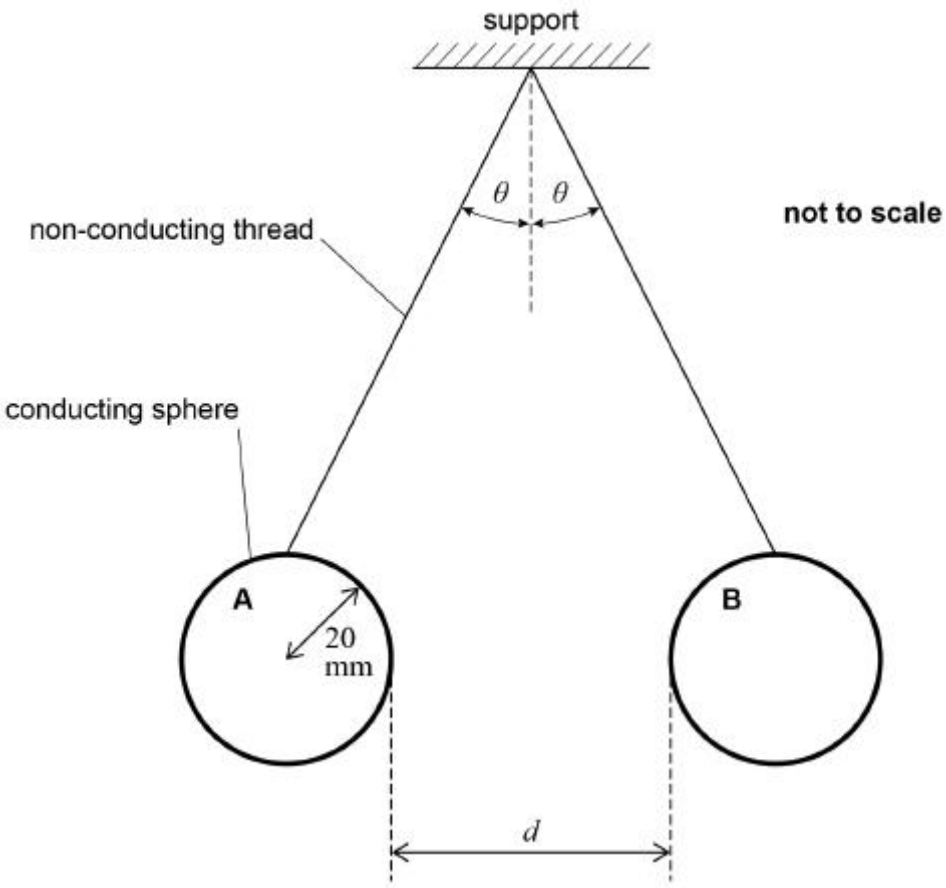
Name of the Student:_____
Max. Marks : 23 Marks **Time : 23 Minutes**

Q1.

The diagram shows an arrangement used to investigate the repulsive forces between two identical charged conducting spheres.
The spheres are suspended by non-conducting thread.



Each sphere has a mass of 3.2×10^{-3} kg and a radius of 20 mm.
The distance d is 40 mm.

The capacitance of a sphere of radius r is $4\pi\varepsilon_0 r$.

Each sphere is charged by connecting it briefly to the positive terminal of a high-voltage supply, the other terminal of which is at 0 V.
After this has been done the charge on each sphere is 52 nC.

(a) Calculate the potential of one of the spheres.

potential = _____ V

(3)

(b) The charged spheres in the diagram above are at equilibrium.

Draw labelled arrows on the diagram to show the forces on sphere **B**.

(2)

(c) Suggest a solution to **one** problem involved in the measurement of d in the diagram.

_____

_____

_____

_____

_____

_____

(2)

(d) Show that the magnitude of the electrostatic force on each sphere is about 4×10^{-3} N.

(3)

(e) A student measures the angle θ when the apparatus in the diagram above is at equilibrium. The student records θ as 7°.

Discuss whether this measurement is consistent with the other data in this investigation.

_____

_____

_____

_____

(2)

(f) The student says that the gravitational force between the two spheres has no **significant** effect on the angle at which the spheres are in equilibrium.

Deduce with a calculation whether this statement is valid.

_____

_____

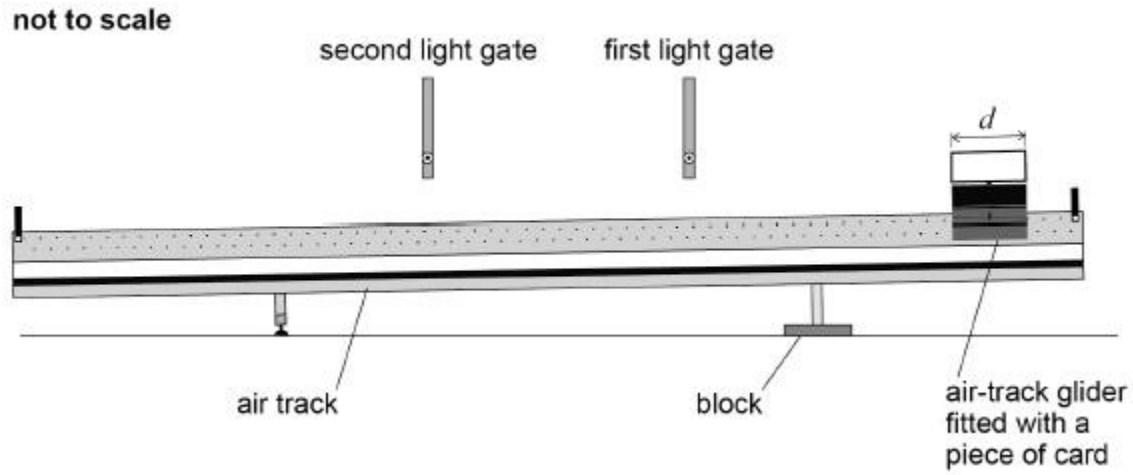
(2)

(Total 14 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.

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.

_____

_____

_____

_____

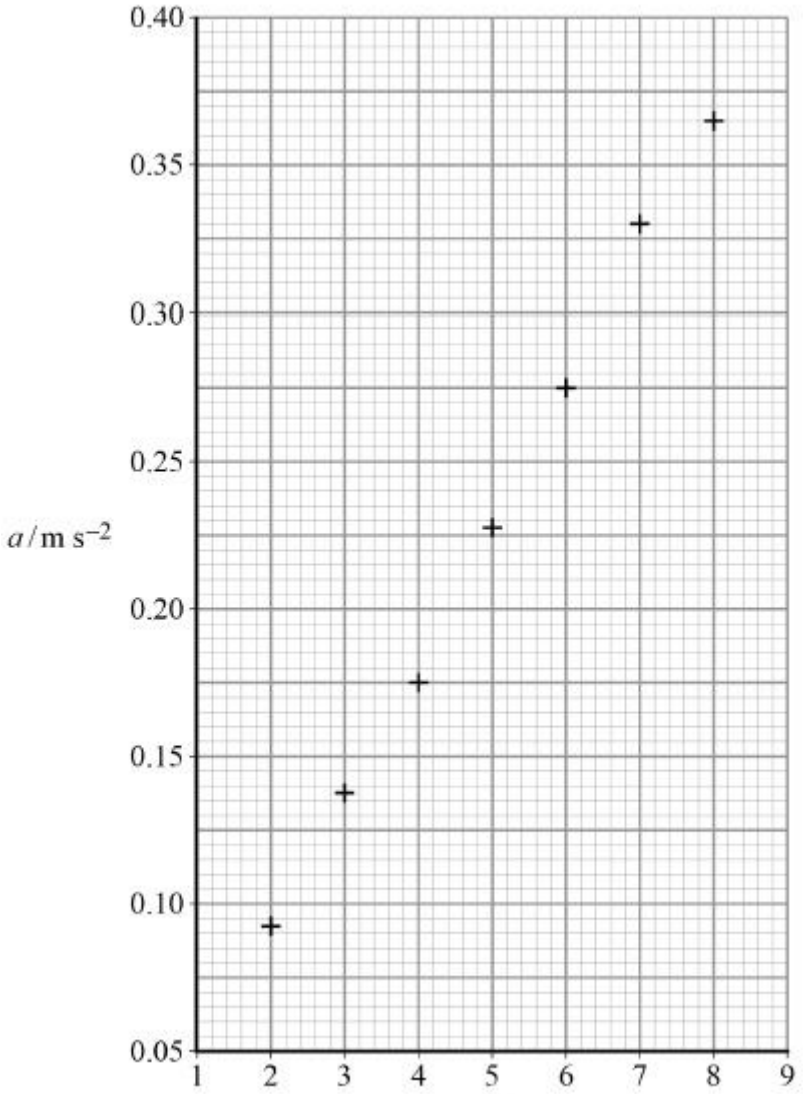
_____

(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



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)