

2022 年 澳門中學物理競賽

Concurso de Física para Alunos do
Ensino Secundário de Macau 2022

高級組

Avançada

學生証號碼：

Número do Cartão de Estudante _____

座位編號：

Número do Assento _____

競賽答卷注意事項

1. 使用藍色或黑色圓珠筆答題。若使用鉛筆和其他顏色筆答卷，可被視為白卷處理。
2. 將答題內容填寫在每一題下方框內。若空間不足，可使用每頁背面的方框繼續填寫。若空間再不足，可使用答卷最後補充頁上（第 17 至 18 頁）的方框繼續填寫，但需要標注填寫內容對應的題號。
3. 保持卷面整潔，適當使用草稿紙。卷面不可使用塗改工具。若必要，可用圓珠筆劃去已填下的不適用內容。
4. 本卷有概念題 5 題及計算題 5 題。概念題每題 10 分、計算題每題 20 分。卷面共 150 分。

Guidelines when answering the exam paper

1. Use blue or black pens to answer. If you use pencils or pens of other colors, those parts might be ignored and considered blank.
2. Fill in your answers within the bounding boxes under the questions. If the space is not enough, you can use the boxed spaces on the back. If that space is still not enough, you can use the boxed spaces on the supplementary pages (pp. 17 and 18) and supply the corresponding question number when you fill in the answers.
3. Keep the pages clean and use the provided scrap papers when needed. Do not use erasing or covering materials on the exam paper. If necessary, strike out the improper filled contents with cross lines.
4. There are 5 concept questions and 5 calculation questions. Each concept question is worth 10 points while each calculation question is worth 20 points. The total number of points counted in the exam is 150.

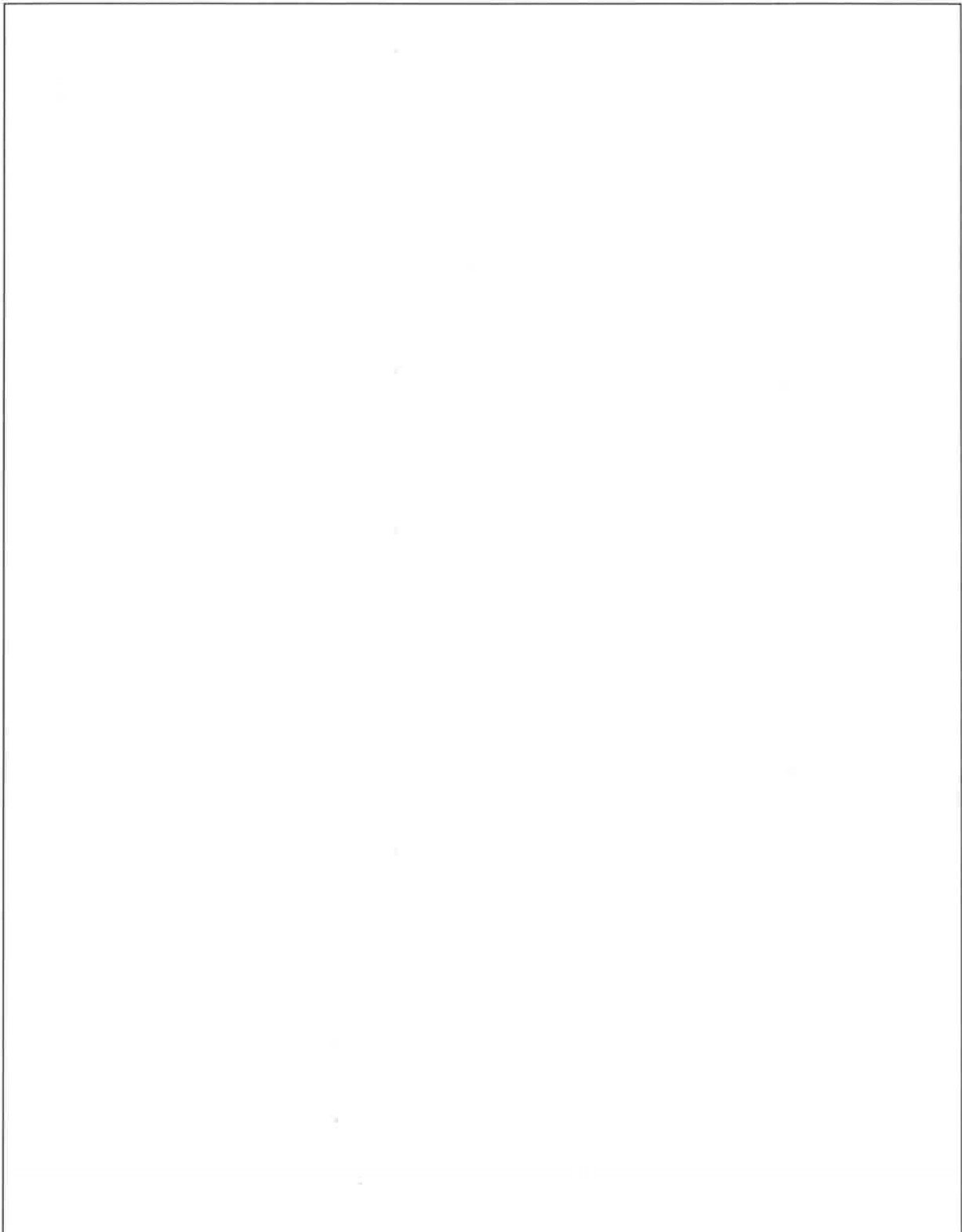
第一部分：概念題

PART I: Concept questions

1. 當應用理想氣體定律時，須對“理想氣體”做那些假設？范德瓦提出了一個方程來修正理想氣體定律的限制。該范德瓦方程是什麼以及它涵蓋了哪方面的考慮？
What does one assume about an “ideal gas” when applying the ideal gas law? Van der Waals introduced an equation to correct for the limitations of this gas law. What is this van der Waals equation and what does it account for?

2. 簡述核能發電的工作原理。

Briefly explain the working mechanism of nuclear power generation of electricity.



3. 試簡單解釋伽利略變換、洛倫茲變換、與龐加萊變換之間的區別。

Briefly explain the differences between Galilean transformation, Lorentz transformation, and Poincare transformation.

4. 爲何某些元素例如鐵、鈷會顯現鐵磁性，而其他元素不會？試從量子 and 原子理論的角度解釋。

Why some elements such iron or cobalt exhibit ferromagnetism, but not other elements?
Explain briefly from the perspective of quantum and atomic theories.

5. 電路裏經常會用一個小電容來過濾掉 DC 偏置並保留 AC 信號。這個效應為什麼可行？試簡單解釋。

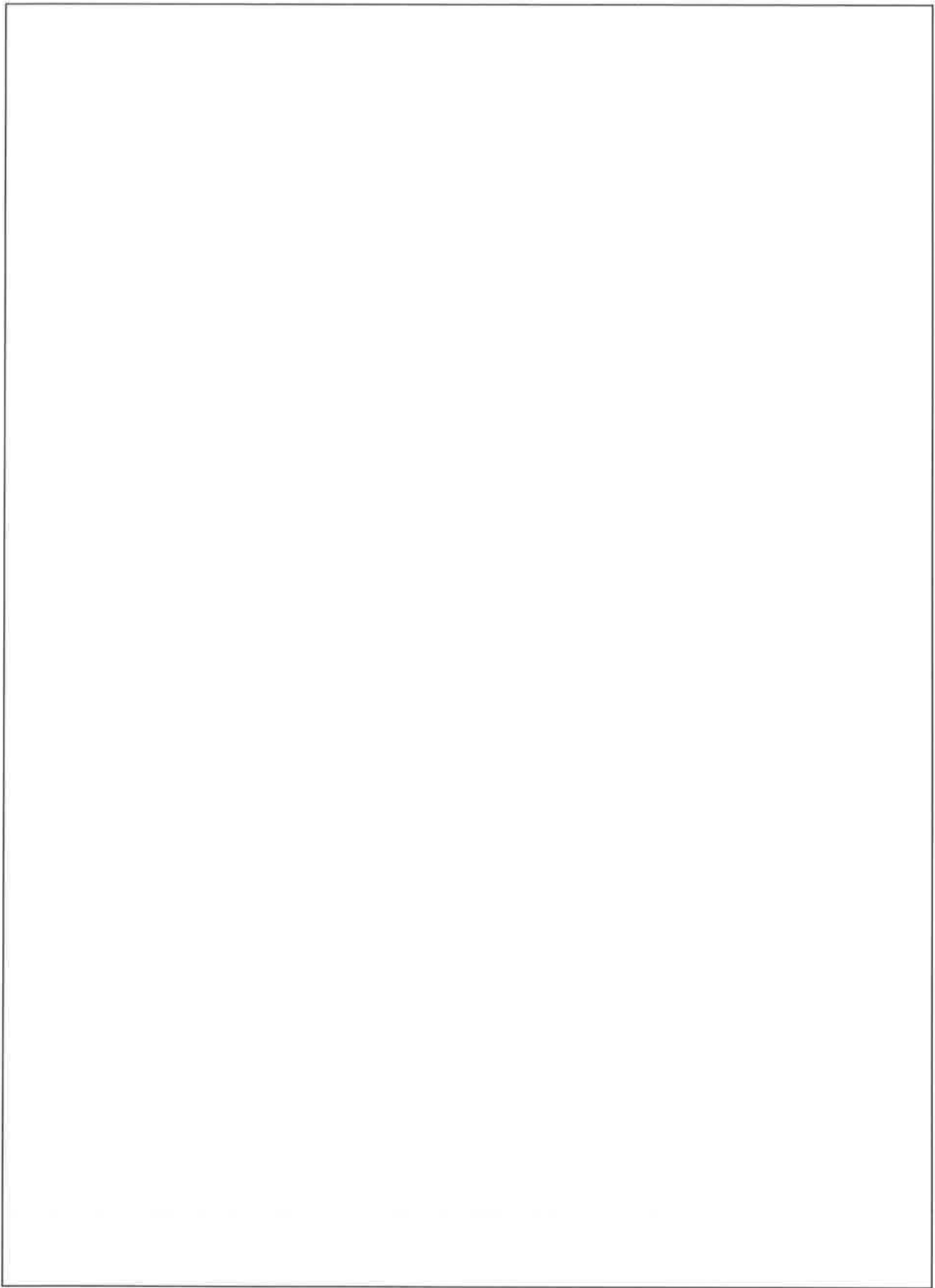
A small capacitor is often used in an electrical circuit to filter out DC offset and retain the AC signal. Why would this effect work? Explain briefly.

第二部分：計算題

PART II: Calculation questions

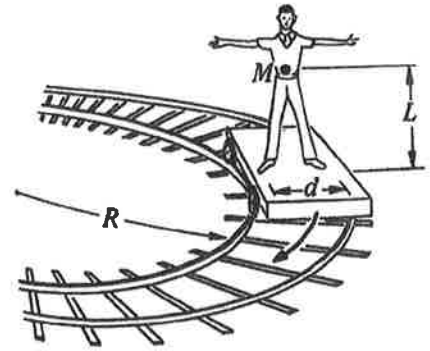
1. 我們知道大氣壓力隨海拔高度的增加而減小。現假設大氣的溫度 T 均勻，那麼大氣壓力 p 和高度 z 之間的關係式是什麼？

We know that the atmospheric pressure decreases along with altitude. Now assume the temperature T throughout the atmosphere is constant. What is the relation formula between the atmospheric pressure p and the altitude z ?

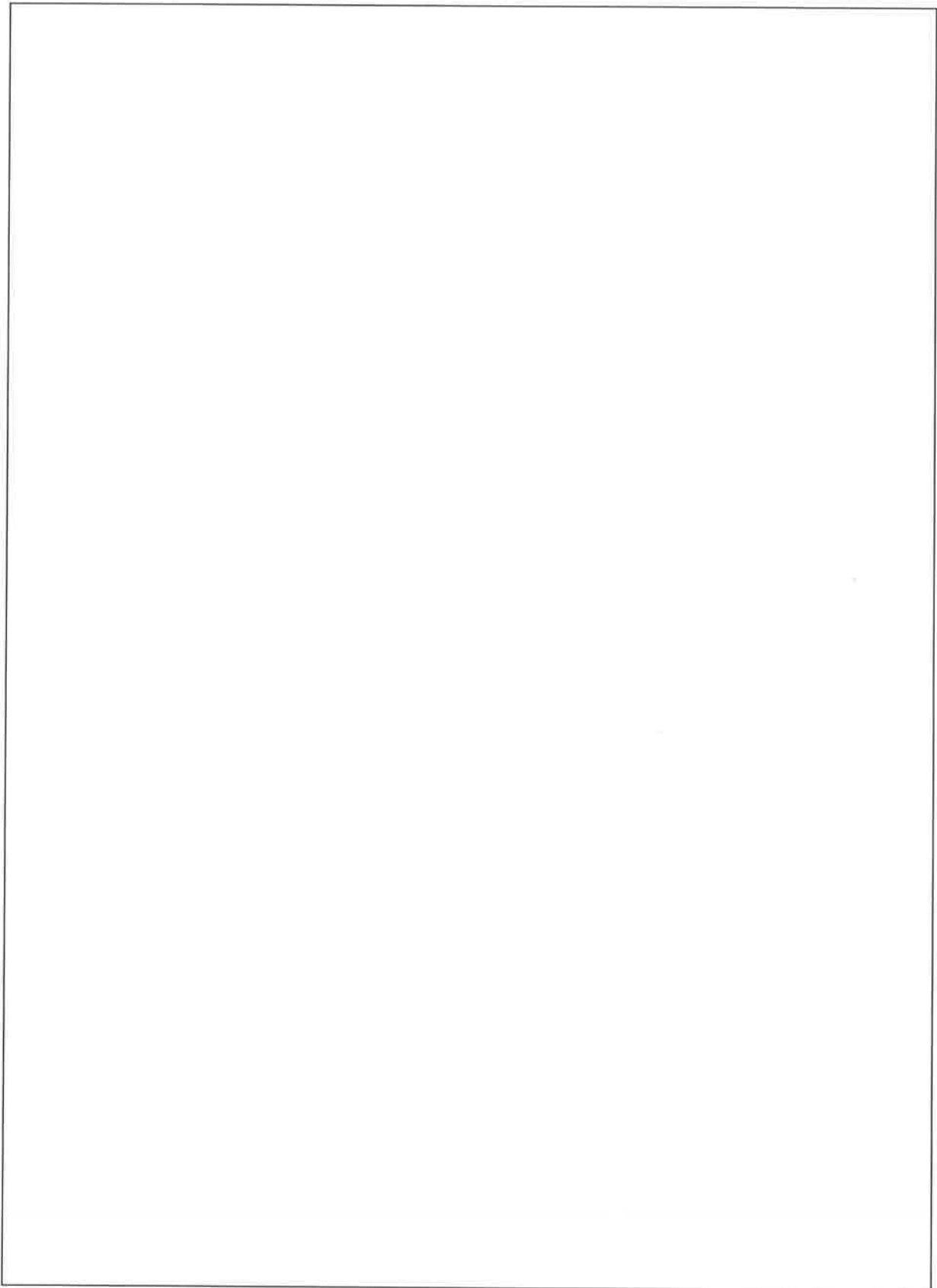


2. 如圖所示，有一質量為 M 的人站立在一鐵軌平板車上，正面向車的行進方向。鐵軌無傾斜、半徑為 R ，行進速度為 v 。他身體的質心離平板車距離為 L ，雙腳以距離 d 分開。他雙腳分別承受的重量為多少？

Shown in the figure, a man of mass M stands on a railroad car which is rounding an unbanked turn of radius R at speed v . He faces right towards the direction of motion. His center of mass is at a distance L above the car and his feet are distance d apart. What are the weights on each one of his feet?

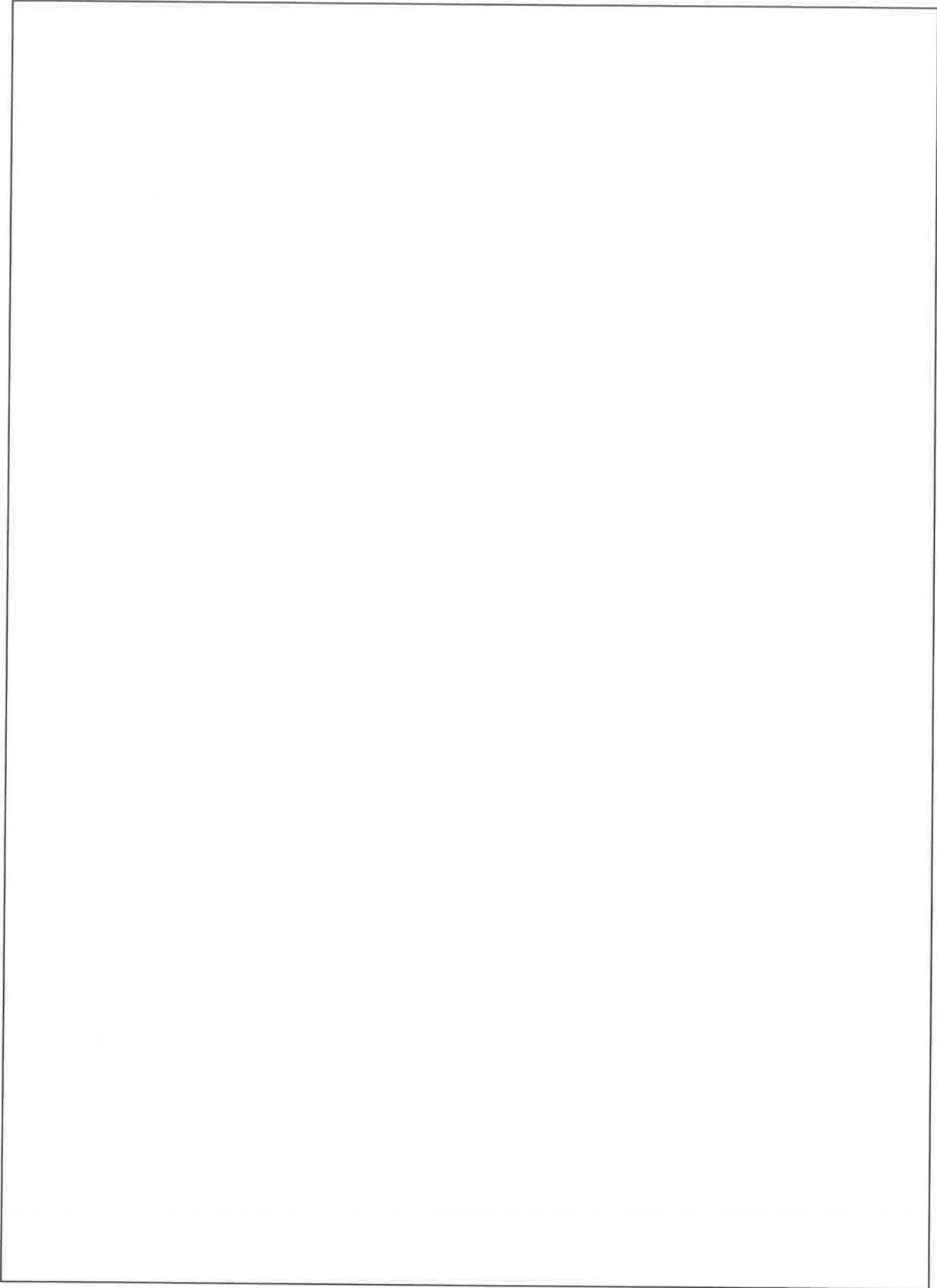


A large empty rectangular box provided for the student to write their solution to the problem.

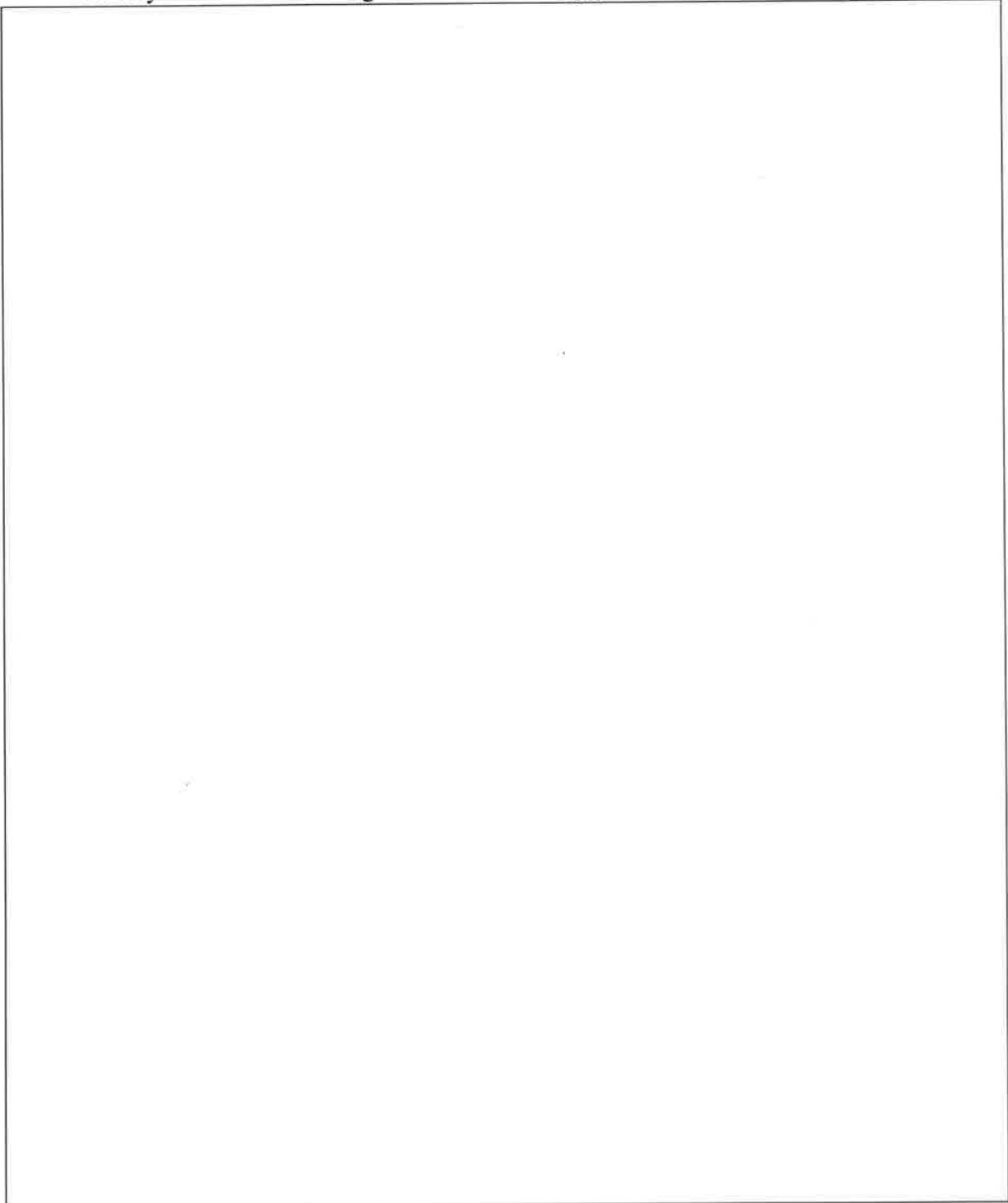


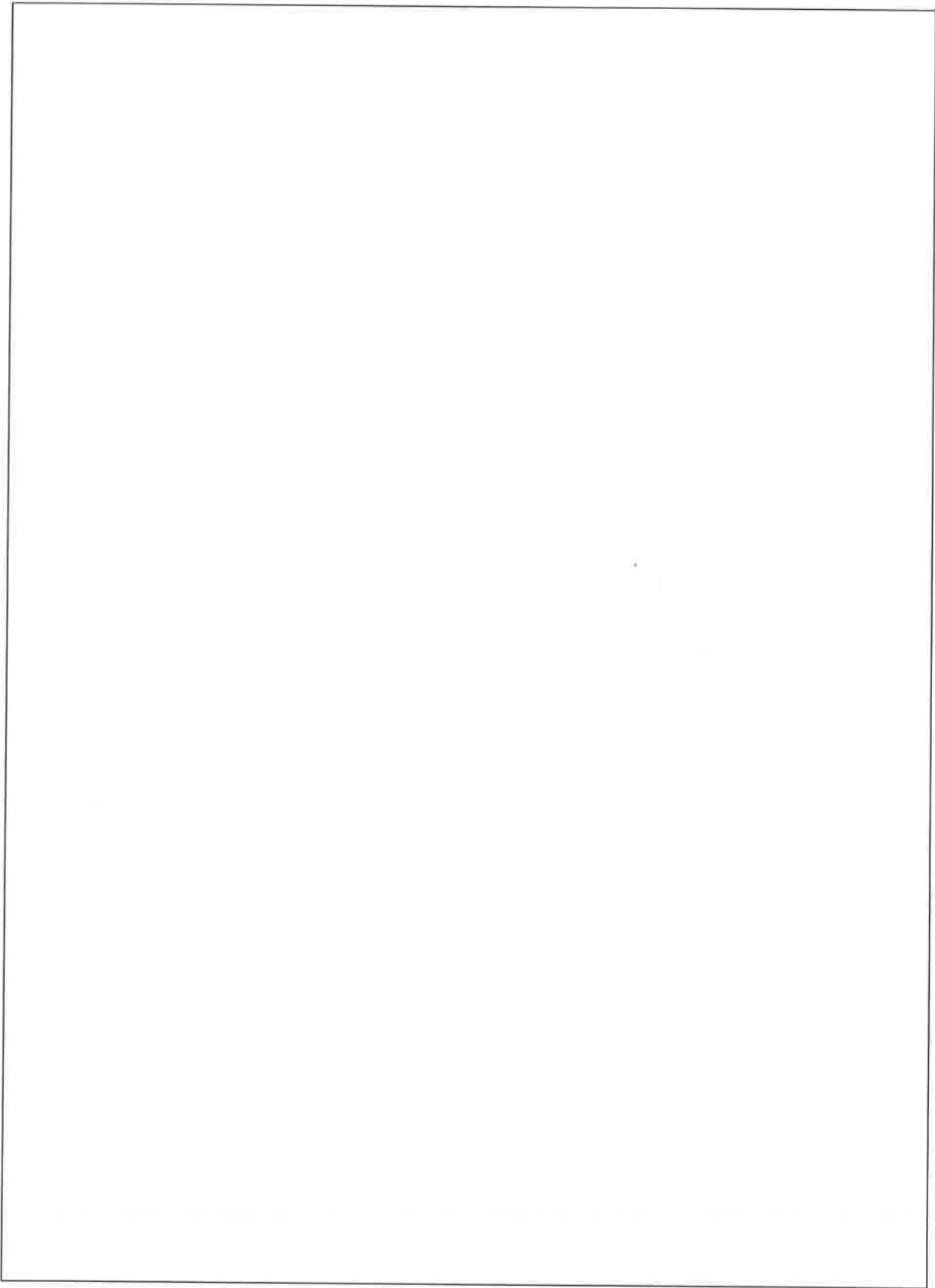
3. 想像一名 1.8m 高的運動員正在進行擲鐵餅運動，鐵餅質量為 8kg。以均勻角速度旋轉。假設他的臂長（從手心到身體質心）為 1m，而他手臂用的力是 400N。旋轉後，他將鐵餅在與頭頂水平處拋出，拋出角度與地面成 25° 角。那麼在擊地之前，鐵餅會飛行多遠？

Imagine a 1.8m tall athlete is playing the game of discus, where the discus has a mass of 8kg. spins at a constant angular velocity. Assume his arm length (from the palm to the body center of mass) is 1m and the force he experiences in his arms is 400N. After spinning, he throws out the discus at the top of his head at an angle of 25° with respect to the ground. What is the distance the discus travels before it hits the ground?



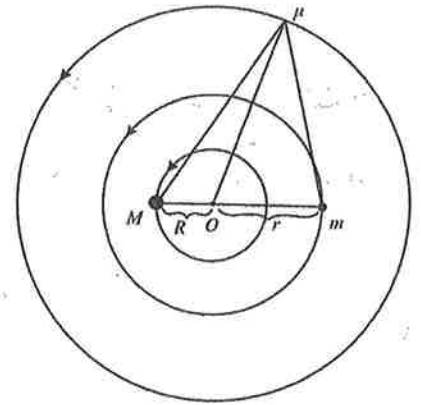
4. 考慮質量為 M 和 m 的兩個質點，由於萬有引力分別以半徑 R 和 r 的圓軌道繞行兩者共有的質心。假如萬有引力常數寫為 G ，那麼 M 和 m 之間連線的角速度 ω 為多少？
- Consider that two particles of masses M and m are orbiting circularly with radii R and r , respectively, around their shared center of mass due to gravitation. What is the angular velocity ω of the line linking M and m , assuming gravitational constant to be G ?

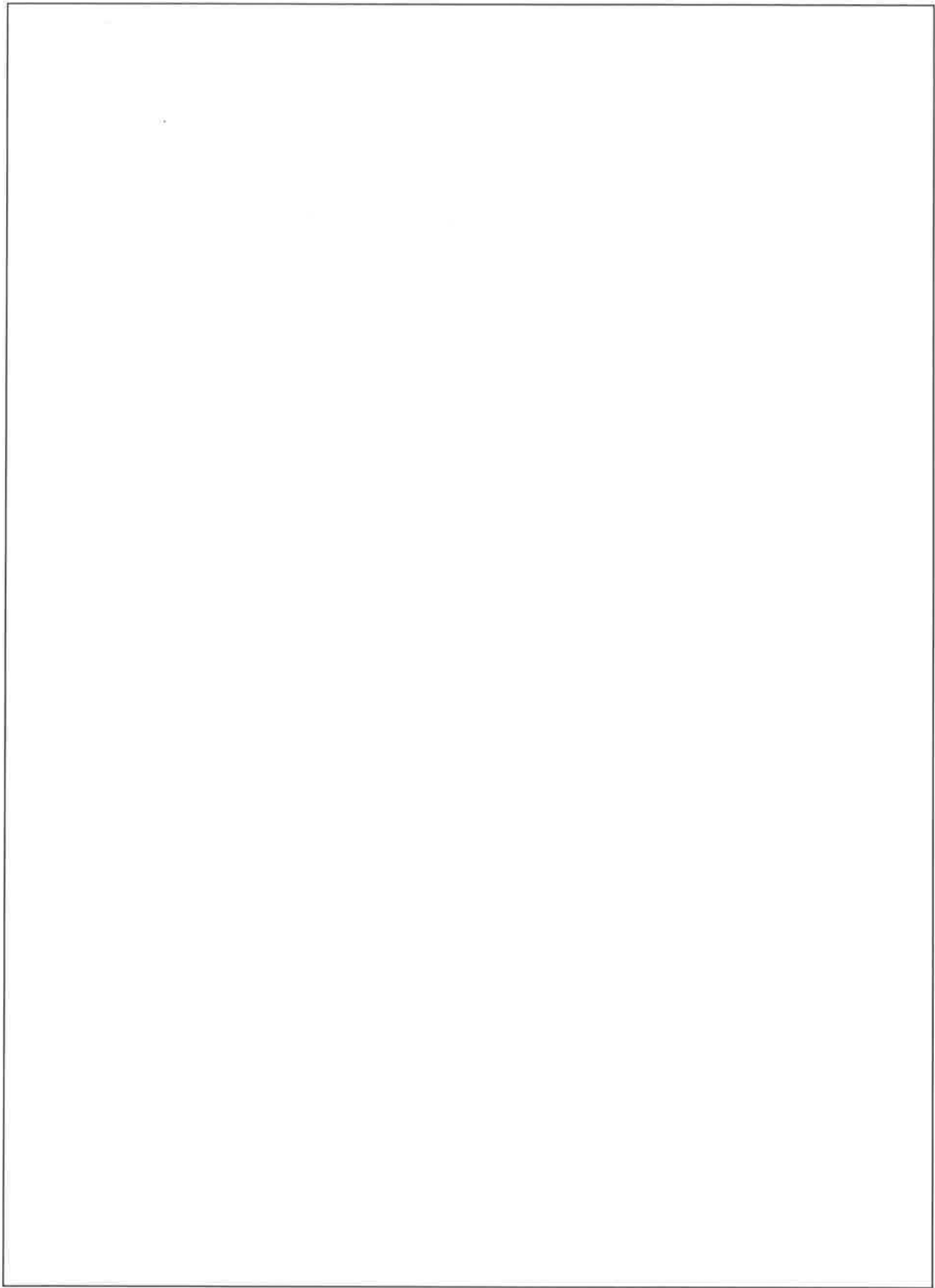




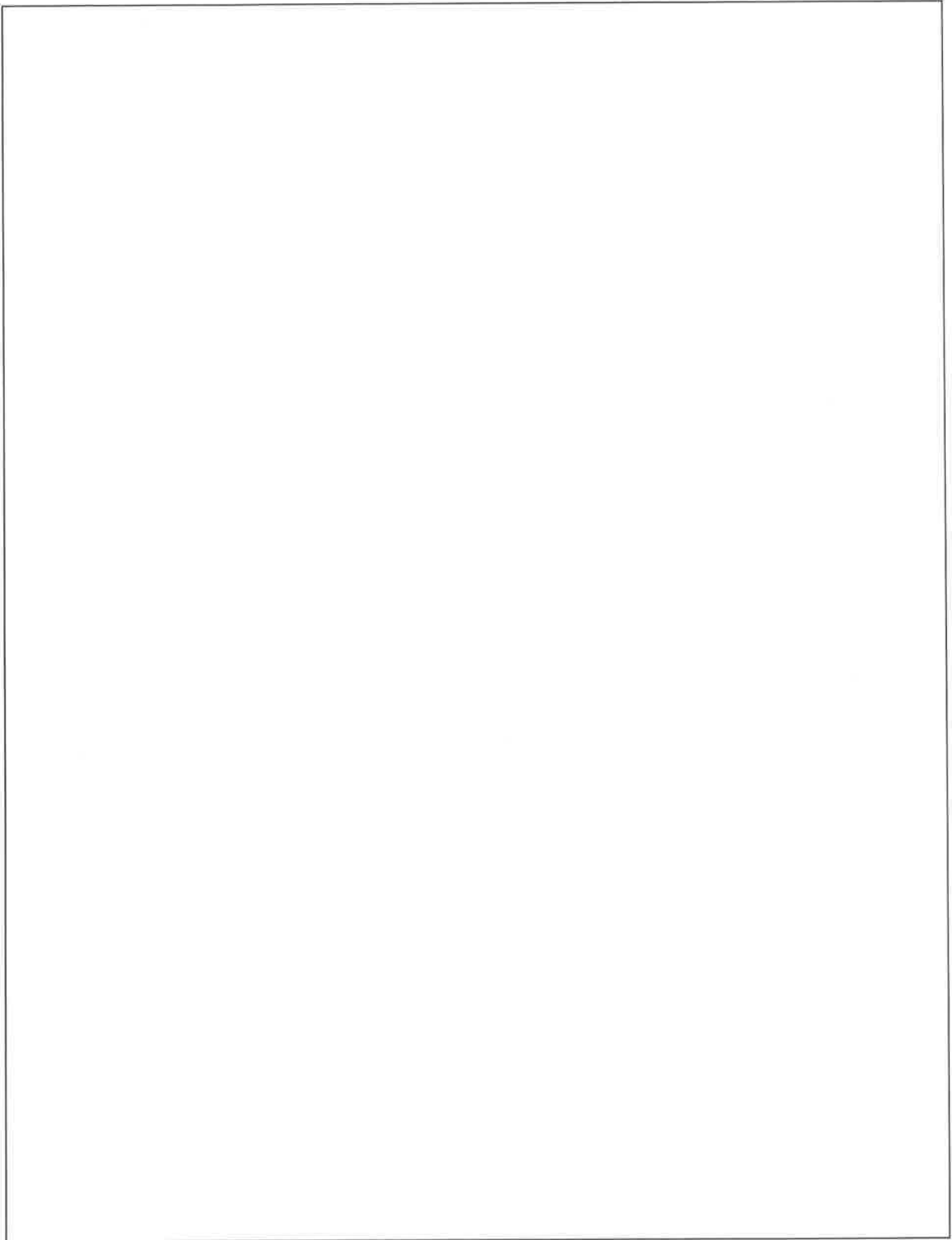
5. 承接上題（題 4），如圖所示，考慮在 M 和 m 形成的軌平面上放置一質量可忽略的質點 μ ，並假定 μ 繞質心 O 作圓周運動。若 μ 與 M 和 m 保持相對靜止， μ 與 M 之間以及 μ 與 m 之間的距離分別為多少（以 r 和 R 表示）？

Continuing the last question (question 4), consider that a particle μ of negligible mass is placed on the orbital plane formed by M and m and undergoes orbital circulation around the center of mass O , as shown in the figure. What are the distances between μ and M and between μ and m , if μ stays relatively static with respect to M and m (in terms of r and R)?





補充頁 1



補充頁 2

