Practice Question Set For A-Level
Subject : Physics
Paper-2 Topic : 4_Materials

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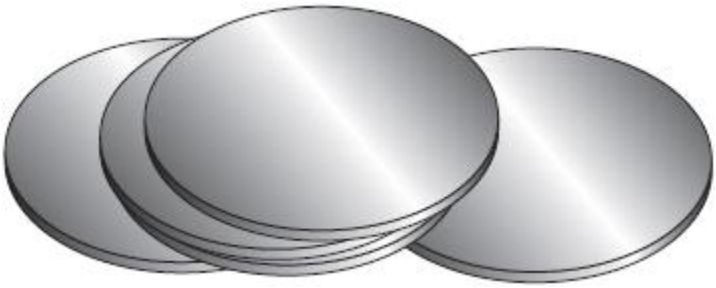
Name of the Student:_____
Max. Marks : 23 Marks **Time : 23 Minutes**

Q1.

A student is investigating the properties of steel. He has fifty steel discs available.



Each disc has a diameter $d \approx 1.3$ cm and a thickness $t \approx 2$ mm.

A balance which can measure mass with a resolution of 0.2 g is available.

Determine the minimum number of discs that should be placed on the balance together if the percentage uncertainty in the measurement of the mass is to be less than 0.5%.

(4)

density of steel = 7900 kg m^{-3}

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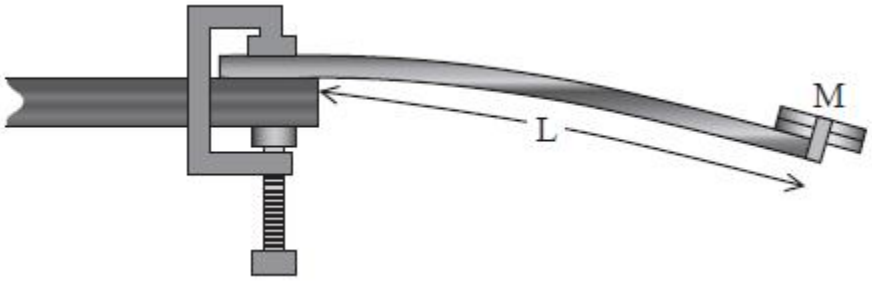
Minimum number of discs = ...

(Total for question = 4 marks)

Q2.

A metre rule clamped at one end is an example of a cantilever. The diagram shows an arrangement of a

cantilever where a mass *M* is attached to the end of a metre rule and the rule clamped with a free length *L*.



When *M* is displaced, the period of oscillation *T* of the cantilever is related to *L* and the Young modulus *E* of the material of the metre rule by the following equation:

$$T^2 = \frac{KML^3}{E}$$

where *K* is a constant.

A student uses this arrangement to compare the Young modulus values for two metre rules.
The metre rules have identical dimensions, but are made from different types of wood.

(a) One of the metre rules is set into oscillation, and the time for 20 oscillations is measured with an electronic stopwatch. This is repeated twice with the same metre rule. The same procedure is carried out for the second metre rule, using an identical mass and free length.

(i) Explain why a pointer placed at the equilibrium position of the end of the metre rule would help the student to obtain repeatable data.

(2)

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(ii) The student collects the following data.

	Time for 20 oscillations t_1 / s	Time for 20 oscillations t_2 / s	Time for 20 oscillations t_3 / s
Metre rule 1	19.3	19.1	19.3
Metre rule 2	21.3	21.5	21.5

Use this data to calculate a value for the ratio E_2/E_1 of the Young modulus values of the two metre rules.

(3)

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E_2/E_1 = ...

(b) The student intends to use a graphical method to determine a value for the Young modulus of one of the metre rules. She decides that she will vary the free length *L* and measure the time period for each length.

(i) State what variables she should plot.

(1)

y-axis

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x-axis

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(ii) Explain how the student can use her graph to determine the Young modulus of the rule. You may assume that she has been provided with the value of *K*.

(2)

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(c) Explain what the student could do to reduce the uncertainty in her measurement of the time period.

(2)

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(Total for question = 10 marks)

Q3.

A medical scanner uses a moving table to position the patient. Strain gauges are used to monitor the shape of the table which enables a more precise positioning of the patient.

Strain gauges consist of a thin length of wire attached, in a zigzag pattern, to a small flexible piece of plastic. The strain gauge is attached to the table. When the table is subjected to forces, the dimensions of the plastic change. This causes a change in the length of the wire and hence a change in the resistance of the wire.

(a) Resistance can be measured directly using an ohmmeter or indirectly using measurements from a voltmeter and ammeter.

Describe **two** benefits of using an ohmmeter compared to using a voltmeter and an ammeter.

(2)

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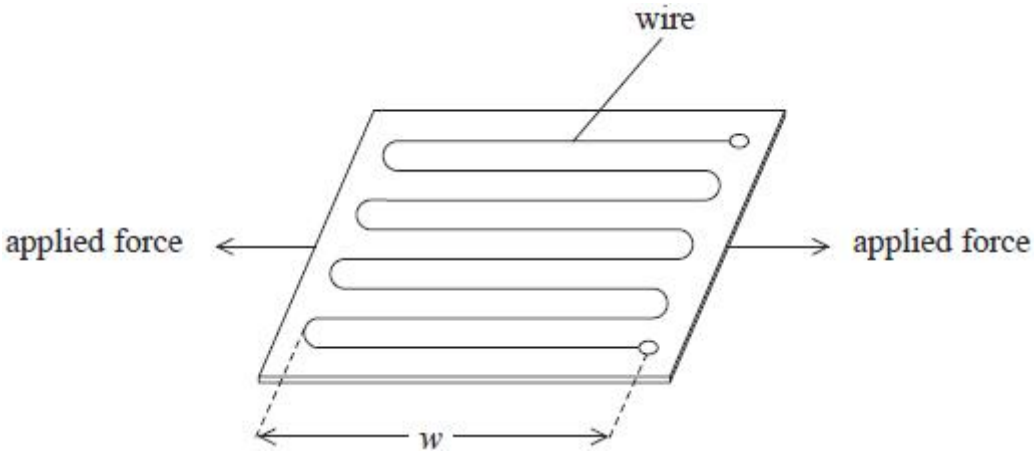
(b) The diagram shows forces applied to a strain gauge. The 'width' of the strain gauge is defined by the distance *w*.



(i) State and justify how the applied forces change the resistance of the wire.

(2)

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(ii) The gauge factor *GF* of a strain gauge is given by

$$GF = \frac{\Delta R}{\varepsilon R}$$

where ε is the strain
R is the initial resistance
ΔR is the change in resistance

When forces are applied to the strain gauge, the resistance of the gauge changes by 0.10%.
Calculate the change in the width of the strain gauge.
w = 5.0 cm
GF = 2.0

(3)

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Change in width = ...

(c) Explain the benefit of arranging the wire in a zigzag pattern.

(2)

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(Total for question = 9 marks)