**1** Figure 10 shows two students investigating reaction times.

Student B supports his left hand on a desk.

Student A holds a ruler so that the bottom end of the ruler is between the finger and thumb of student B.

When student A releases the ruler, student B catches the ruler as quickly as he can with his left hand.

The investigation is repeated with the right hand of student B.

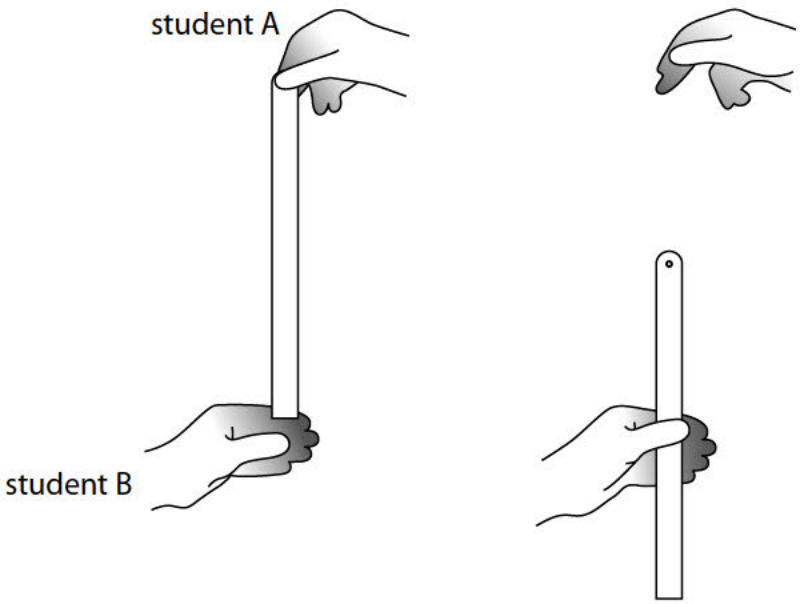



**Figure 10**

(a) Give a reason why it is better to have the 0 cm mark at the bottom of the ruler rather than at the top.

**(1)**

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(b) Give a reason why two students are needed for this investigation.

**(1)**

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(c) The students took five results for the left hand and five results for the right hand.

Figure 11 shows their results.

| which hand | distance dropped (cm) | | | | | |
|---|---|---|---|---|---|---|
| | trial 1 | trial 2 | trial 3 | trial 4 | trial 5 | average |
| left | 10.1 | 25.5 | 18.4 | 14.6 | 11.7 | 14 |
| right | 17.5 | 16.1 | 19.4 | 18.6 | 20.2 | ..... |

**Figure 11**

(i) Calculate the average distance dropped for the right hand. Give your answer correct to 2 significant figures.

**(2)**

distance = ..... cm

(ii) Calculate the average time for the left hand.

Use the equation

$$\text{time}^2 = \frac{\text{distance}}{500}$$

**(2)**

average time = ..... s

(d) Explain whether any of the readings are anomalous.

**(2)**

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(e) Give **two** ways that the students can improve the quality of their data, other than ignoring anomalous results.

**(2)**

1 .....

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2 .....

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(f) Describe how the students could develop their investigation to investigate how reaction time changes with another variable.

**(2)**

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**(Total for Question = 12 marks)**

**2** Figure 4 shows two students investigating their reaction times.

Student B supports his left hand on a desk.

Student A holds a ruler so that the bottom end of the ruler is between the finger and thumb of student B.

When student A releases the ruler, student B catches the ruler as quickly as he can.

The investigation is repeated with the right hand of student B.

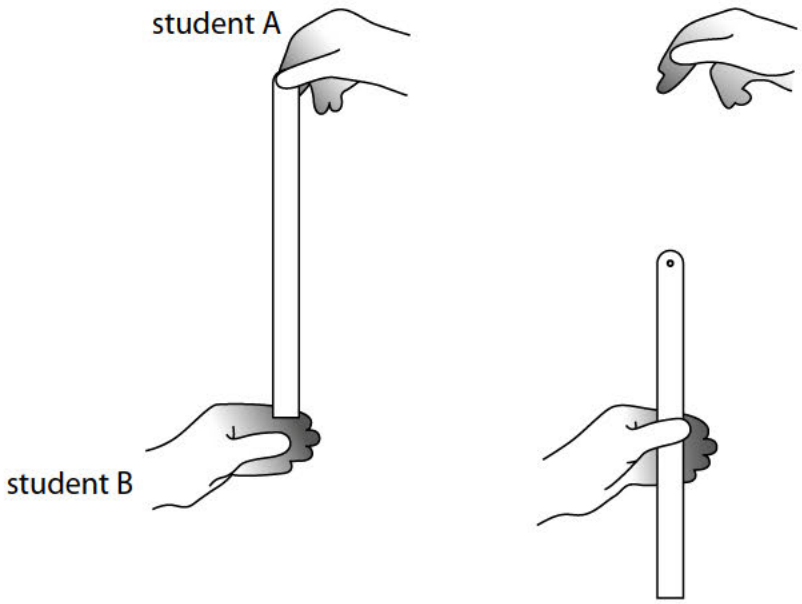



**Figure 4**

(a) The students took five results for the left hand and five results for the right hand.

Figure 5 shows their results.

| which hand | distance dropped (cm) | | | | | |
|---|---|---|---|---|---|---|
| | trial 1 | trial 2 | trial 3 | trial 4 | trial 5 | average |
| left | 10.1 | 25.5 | 18.4 | 14.6 | 11.7 | 14 |
| right | 17.5 | 16.1 | 19.4 | 18.6 | 20.2 | ..... |

**Figure 5**

(i) Calculate the average distance dropped for the right hand.

Give your answer correct to 2 significant figures.

**(2)**

distance = ..... cm

(ii) Calculate the average time for the left hand.

Use the equation

$$\text{time}^2 = \frac{\text{distance}}{500}$$

**(2)**

average time = ..... s

(b) Explain whether any of the readings are anomalous.

**(2)**

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(c) Give **two** ways that the students can improve the quality of their data other than ignoring anomalous results.

**(2)**

1 .....

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2 .....

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(d) Describe how the students could develop their investigation to investigate how reaction time changes with another variable.

**(2)**

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**(Total for Question = 10 marks)**

**3** A student uses a di n
Figure 20.

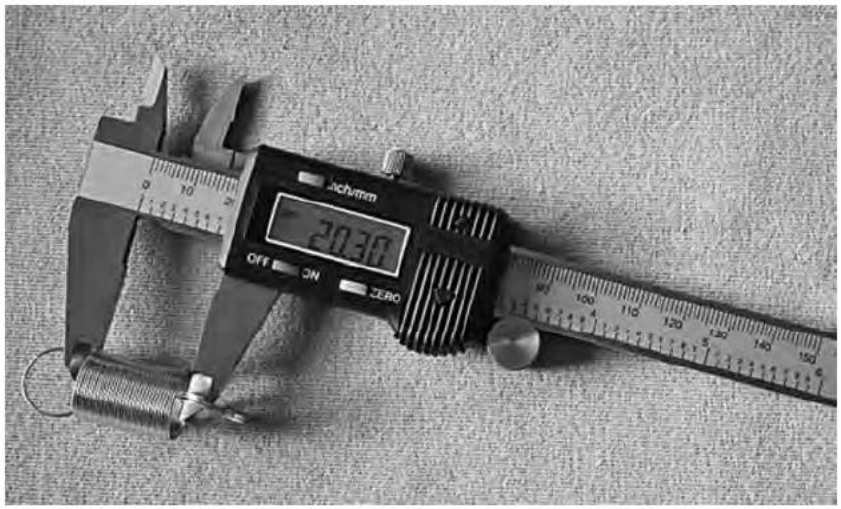



**Figure 20**

The spring is bendy and difficult to measure.

The student takes the six readings shown in Figure 21.




**Figure 21**

(a) Calculate the average length of the spring.

**(2)**

average length = ..... mm

(b) The student investigates the stretching of a spring with the equipment shown in Figure 22.

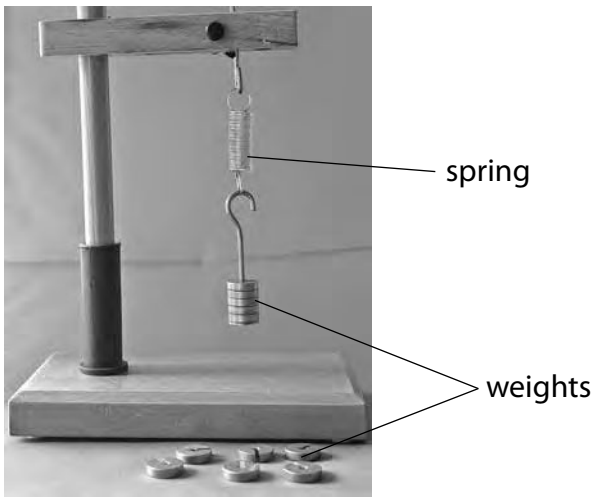



**Figure 22**

The student investigates the extension of the spring using six different weights.

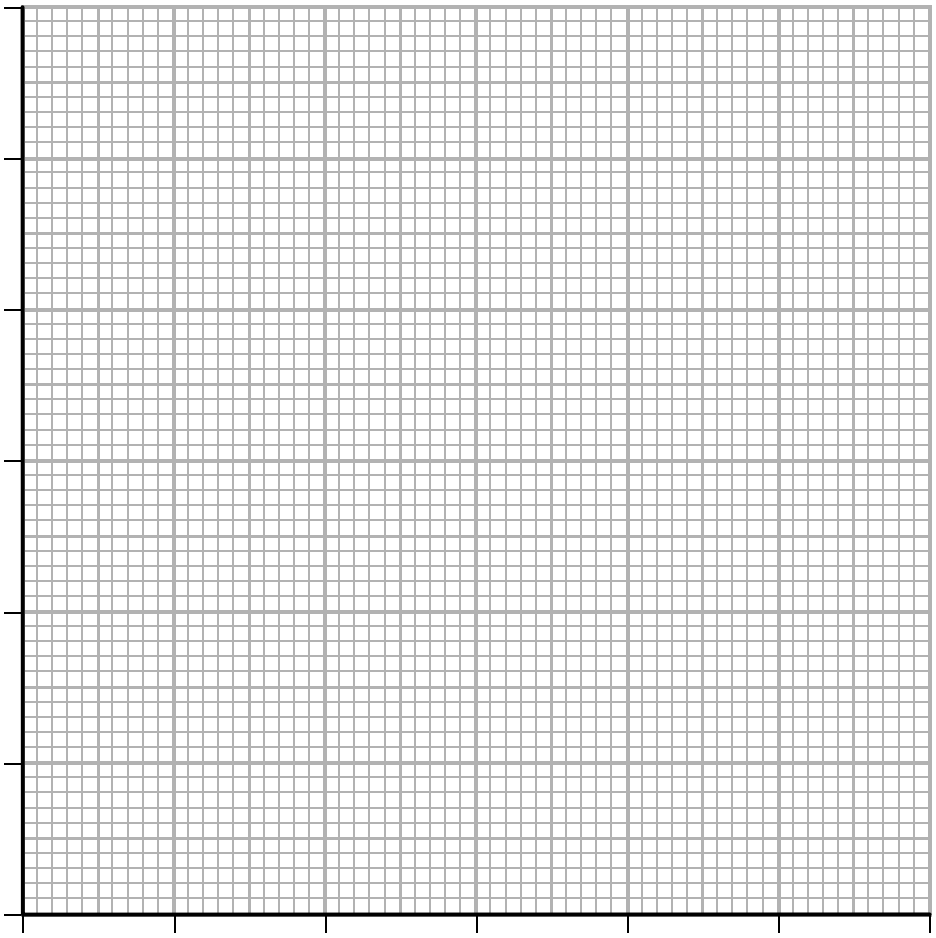
The results are shown in Figure 23.

| weight (N) | extension (mm) |
|---|---|
| 0.20 | 4.0 |
| 0.40 | 8.0 |
| 0.60 | 12.0 |
| 0.80 | 16.0 |
| 1.00 | 20.0 |
| 1.20 | 24.0 |

**Figure 23**

(i) Draw a graph for the readings, using the grid shown.

**(3)**



(ii) The student writes this conclusion:

'*The extension of the spring is directly proportional to the weight stretching the spring.*'

Comment on the student's conclusion.

**(3)**

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(c) The student extends the investigation by finding information about the stretching of wires.

The student finds the graph shown in Figure 24 for the stretching of a wire.

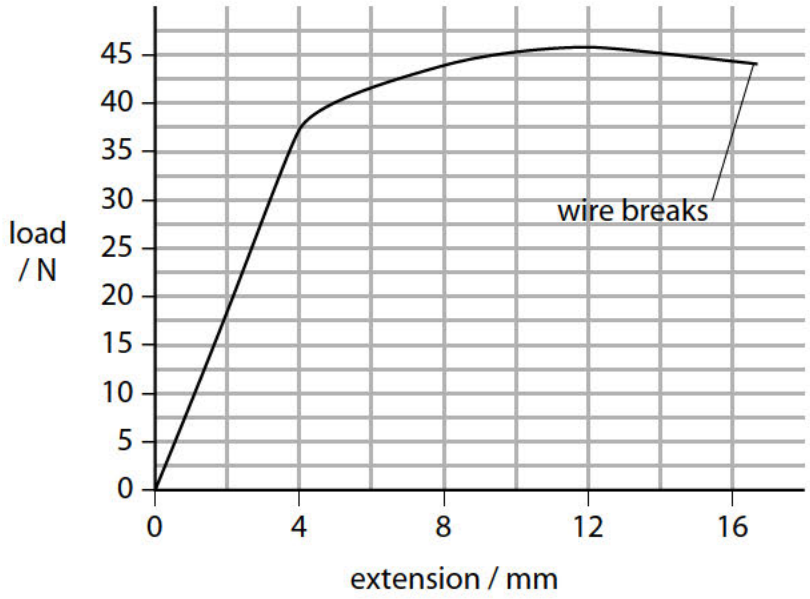



**Figure 24**

Describe the non-linear stretching of the wire shown in Figure 24.

**(3)**

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**(Total for Question = 11 marks)**

**4** A student uses a digital calliper to measure the length of a spring, as shown in Figure 10.

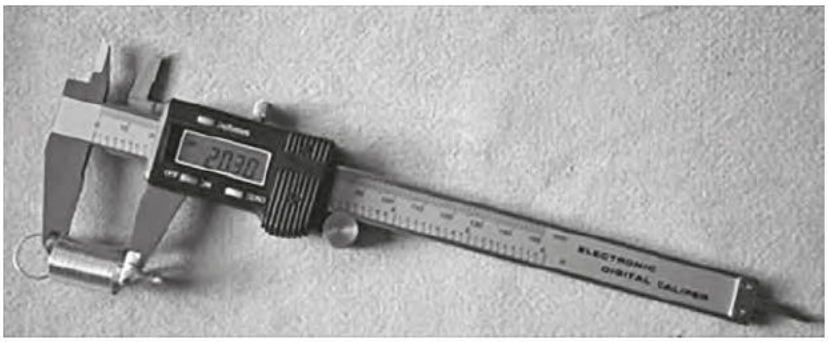



**Figure 10**

The spring is bendy and difficult to measure.

The student takes the six readings shown in Figure 11.




**Figure 11**

(a) Calculate the average length of the spring.

**(2)**

average length = ..... mm

(b) The student investigates the stretching of a spring with the equipment shown in Figure 12.

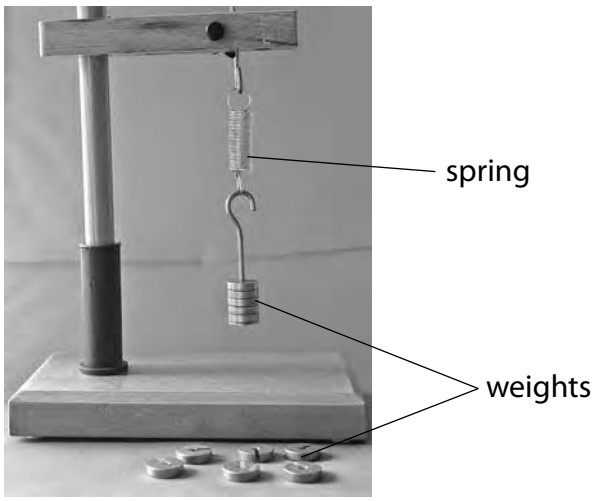



**Figure 12**

The student investigates the extension of the spring using six different weights.

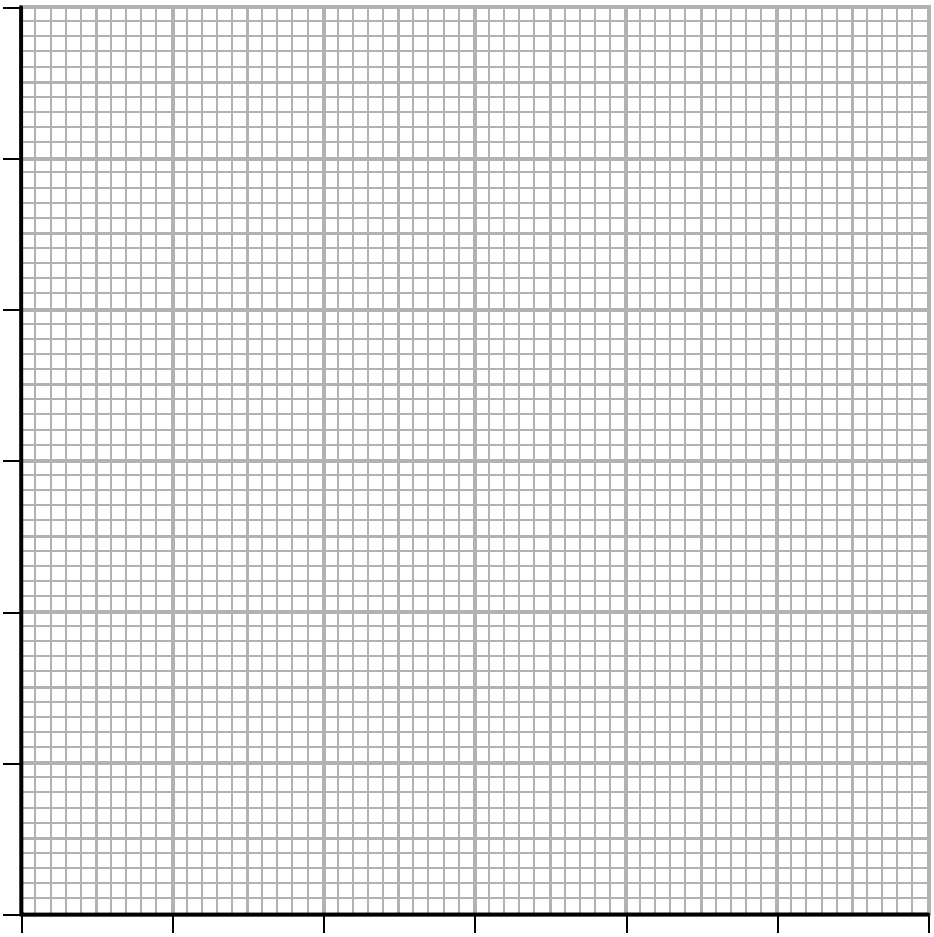
The results are shown in Figure 13.

| weight (N) | extension (mm) |
|---|---|
| 0.20 | 4.0 |
| 0.40 | 8.0 |
| 0.60 | 12.0 |
| 0.80 | 16.0 |
| 1.00 | 20.0 |
| 1.20 | 24.0 |

**Figure 13**

(i) Draw a graph for the readings, using the grid shown.

**(3)**



(ii) The student writes this conclusion:

'*The extension of the spring is directly proportional to the weight stretching the spring.*'

Comment on the student's conclusion.

**(3)**

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(c) The student extends the investigation by finding information about the stretching of wires.

The student finds the graph shown in Figure 14 for the stretching of a wire.

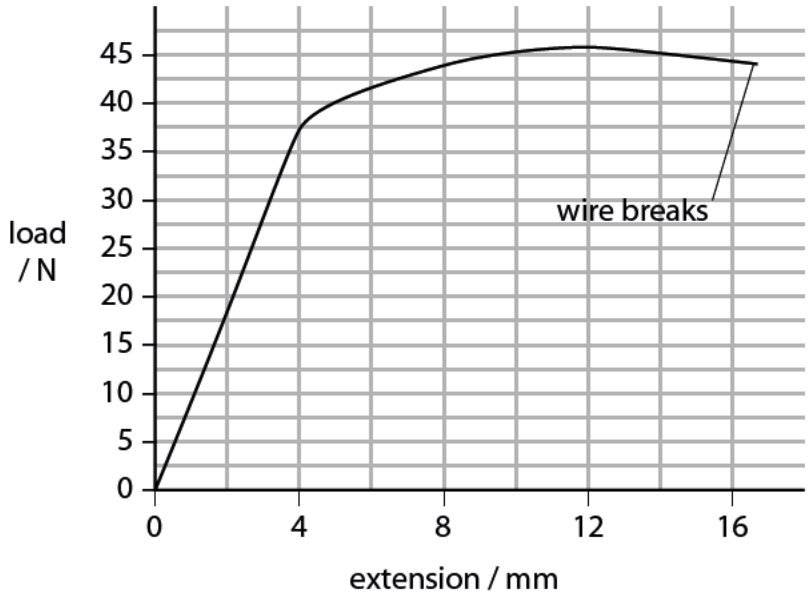



**Figure 14**

Describe the non-linear stretching of the wire shown in Figure 14.

**(3)**

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**(Total for Question = 11 marks)**