1 Which list puts the forces in order of increasing magnitude?

A 2 pN < 2 fN < 2 TN < 2 GN ⬭

B 2 pN < 2 fN < 2 GN < 2 TN ⬭

C 2 fN < 2 pN < 2 TN < 2 GN ⬭

D 2 fN < 2 pN < 2 GN < 2 TN ⬭

(Total 1 mark)

2 A student carries out an experiment to determine the resistivity of a metal wire.
She determines the resistance from measurements of potential difference between the ends of the wire and the corresponding current. She measures the length of the wire with a ruler and the diameter of the wire using a micrometer. Each measurement is made with an uncertainty of 1%

Which measurement gives the largest uncertainty in the calculated value of the resistivity?

A current ⬭

B diameter ⬭

C length ⬭

D potential difference ⬭

(Total 1 mark)

3 A student has a diffraction grating that is marked 3.5×10^3 lines per m.

(a) Calculate the percentage uncertainty in the number of lines per metre suggested by this marking.

percentage uncertainty = ____________________ %

(1)

(b) Determine the grating spacing.

grating spacing = ____________________ mm

(2)

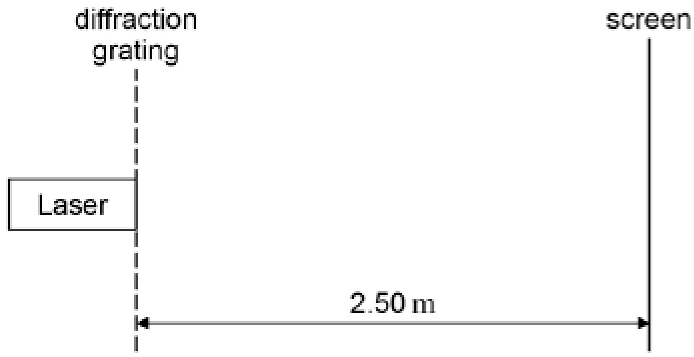
(c) State the absolute uncertainty in the value of the spacing.

absolute uncertainty = ____________________ mm

(1)

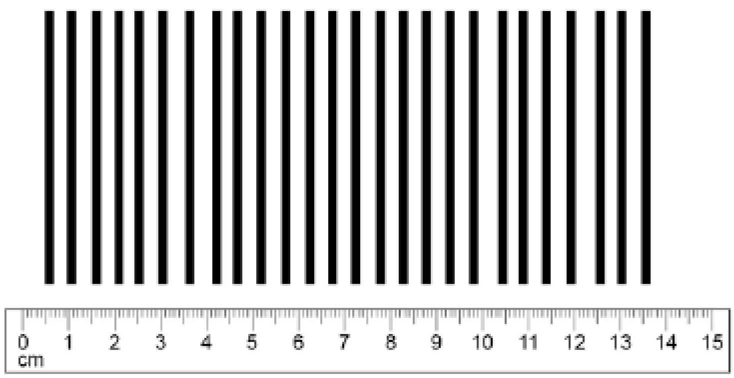
(d) The student sets up the apparatus shown in **Figure 1** in an experiment to confirm the value marked on the diffraction grating.

Figure 1



The laser has a wavelength of 628 nm. **Figure 2** shows part of the interference pattern that appears on the screen. A ruler gives the scale.

Figure 2



Use **Figure 2** to determine the spacing between two adjacent maxima in the interference pattern. Show all your working clearly.

spacing = ____________________ mm

(1)

(e) Calculate the number of lines per metre on the grating.

number of lines = ______________________

(2)

(f) State and explain whether the value for the number of lines per m obtained in part (e) is in agreement with the value stated on the grating.

____

____

____

(2)

(g) State **one** safety precaution that you would take if you were to carry out the experiment that was performed by the student.

____

____

____

(1)

(Total 10 marks)

4 1.0 kilowatt-hour (kW h) is equivalent to

A 6.3×10^{18} eV ⬭

B 6.3×10^{21} eV ⬭

C 2.3×10^{22} eV ⬭

D 2.3×10^{25} eV ⬭

(Total 1 mark)

5 Measurements are made to determine the tension, length and mass per unit length of a string stretched between two supports. The percentage uncertainties in these measurements are shown below.

Quantity	Percentage uncertainty
Length	0.80%
Tension	4.0%
Mass per unit length	2.0%

A stationary wave is formed on the string.

What is the percentage uncertainty in the calculated value of the frequency of the first harmonic?

A 1.8% ⬭

B 3.8% ⬭

C 6.8% ⬭

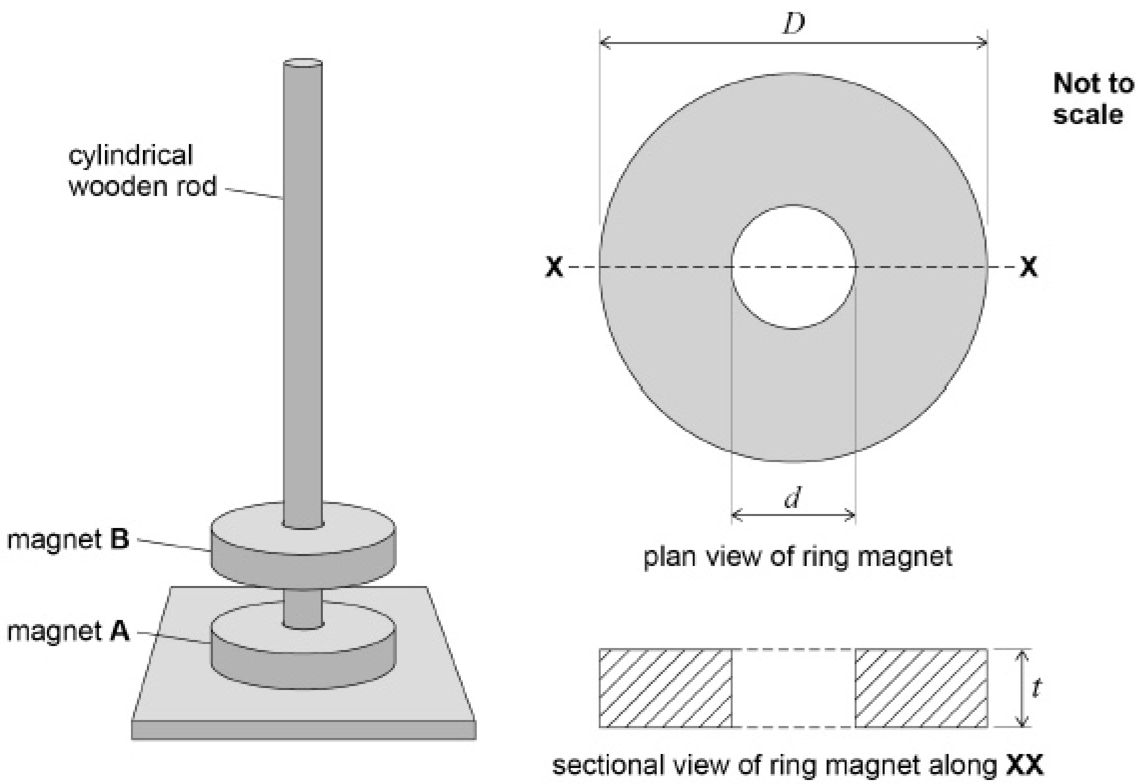
D 13% ⬭

(Total 1 mark)

6 Identical ring magnets **A** and **B** are arranged on a cylindrical wooden rod. The magnets' magnetic poles are on their largest faces. When placed with like poles in opposition, the magnets repel one another as shown in **Figure 1**.

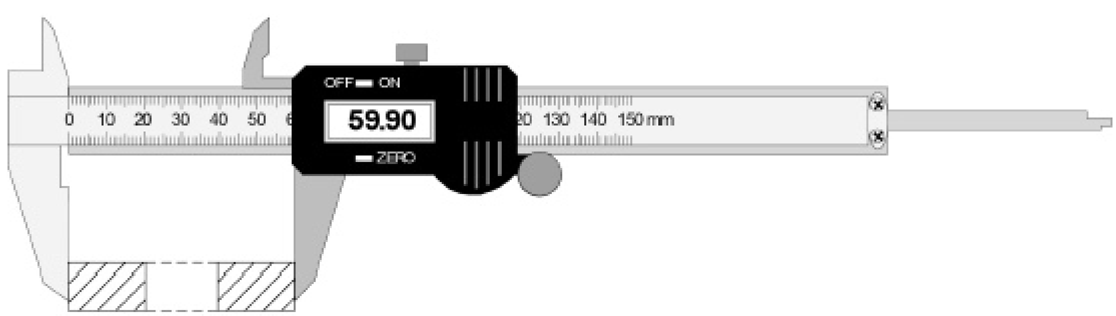
The plan and sectional views in **Figure 1** identify the dimensions of these magnets. Each magnet has a circular cross-section and the central hole is circular.

Figure 1



(a) A student uses digital vernier calipers to find the external diameter D of magnet **B**, as shown in **Figure 2**.

Figure 2



State precautions the student should take to reduce the effect of systematic and random errors when making this measurement.

Precaution to reduce effect of systematic error:

____

____

____

Precaution to reduce effect of random error:

____

____

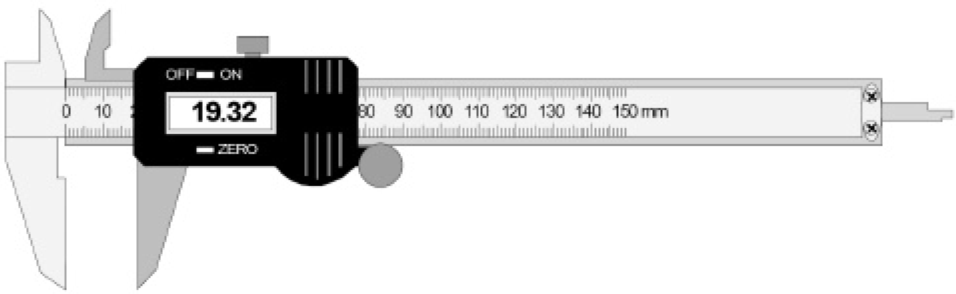
____

(2)

(b) **Figure 3** shows the reading on the calipers as the internal diameter d is measured.

Draw the sectional view of magnet **B** on **Figure 3** to indicate how d is measured.

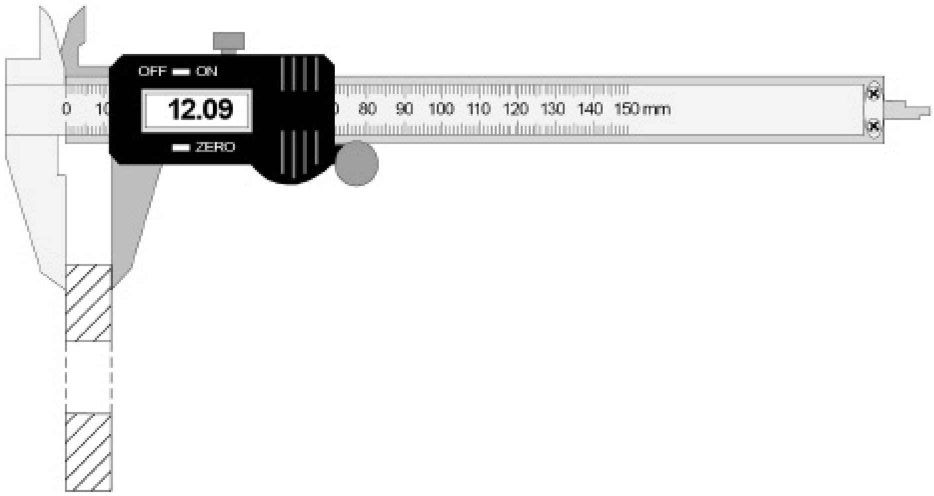
Figure 3



(1)

(c) **Figure 4** shows the reading on the calipers when the thickness t of magnet **B** is measured.

Figure 4



The readings that correspond to the dimensions of magnet **B** are shown in **Figures 2**, **3** and **4**.

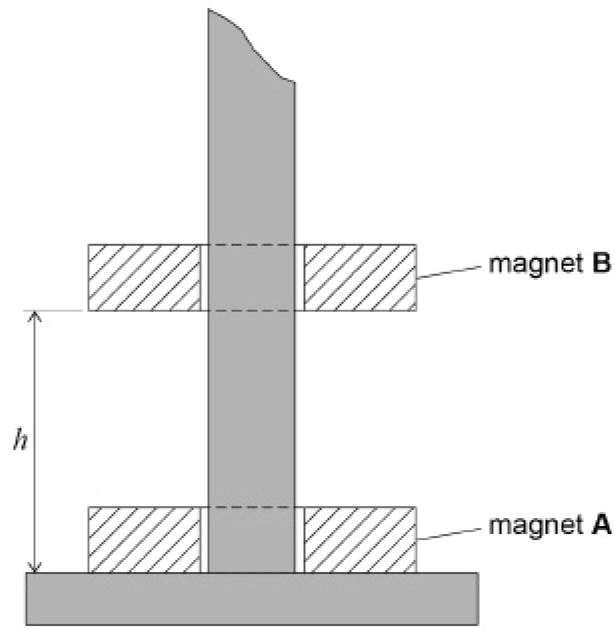
Calculate the volume of magnet **B**.

volume = ____________________ m^3

(3)

(d) The student measures the mass m_B of magnet **B** and then positions the magnet so it is in equilibrium above magnet **A** as shown in **Figure 5**.
The student measures the distance h.

Figure 5



The student adds modelling clay to magnet **B** to reduce h by 50%
She measures the mass m_C of this clay.

She concludes that the force F exerted on magnet **B** by magnet **A** is given by $F = \frac{k}{h^3}$

where k is a constant.

Describe an experiment to test the student's conclusion that $F = \frac{k}{h^3}$

Your answer should include:

- the procedure that could be used
- how the data produced could be analysed by a graphical method
- how the value of the constant k could be determined.

(5)

(Total 11 marks)