Name of the Student:_____
Max. Marks : 25 Marks **Time : 25 Minutes**

Q1.

(a) The table contains information about two galaxies.

Galaxy	Red shift, z	Distance from Earth / ly
NGC 936	4.8×10^{-3}	6.8×10^{7}
NGC 3379	3.0×10^{-3}	3.2×10^{7}

Discuss whether these data are consistent with Hubble's Law.

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(3)

(b) Quasars are the most distant measurable objects.

Discuss **one** problem associated with the determination of the distance from the Earth to a quasar.

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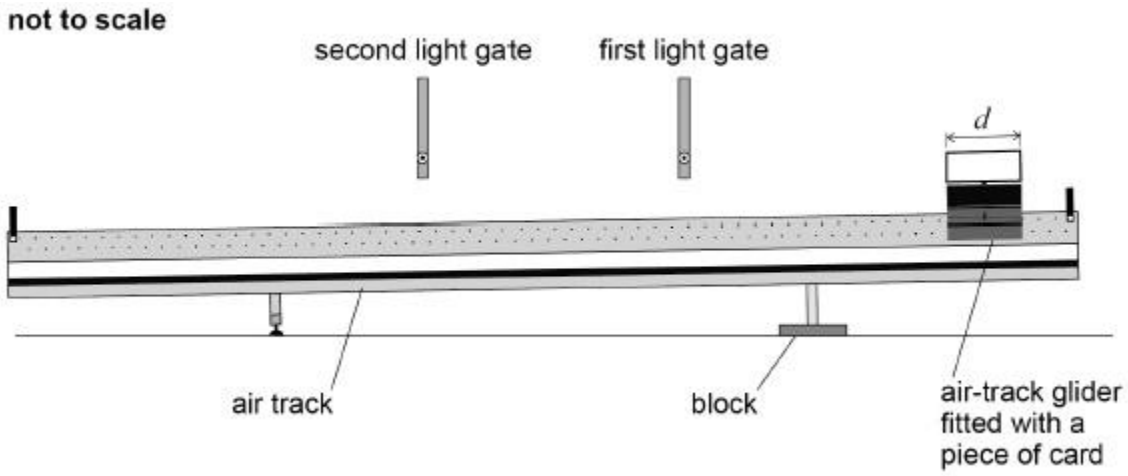
(2)
(Total 5 marks)

Q2.

Figure 1 shows the apparatus used by a student in an experiment to measure the acceleration due to gravity, g.

Figure 1



In the experiment:

- a block is used to raise one end of the air track as shown in **Figure 1**
- an air-track glider is released from rest near the raised end of the air track and passes through the first light gate and then through the second light gate
- a piece of card of length *d* fitted to the air-track glider interrupts a light beam as the air-track glider passes through each light gate
- a data logger records the time taken by the piece of card to pass through each light gate and also the time for the piece of card to travel from one light gate to the other.

(a) **Table 1** gives measurements made with the light gates as shown in **Figure 1**.

Table 1

Time to pass through first light gate / s	Time to pass through second light gate / s	Time to travel from first to second light gate / s
0.50	0.40	1.19

The length d of the piece of card is 10.0 cm

Assume there is negligible change in velocity while the air-track glider passes through a light gate.

Determine the acceleration a of the air-track glider.

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a = _____ m s^{-2}

(3)

(b) Two further sets of readings, **A** and **B**, are taken each with the light gates in different positions along the air track.
Assume the acceleration is the same in each set.

Table 2 shows these additional sets of results.

Table 2

Set	Time to pass through first light gate / s	Time to pass through second light gate / s	Time to travel from first to second light gate / s
A	0.61	0.42	1.77
B	0.55	0.37	2.11

Explain how the data in **Table 2** show that the distance between the light gates in set **B** is greater than in set **A**.

Assume there is negligible change in velocity while the air-track glider passes through a light gate.

_____

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_____

(2)

(c) Additional values for the acceleration of the air-track glider are obtained by further raising the end of the air track by using a stack consisting of identical blocks.
Adding each block to the stack raises the end of the air track by the same distance.

Figure 2 is a graph of these results showing how a varies with n, the number of blocks in the stack.

Figure 2

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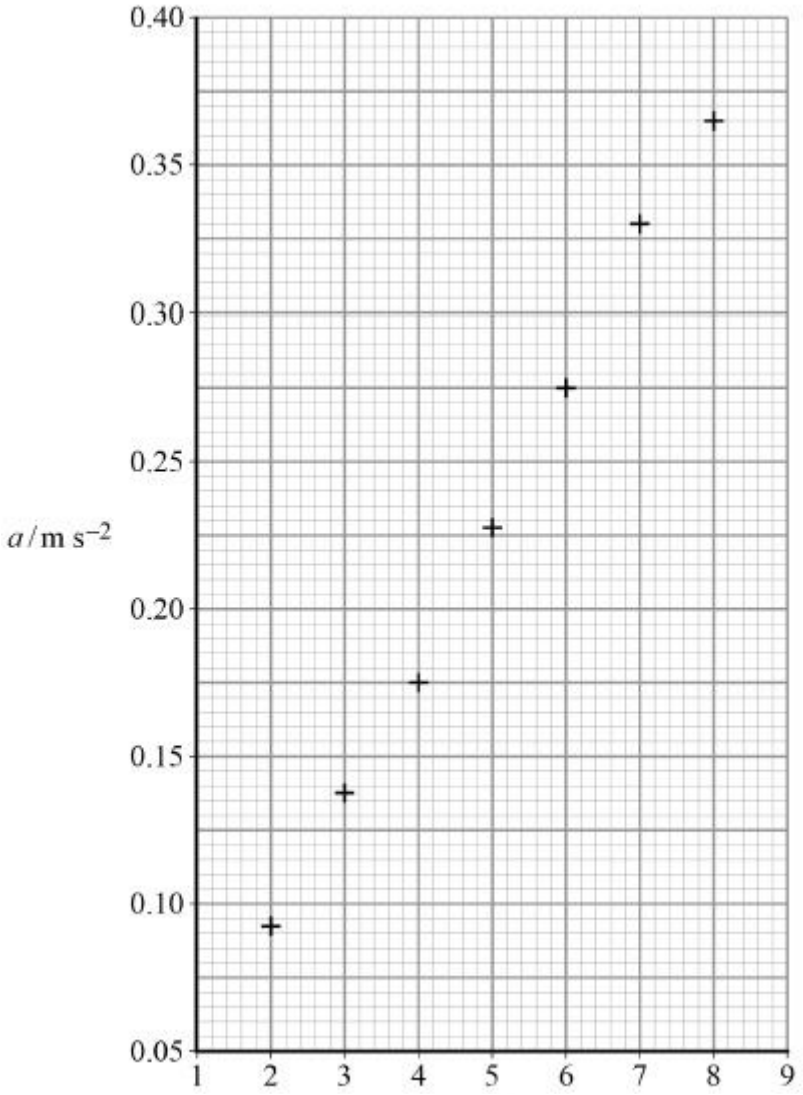

Draw a suitable best-fit straight line on **Figure 2** and determine G, the gradient of your line.

G = _____

(2)

(d) It can be shown that, for the apparatus used by the student, g is equal to $\frac{2G}{h}$ where h is the thickness of each block used in the experiment.

The student obtains a value for g of 9.8 m s^{-2}

Calculate h.

h = _____ m

(1)

(e) Explain how you could find out, without drawing another graph, whether the data presented in the graph in **Figure 2** support the suggestion that a is directly proportional to n.

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(1)

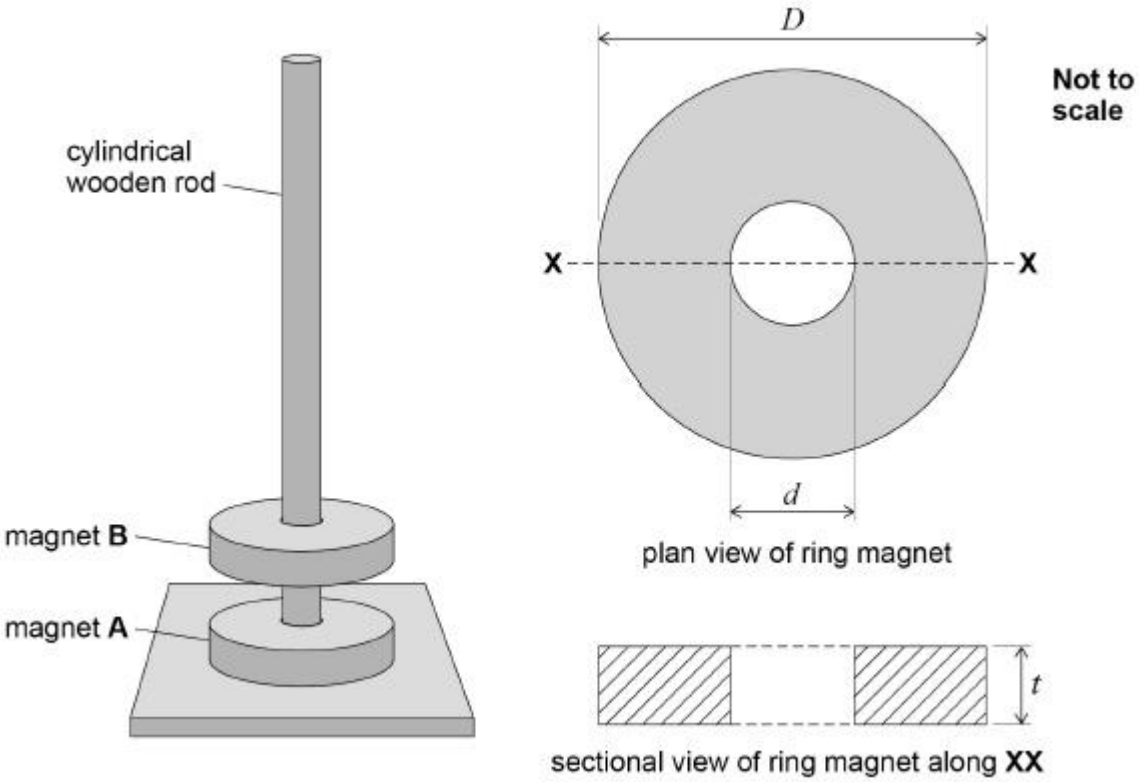
(Total 9 marks)

Q3.

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

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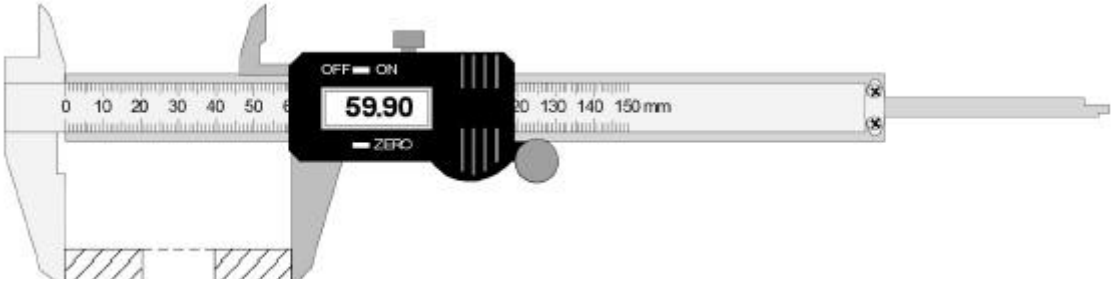


State precautions the student should take to reduce the effect of systematic and random errors when making this measurement.

Precaution to reduce effect of systematic error:

_____

_____

_____

Precaution to reduce effect of random error:

_____

_____

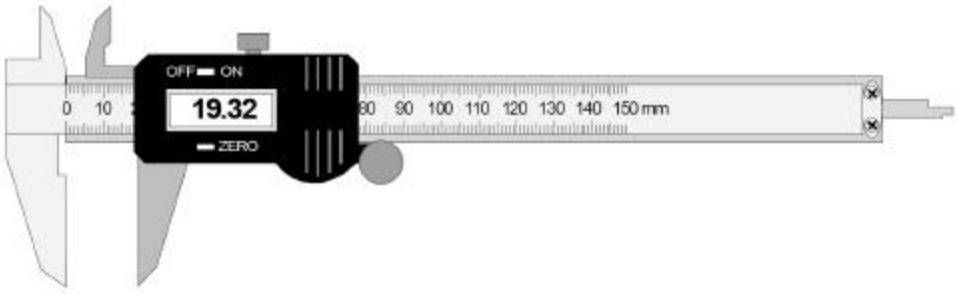
_____

(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



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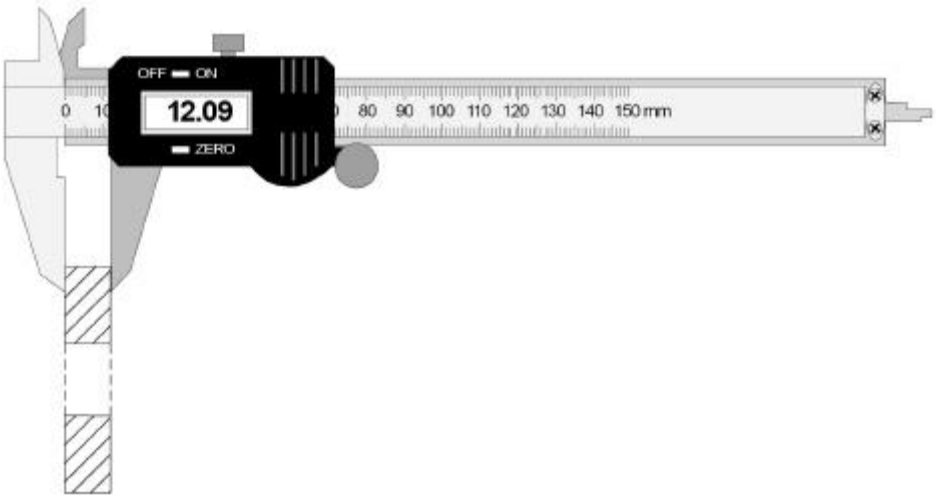
(1)

(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

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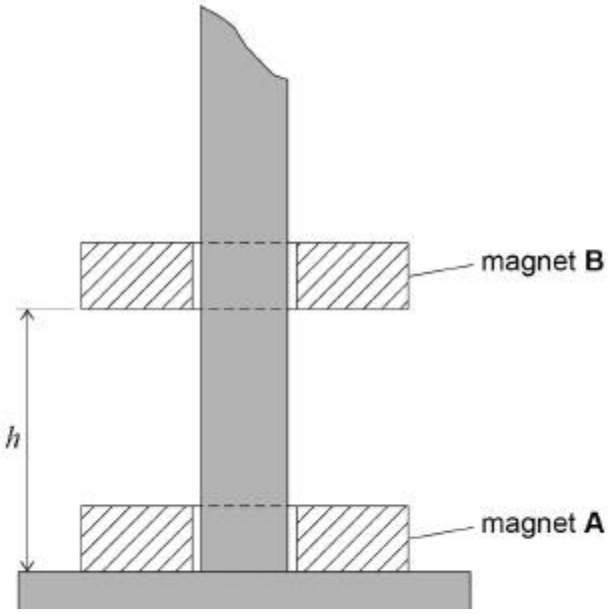

The student adds modelling clay to magnet **B** to reduce h by 50%
She measures the mass m_C of this clay.

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.

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(5)
(Total 11 marks)

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