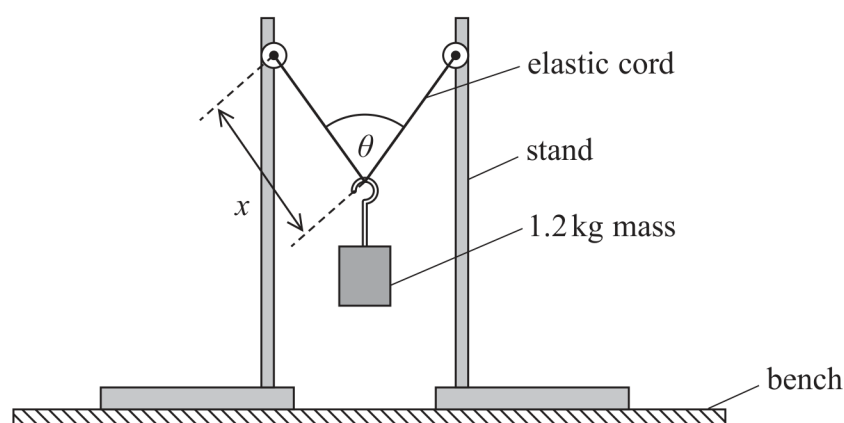4   A student investigated the extension of an elastic cord. She hung a 1.2 kg mass from the elastic cord as shown.

(a) Identify a health and safety issue and how it may be dealt with.

(2)

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(b) The student varied the distance between the two stands to vary the angle θ.

She measured θ using a protractor. For each value of θ she measured the corresponding length x with a metre rule.

(i) Identify **two** sources of uncertainty with this method.

(2)

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(ii) Suggest a modification to reduce the effect of **one** of these sources of uncertainty.

(1)

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(c) The student determined the extension Δx of the elastic cord for each value of θ.

The relationship between θ and Δx is given by

$$\cos\left(\frac{\theta}{2}\right) = \frac{mg}{k\Delta x}$$

where
m is the mass hung from the elastic cord
k is the stiffness of the elastic material.

(i) Explain why a graph of $\cos\left(\frac{\theta}{2}\right)$ against $\frac{1}{\Delta x}$ can be used to determine a value for g.

(2)

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(ii) The student recorded the following data.

$\cos\left(\dfrac{\theta}{2}\right)$	Δx / m	
0.938	0.165	
0.926	0.169	
0.911	0.175	
0.902	0.178	
0.891	0.183	

Plot a graph of $\cos\left(\frac{\theta}{2}\right)$ on the y-axis against $\frac{1}{\Delta x}$ on the x-axis on the grid opposite.

Use the additional column of the table for your processed data.

(6)

(iii) Determine the gradient of the graph.

(3)

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Gradient = ...

(iv) Determine a value for g from the gradient of the graph.

$m = 1.20\,\text{kg}$
$k = 145\,\text{N}\,\text{m}^{-1}$

(2)

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$g =$ ....

(Total for Question 4 = 18 marks)