2022/2023 學年　學界物理比賽

Concurso Interescolar de Física do ano lectivo de 2022/2023

初级组

Elementar

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，可被視爲白卷處理。

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 16 至 17 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 4 題及計算題 4 題。概念題每題 10 分、計算題每題 20 分。卷面共 120 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. 16 and 17) 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 4 concept questions and 4 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 120.

第一部分：概念題　　PART I: Concept questions

1. 海市蜃樓是一種自然現象，使人們產生一種錯覺，誤以為前面不遠處會有水源，通常是在沙漠中或在一條又長又直的道路上發生。解釋這是如何發生的。
   A mirage is a natural phenomenon that gives people an illusion that some water is at some locations nearby. This usually happens in a desert or on a long straight road. Explain how this happens.

2. 考慮室溫下的黑芝麻、青豆和紅蘋果。 哪個能發出黑體輻射？ 當溫度升高時，黑體輻射會發生什麼變化？ 解釋。
Consider black sesame, green peas and red apple under room temperature. Which one can give out blackbody radiation? What happens to the blackbody radiation when temperature increases? Explain.

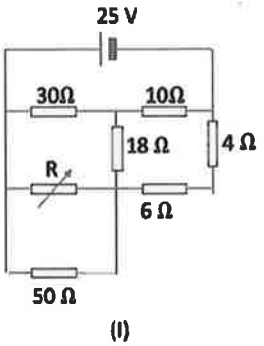
3. 颱風或熱帶氣旋在北半球總是逆時針旋轉，但在南半球總是順時針旋轉。 為什麼？ （提示：這與地球自轉有關。）
Typhoons or tropical cyclones always spin counterclockwise in the Northern Hemisphere but clockwise in the Southern Hemisphere. Why? (Hint: This is related to the self rotation of the Earth.)

4. 橫波可以在水面上傳播，但不能在水內部傳播。為什麼？
Transverse wave can be transmitted on water surface but not inside water. Why?

第二部分：計算題　　PART II: Calculation questions

1.

(a) 在電路 (I) 中，找出可變電阻 R 的值，使得在 18 Ω 電阻中消耗的功率最小。
In Circuit (I), find the value of the variable resistor R such that the power dissipated in the 18 Ω resistor is minimum.



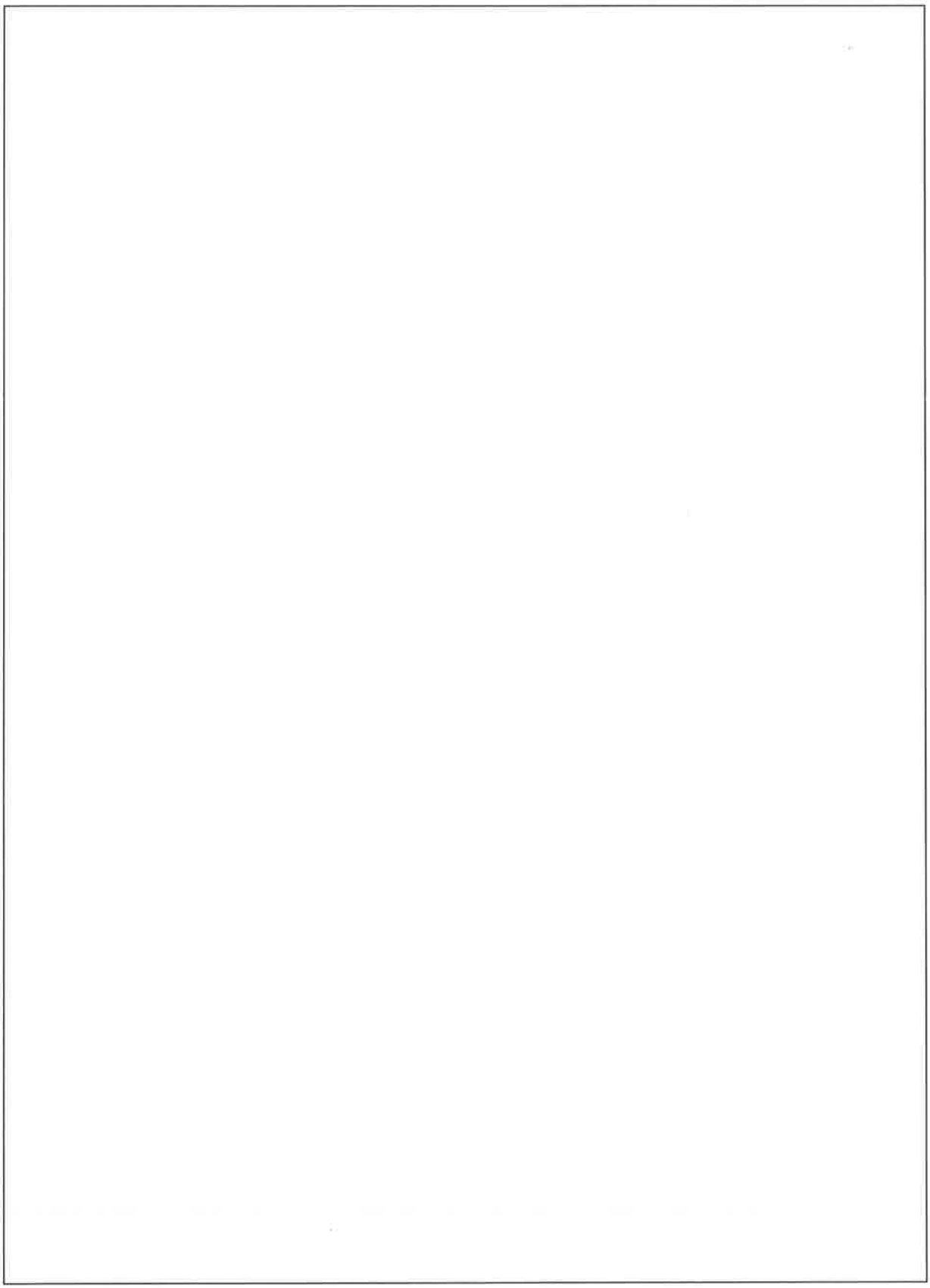
(I)

(b) 燈絲燈泡的電阻由方程 $R = A+BP$ 表示，其中 A 和 B 是常數，P 是燈泡發出的功率。在正常工作期間，輸入電壓為 230V，燈泡發出的功率為 100 W。但是，當冷燈泡剛開著時，燈絲的電阻僅為正常運行時電阻的 1/5。同時，在相同的輸入電壓下，冷燈泡的瞬間功率比正常工作時的功率大 5 倍。

The resistance of a filament light bulb is given by $R = A+BP$, where A and B are constants, and P is the power emitted by the bulb. During normal operation, the power emitted is 100 W at an input voltage of 230V. However, when the bulb is just switched on from cold, the resistance of the filament is only 1/5 of its resistance during normal operation. At the same time, the power of the cold bulb is instantaneously 5 times greater than the normal operating power under the same input voltage.

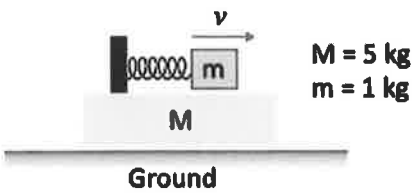
(i) 找出 A 和 B 的值。Find out the values of A and B.

(ii) 如果輸入電壓變為 210 V，燈泡的穩定發射功率是多少？What would be the steady emitted power of the bulb if the input voltage becomes 210 V?



2.

(a) 一個平臺（M = 5 kg）上豎立著一支桿子，上面以彈弓綁住一件物體（m = 1 kg），而該彈弓的彈簧常數為 k = 400 N/m。假設物體與平台之間沒有摩擦，而平臺與地面之間的靜摩擦係數為 μ = 0.1。將物體置於其平衡位置，然後給定水平速度 v。在平臺不會在地面上滑行的情況下，v 最大可以是多少？



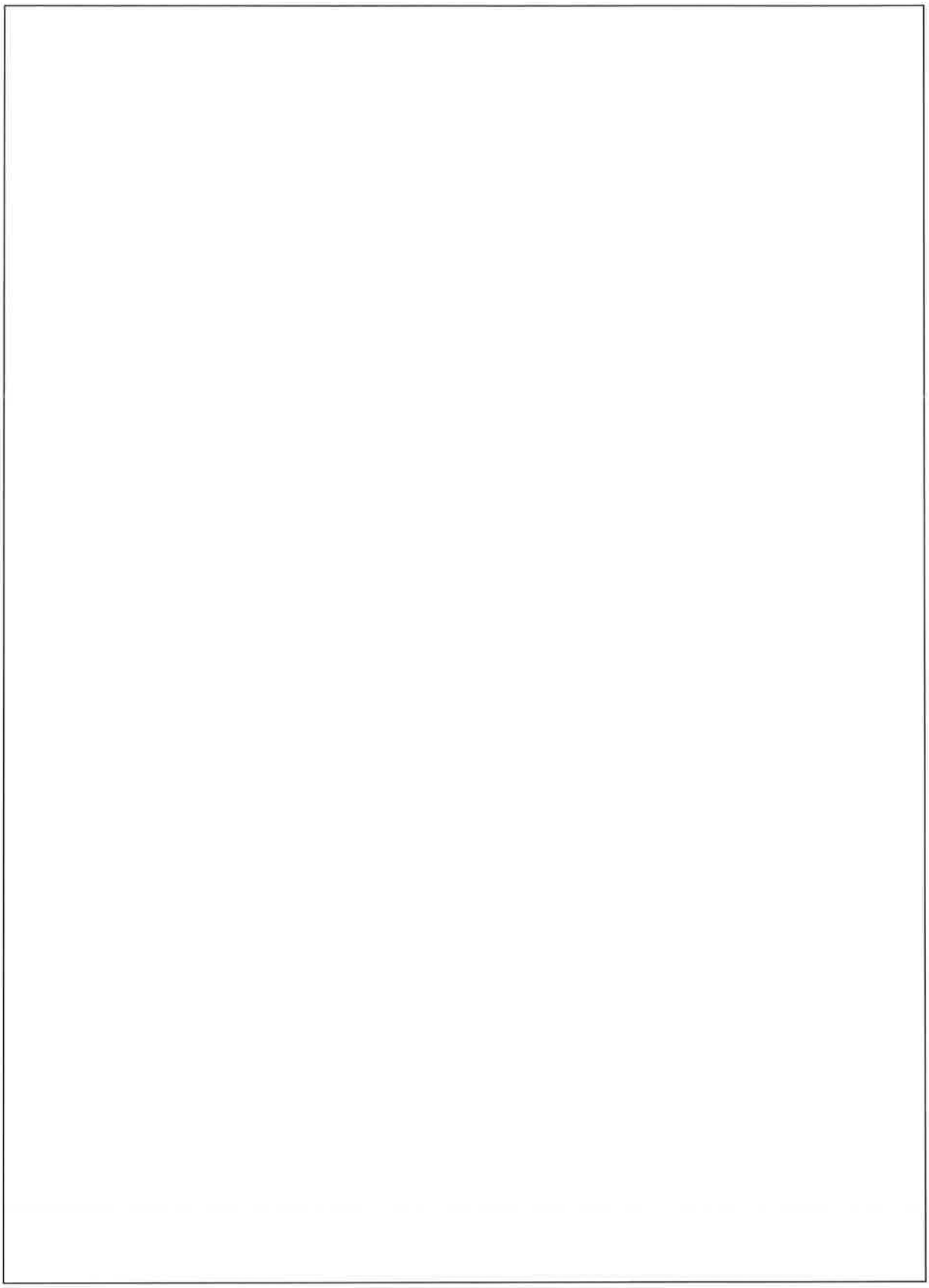
An object (m = 1 kg) is tied to a pole erected on a platform (M = 5 kg) with a spring of spring constant k = 400 N/m. Suppose that there is no friction between the object and the platform, while the coefficient of static friction between the platform and the ground is μ = 0.1. The object is placed at its equilibrium position, and then given a horizontal velocity v. What is the maximum v such that the platform would not slip on the ground?

(b) 鼓皮的基頻可以方程 $f = \frac{0.47hv}{a^2\sqrt{1-\rho^2}}$ 表示，其中 h 是皮的厚度，v 是聲波在皮中的速度，ρ 是彈性常數。所有單位均採用 SI 單位。

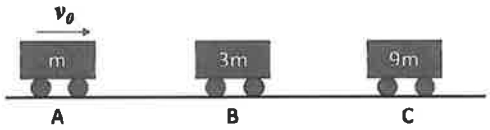
The fundamental frequency of a drum skin is given by $f = \frac{0.47hv}{a^2\sqrt{1-\rho^2}}$, where h is the skin thickness, v is the speed of sound in the skin, and ρ is the elasticity constant. All units are in SI units.

I. 彈性常數 ρ 的單位是什麼？ What is the unit for ρ the elasticity constant?

II. 找出方程中 a 的單位。Determine the units of the quantity a.



3.



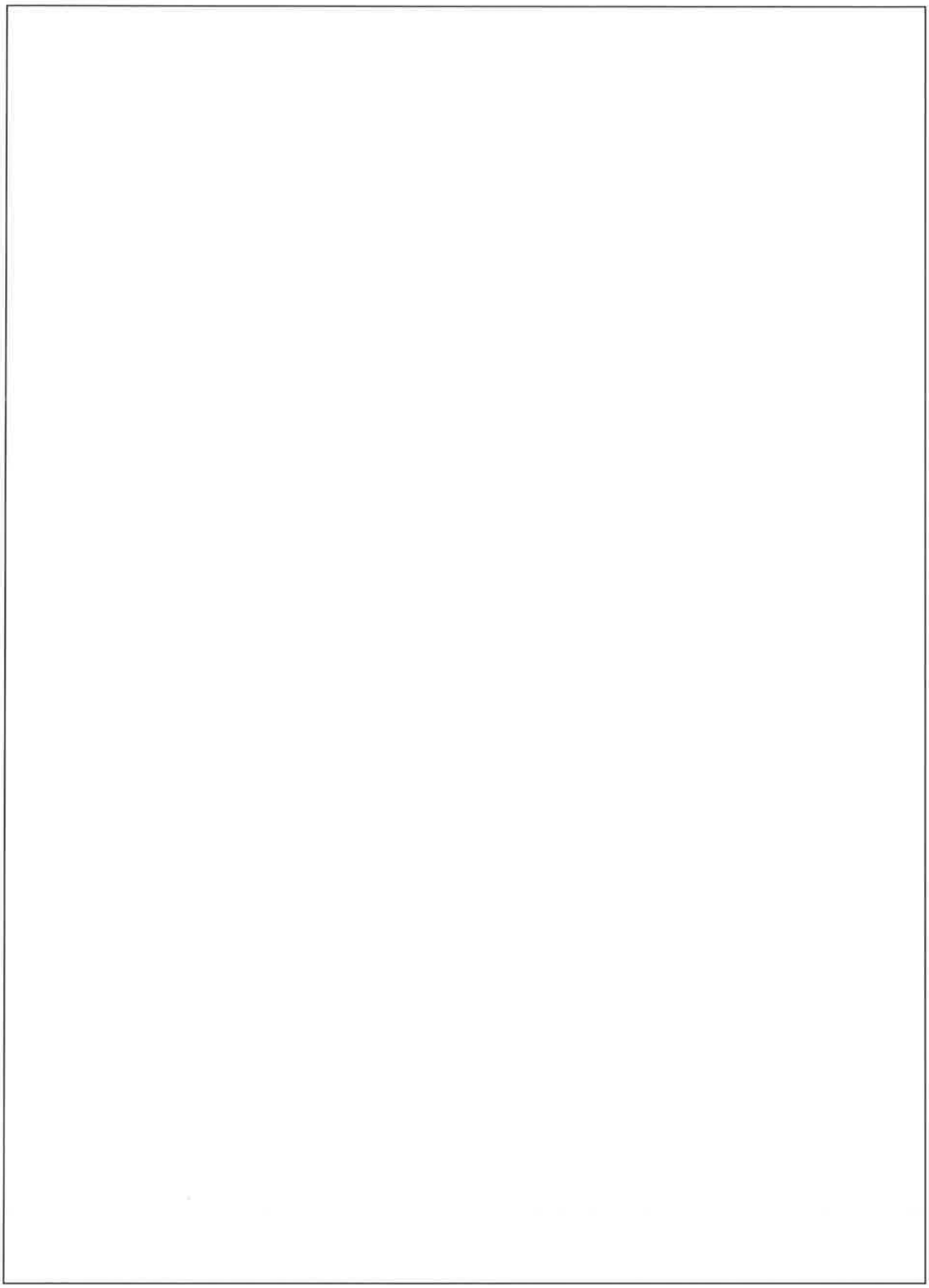
無摩擦力的地面上放置著三輛質量分別為 m, $3m$ and $9m$ 的小車 A、B 和 C。假設小車 B 和 C 在開始時處於靜止狀態，而小車 A 以 v_0 的初始速度向 B 移動。

Consider three carts A, B and C with masses m, $3m$ and $9m$ on a frictionless ground. Suppose that carts B and C are at rest at the beginning while cart A moves towards B at an initial speed of v_0.

(a) 假設所有碰撞都是<u>完全非彈性</u>的，小車 C 的最終速度是多少？
Assume that all collisions are completely **inelastic**, what is the final speed of cart C?

(b) 整個系統的總動能變化是多少？
What is the change in total kinetic energy of the entire system?

(c) 現在假設所有碰撞都是<u>完全彈性</u>的，則小車 C 的最終速度是多少？
Now assume that all collisions are completely **elastic**, what is the final speed of cart C?



4.

一件質量為 m 的物件被綁在一條無質量且不可伸展的繩子上，而繩子另一端通過滑輪固定在牆上（見圖 1）。繩子的水平部分長度為 L。忽略系統中的任何摩擦力。請以 m，L 和 g (引力加速度) 來表達您的答案。

An object of mass m is tied to a massless unstretchable string. The string is passed over a pulley and the other end of the string is fixed on the wall (See Fig. 1). The length of the horizontal part of the string is L. Neglect any friction in the system. In the following, express your answers in terms of m, L and g (gravitational acceleration).

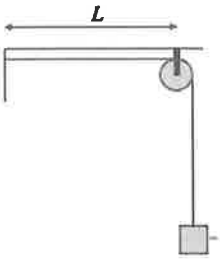


Fig. 1 圖 1

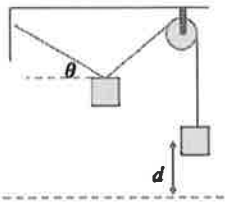


Fig. 2 圖 2

(a) 繩子內部的張力是多少？ What is the tension inside the string?

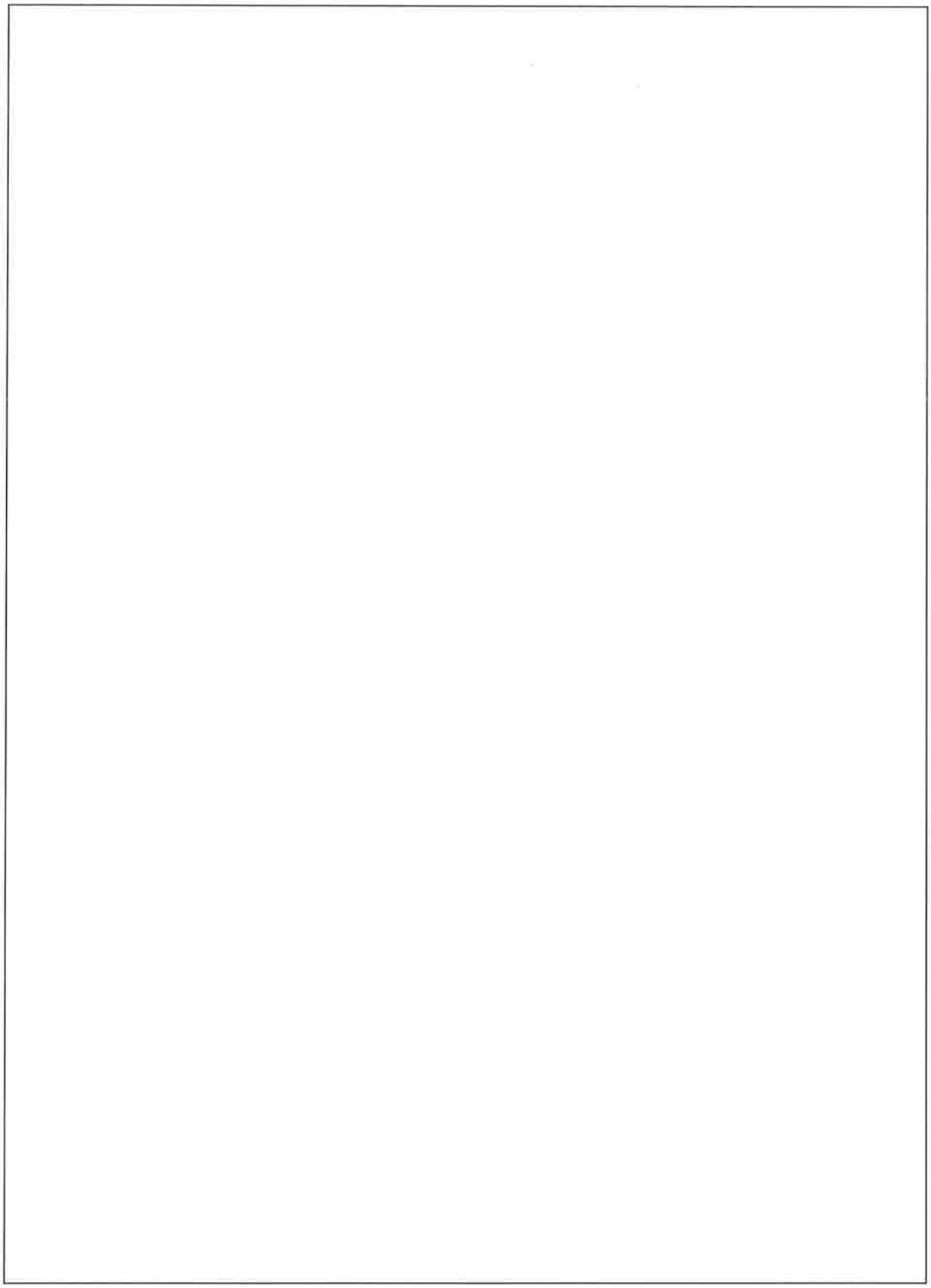
另一個質量為 m 的物體現在懸掛在繩子的水平部分，系統最終達到平衡（見圖 2）Another equivalent object of mass m is now hung from the horizontal part of the string, and the system finally reaches equilibrium (see Fig. 2).

(b) 現在繩子固定端的張力是多少? What is the tension now at the fixed end of the string?

(c) 圖 2 所示的角度θ是多少? What is the angle θ as indicated in Fig. 2?

(d) 原來的物體在此過程中向上移動的距離 d 是多少？ What is the distance d that the original object has moved up during the process?

(e) 如果將一個質量為 $2m$ 的物體掛在繩子的水平部分，那麼新的角度θ會是多少？ If a mass of $2m$ is hung at the horizontal part of the string, what would be the new angle θ?



補充頁 1

補充頁 2