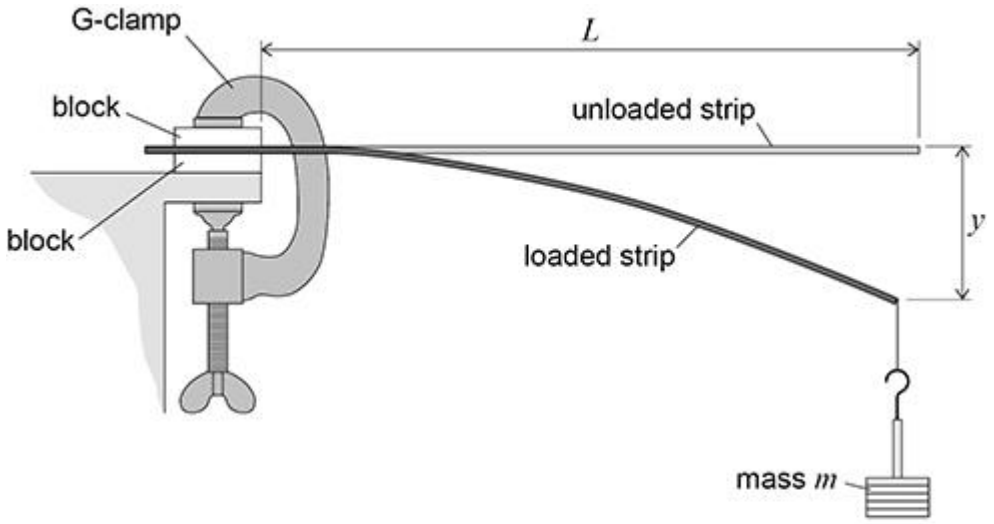
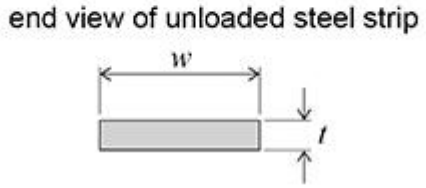
Name of the Student:_____
Max. Marks : 17 Marks **Time : 17 Minutes**

Q1.

Figure 1 shows a strip of steel of rectangular cross-section clamped at one end.
The strip extends horizontally over the edge of a bench.

Figure 1

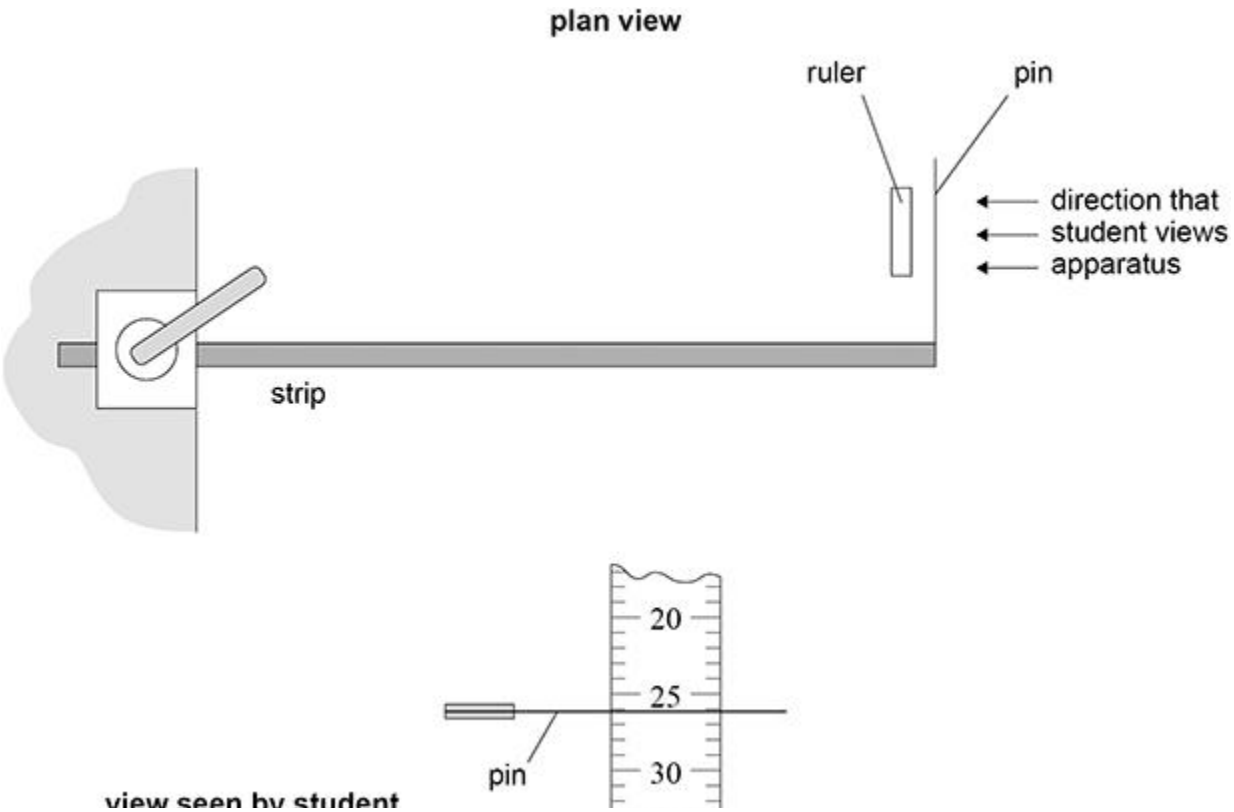




(a) A mass *m* is suspended from the free end of the strip.
This produces a vertical displacement *y*.
A student intends to measure *y* with the aid of a horizontal pin fixed to the free end of the steel strip.
She positions a clamped vertical ruler behind the pin, as shown in **Figure 2**.

Figure 2

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Explain a procedure to avoid parallax error when judging the reading indicated by the position of the pin on the ruler.
You may add detail to **Figure 2** to illustrate your answer.

_____

_____

_____

_____

_____

_____

(2)

(b) It can be shown that

$$y = \frac{4mgL^3}{Ewt^3}$$

where:

L is the distance between the free end of the **unloaded** strip and the blocks
w is the width of the strip and is approximately $1\ \text{cm}$
t is the thickness of the strip and is approximately $1\ \text{mm}$
E is the Young modulus of the steel.

A student is asked to determine E using the arrangement shown in **Figure 1** with the following restrictions:

- only one steel strip of approximate length $30\ \text{cm}$ is available

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- m must be made using a 50 g mass hanger and up to four additional 50 g slotted masses
- the experimental procedure must involve only **one** independent variable
- a graphical method must be used to get the result for E.

Explain what the student must do to determine E.

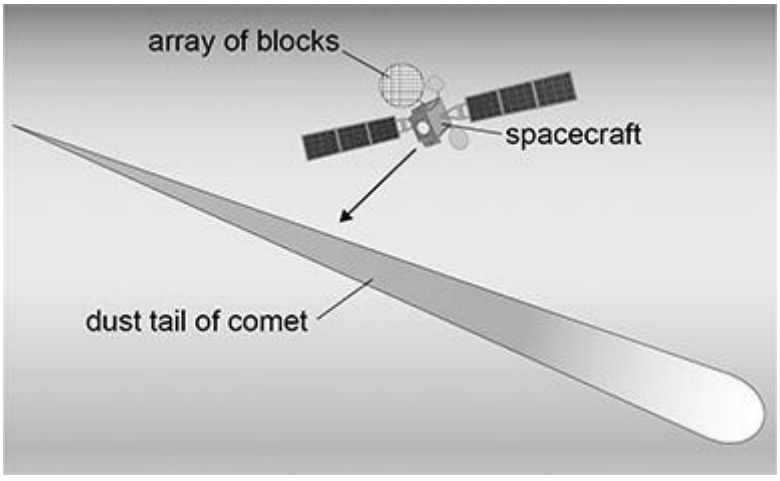
(5)

(Total 7 marks)

Q2.

Figure 1 shows a spacecraft travelling towards a comet.
The spacecraft has an array of blocks designed to capture small dust particles from the comet's tail.

Figure 1



To test the blocks before launch, a spherical dust particle **P** is fired at a right angle to the surface of a fixed, stationary block.
P has a mass of 1.1×10^{-9} kg. It has a speed of 5.9×10^{3} m s^{-1} when it hits the surface of the block.
P comes to rest inside the block.

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(a) Calculate the work done in bringing **P** to rest.

work done = _____ J

(1)

(b) **P** travels a distance of 2.9 cm in a straight line inside the block before coming to rest. The resultant force on **P** varies as it penetrates the block.

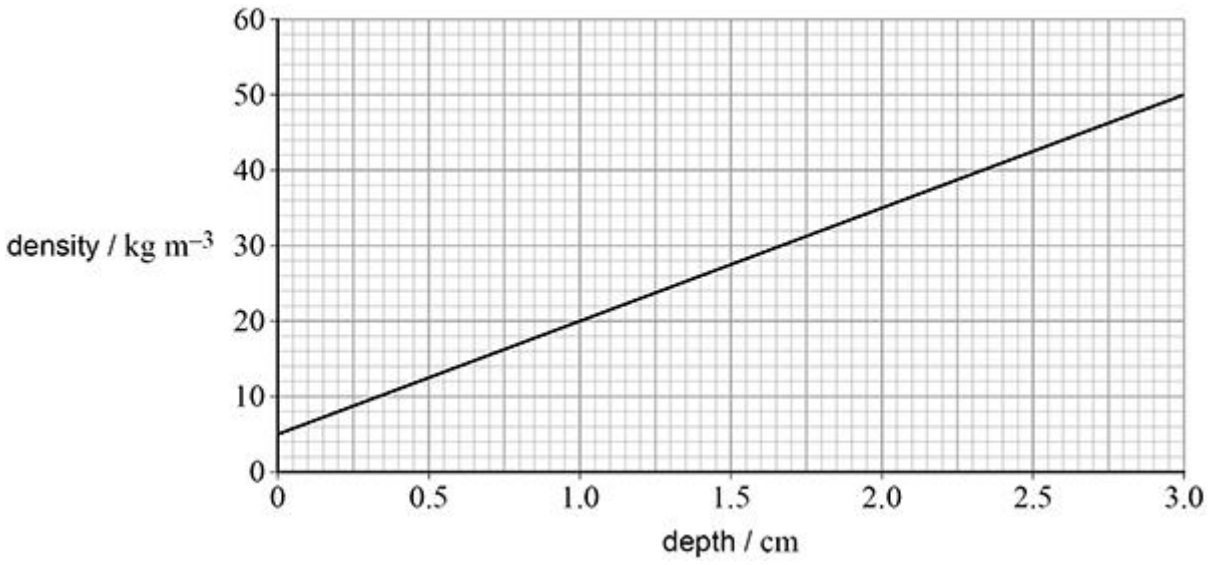
Calculate the average force acting on **P** as it is brought to rest.

average force = _____ N

(2)

(c) The block is rectangular with an area of cross-section of 8.0 cm^2 and a thickness of 3.0 cm. **Figure 2** shows how the density of the block varies with depth up to its maximum thickness.

Figure 2



Calculate the mass of the block.

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mass = _____ kg

(4)

(d) In another test, a spherical particle **Q** is fired at a right angle to the surface of an identical block.

Q has the same mass as **P** and is travelling at the same speed as **P** when it strikes the surface of the block.
Q is made from a less dense material than **P**.

Compare the distance travelled by **Q** with that travelled by **P** as they are brought to rest.

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

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