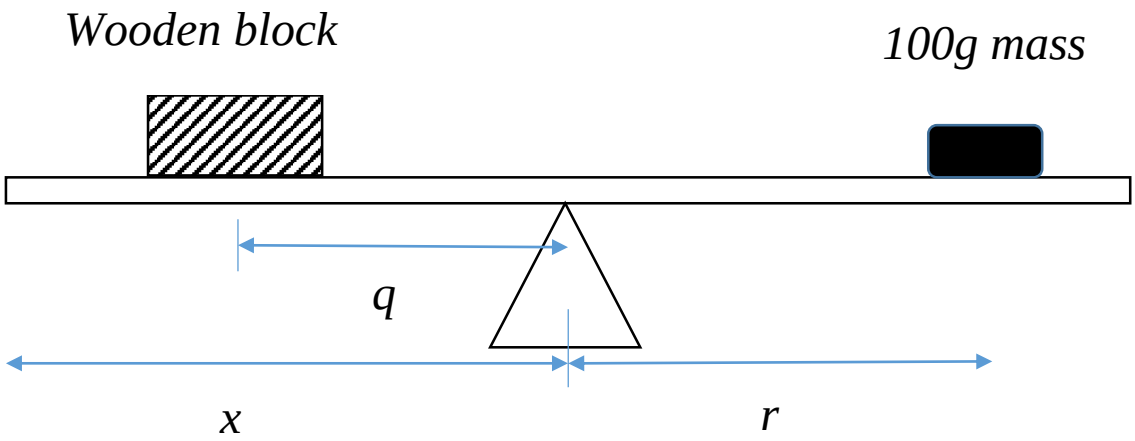
As such, it is highly likely that the mark scheme will accept answers for the **length to be 12.4 ± 0.1cm, width to be 6.9 ± 0.1cm and the height to be 4.9 ± 0.1cm**.

Next, candidates were asked to balance a metre rule on a knife edge with the zero marking on the ruler placed on the candidate's left. They were then asked to record the position of the centre of mass of the metre rule.

Teacher's comment

Many candidates had difficulties in balancing the metre rule as the metre rule did not balance exactly. Candidates could overcome this difficulty by allowing the metre rule to tip one way and then allowing it to tip the other way and taking the average between the two values as the centre of mass of the metre rule.

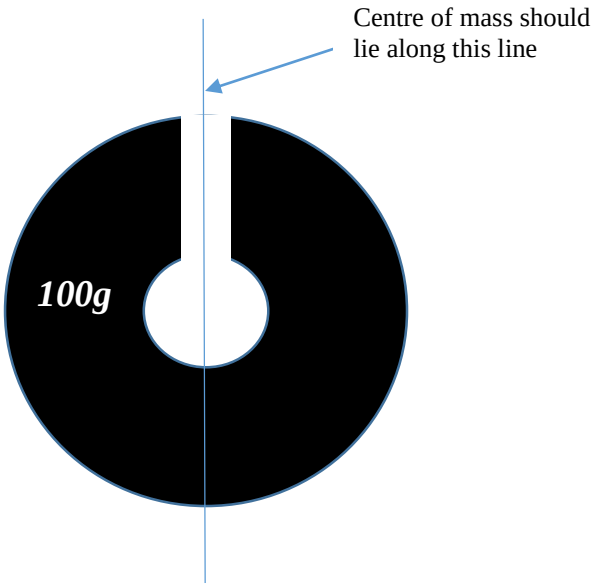
Using a balancing method, candidates were then asked to determine values for q (the distance from the centre of mass of the wooden block to the knife edge) and r using a 100g mass as shown in the figure below.



Teacher's comment

It is noteworthy that the distance r should be measured from the knife edge to the centre of mass of the 100g mass.

To obtain an accurate value for r, candidates could also measure the distance from the knife-edge to the edge of the 100g mass, and then add half the width of the 100g mass to get the distance r.



Question: How did you determine the distance q?

Answer:

Let the distance from the side of the wooden block, nearest to the knife edge, and the centre of mass of the metre rule be y. Then $q = \frac{l}{2} + y$, where l is the length of the wooden block.

Next, using the equation $m = \frac{100r}{q}$, candidates were asked to calculate the mass of the wooden block. The calculated mass, m was found to be **193.75g**. Since the raw data had 3 significant figures, the calculated mass should be recorded as **194g**.

Lastly, candidates were asked to determine the density, ρ of the wood using the equation $\rho = \frac{m}{lwh}$. The calculated density, ρ was found to be **0.462 g/cm^3** (3 significant figures). When calculating the density from the given equation, candidates should not prematurely round up the mass to be 194g but use 193.75g instead.

The final part of this experiment:

Given that the mass, m, of the wooden block can also be expressed as:

$$mq = 100r$$

Plan an experiment to investigate how the mass, m, of the wooden block can be determined accurately using a graph.

Write a plan for the experiment, including:

(i) Instructions on how to carry out the experiment
(ii) The values you will use to plot the graph
(iii) The graph you will plot from the results
(iv) A description of how you will ensure that the value of m is as accurate as possible
(v) An explanation of how you will obtain a value of m from your graph.

Answer:

Instructions:

1. **Replace the 100g mass on the metre rule with a 50g mass and adjust the wooden block so that the metre rule is balanced.**

2. **Record values of q and r on a table.**

3. **Repeat steps 1 and 2 with masses 150g, 200g, 250g, 300g and 350g.**

<u>Teacher's comment</u>

Since we know the mass of the wooden block to be 194g, we should choose masses which are smaller and greater than 194g so that the resulting graph will be evenly spread. For graph-plotting, 5 or 6 plots are required. Since data has already been collected for the 100g mass, we would need another 4 to 5 known masses.

Values used to plot graph:

From y = mx +c, we should rearrange the mq =100r to be $r = \frac{m}{100}q$, so that r represents the y-axis and q represents the x-axis.

The graph you will plot:

Plot a graph of r against q. Since r and q are related to each other by a straight line equation, draw a straight line of best fit through the plotted points where equal number of error points exist on either side of the line.

To ensure that the value of m is as accurate as possible:

Since we know the mass of the wooden block to be approximately 194g, to get an accurate value of m, we should get masses that are evenly spaced around 200g. Three masses below 200g (i.e, 50g, 100g and 150g) and three masses above 200g (i.e, 250g, 300g and 350g) should be used.

To obtain a value of m from the graph:

Since the equation of the straight line is $r = \frac{m}{100}q$, therefore the gradient of the straight line should be equal to $\frac{m}{100}$. Thus multiplying the gradient by 100 will give us an accurate value of m.

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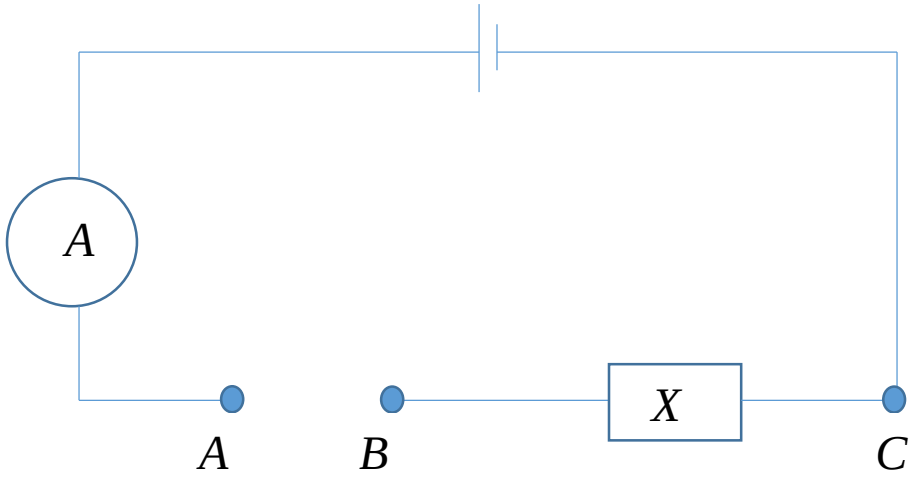
Second Experiment

In this second experiment, students were given a simple circuit involving

(i) 3 resistors with a resistance of 4.7Ω, 4.7Ω and 10Ω.
(ii) A resistor X with unknown resistance
(iii) An additional connecting wire
(iv) An ammeter
(v) A voltmeter
(vi) A source and a switch

The circuit was connected as shown below:



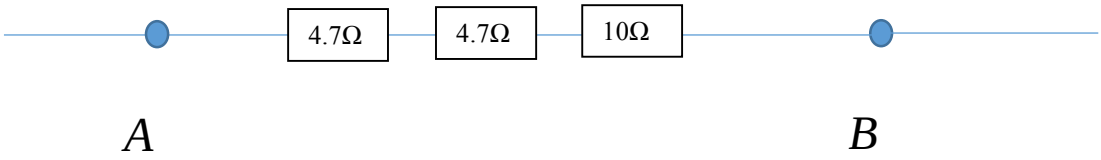
Then candidates were asked to connect a voltmeter between B & C and to use the additional connecting wire to connect A and B. Upon closing the switch, candidates had to measure the readings on the voltmeter and the ammeter.

V_0 = **2.7V**
A_0 = **0.27A**

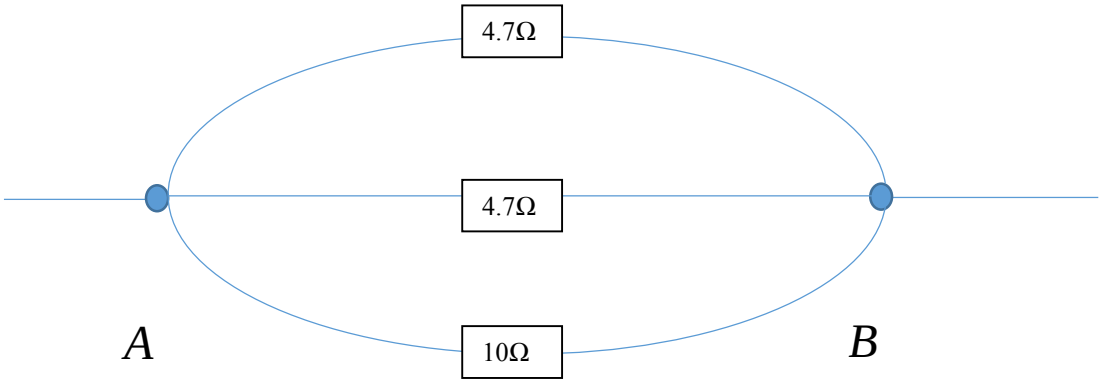
Teacher's comment

Thus students can guess that the resistance of X should be 10Ω.

Candidates were then asked to draw an arrangement of the 3 resistors that could be connected between points A and B, to give a maximum resistance.

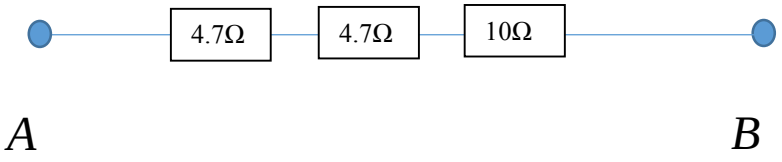
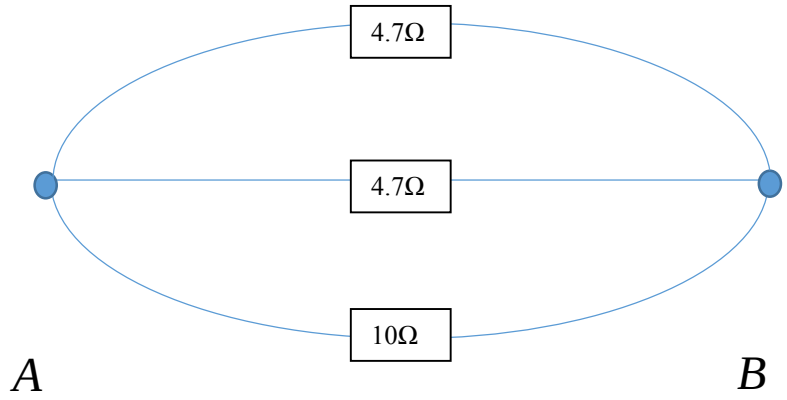
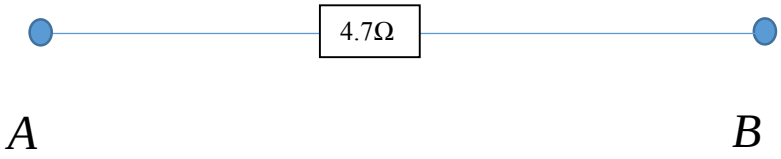
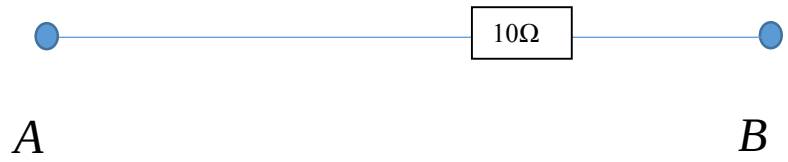
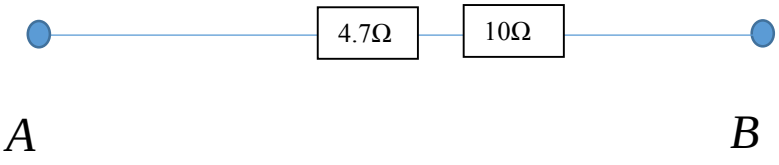


Additionally they were also asked to draw an arrangement of the 3 resistors that could be connected between points A and B, to give a minimum resistance (not zero).



Next candidates were asked to suggest various combinations of the 3 resistors, either singly, in pairs or altogether, so that various values of V and I could be obtained from the voltmeter and ammeter respectively.

Suggested Answer:

Combination of resistors	I/A	V/V
		
		
		
		
		

Teacher's comment

Although many other variations of the resistor combinations could be acceptable, candidates have to note that resistor combinations should give an effective resistance that covers a wide range. For an example, using two 4.7Ω resistors in series would give an effective resistance of 9.4Ω. The value of V and I for such a resistor combination may not be very different with the values obtained when a 10Ω resistor is used.

If it was not mentioned in the question, candidates should collect a series of 5 or 6 data points to obtain an accurate best-fit line. Since the question had already asked for arrangements of the known resistors for a maximum and minimum resistance, students need only suggest another 3 or 4 combinations of the 3 resistors to cover the ranges of resistance in between these two values.

Finally candidates were asked to plot a straight line of I against V and they had to determine the gradient of the line.

Since $I = \frac{V}{R}$, the gradient of the straight line must be equal to $\frac{1}{R}$ and we know that R = 10Ω, the gradient of the straight line must be approximately **0.1**.