

2020 年 澳門中學物理競賽

Concurso de Física para Alunos do
Ensino Secundário de Macau 2020

初級組

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. 試述聲波的特性。為什麼月球上的宇航員即使彼此接近也必須通過無線電進行通信？

State the properties of sound wave. Why do astronauts on the Moon have to communicate by radio even when they are close to one another?

2. 舉出一機械系統振盪的例子。在電路中如何可觀察到振盪？

Give an example for oscillation of mechanical system. How can an oscillation be observed in an electric circuit?

3. 試述空氣阻力與物體試圖在表面上滑動時的摩擦力的相同和相似之處。

State the differences and the similarities between air friction and frictional force when an object attempts to slide across a surface.

4. 單擺在一近似情況下，是簡諧振盪器。試陳述這近似情況。

The simple pendulum is a simple harmonic oscillator under an approximation. Please describe this approximation.

5. 試用電磁波的頻譜討論光的性質。

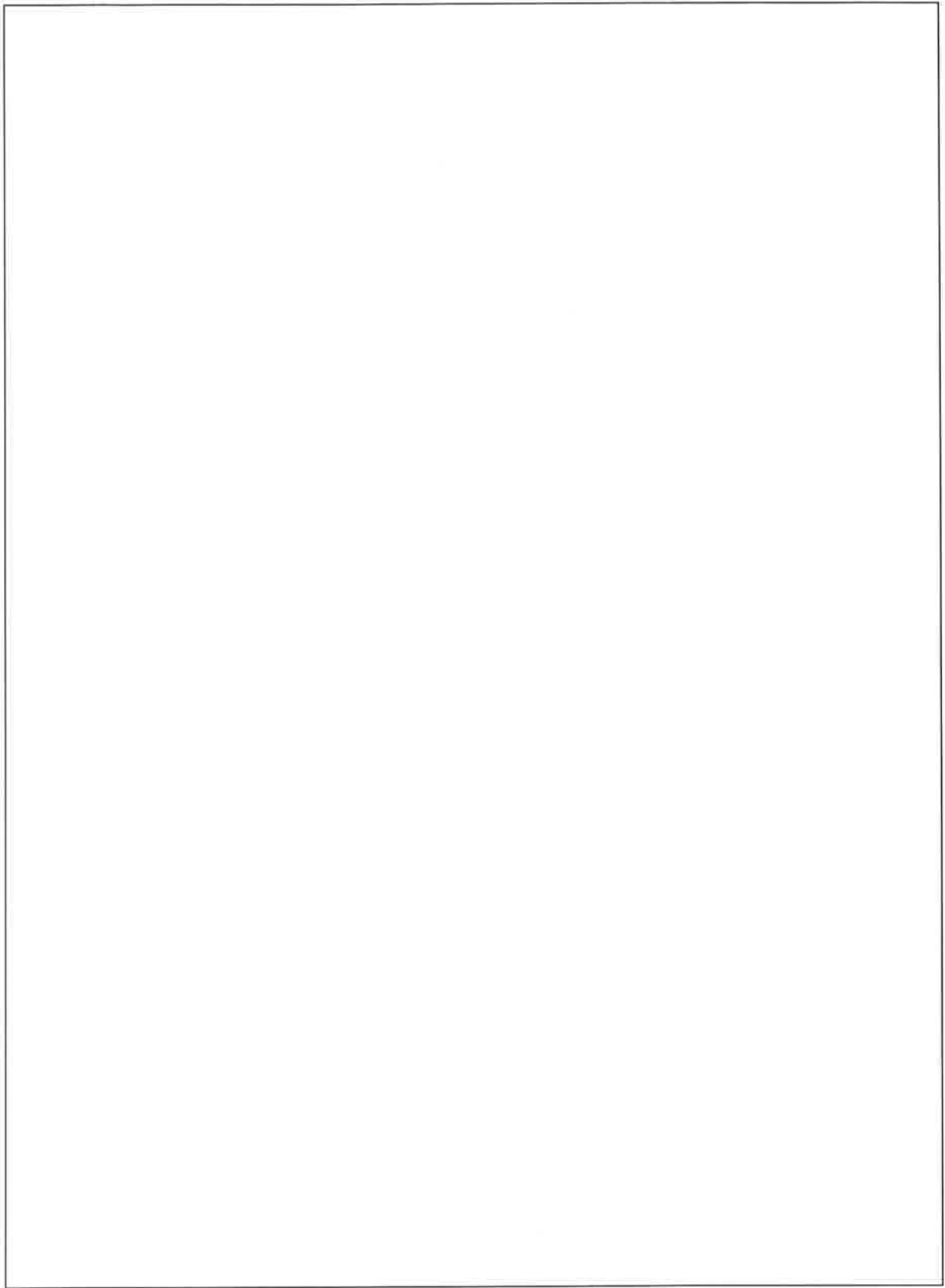
State the properties of light by considering the spectrum of electromagnetic waves.

第二部分：計算題

PART II: Calculation questions

1. 水平地面上有一物體，受到與水平成 37° 角的拉力 F_1 作用 ($F_1 = 20 \text{ N}$)，由靜止開始做勻加速直線運動，從某一時刻開始，拉力變成水平方向大小為 10 N (F_2)，物體在 F_2 力作用下做勻速直線運動 3 s ，此後，拉力消失，物體做勻減速運動 2.4 s ，前進 14.4 m 停止，求物體從開始運動到停止的總時間 t 及總位移 s 。

There is an object on the horizontal ground. It is subjected to a pulling force F_1 ($F_1 = 20 \text{ N}$) at an angle of 37° to the horizontal. It moves from stationary under a uniform acceleration. From a certain moment, the pulling force becomes 10 N (F_2) in the horizontal direction. Under F_2 , it moves with a constant velocity for 3 s . Then, the pulling force disappears and the object decelerates with a constant rate for 2.4 s and moves 14.4 m before it stops. Find the total time t and total displacement s from the start to the stop of the object.



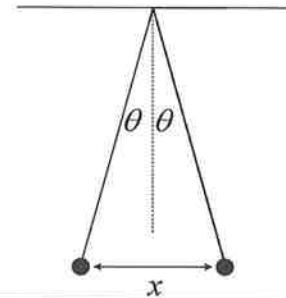
2. 兩相同的球的質量均為 m ，以無質量長度為 l 的細線懸掛之，並帶相同的電荷 q (均勻分佈)，若 θ 很小，證明 $x = \left(\frac{q^2 l}{2\pi\epsilon_0 mg}\right)^{1/3}$ 。[提示：點電荷所產生的電場為 $E = \frac{q}{4\pi\epsilon_0 r^2}$ 。一點電荷在電場中所受的力 $F = qE$ 。]

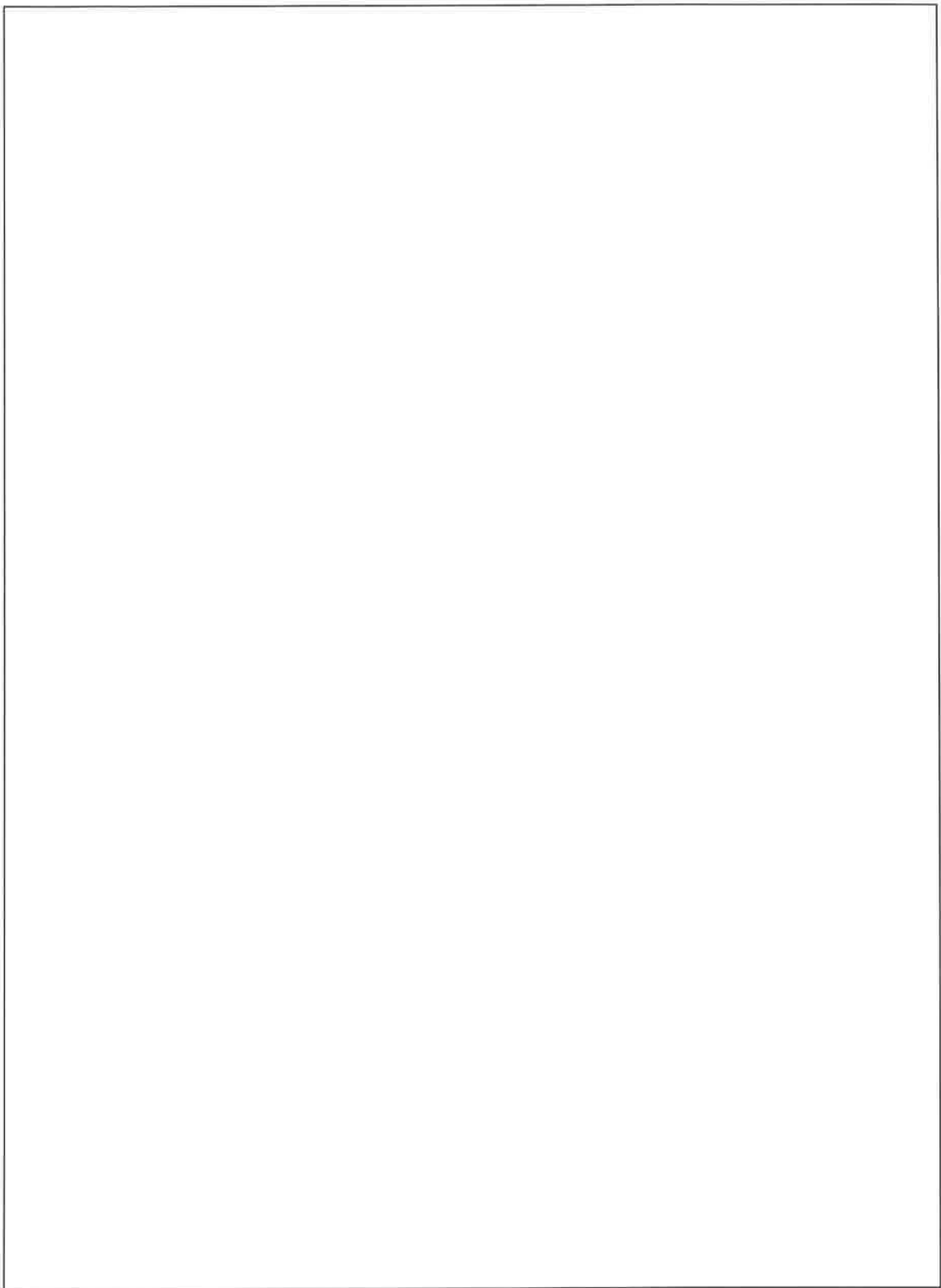
The mass of two identical balls is m , suspended by a massless thin line of length l , and each carrying the same charge q

(uniform distribution). If θ is small, prove $x = \left(\frac{q^2 l}{2\pi\epsilon_0 mg}\right)^{1/3}$.

[Hints: Electric field due to point charge $E = \frac{q}{4\pi\epsilon_0 r^2}$.

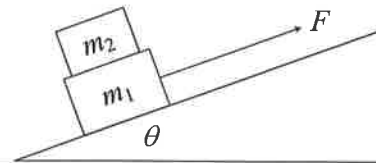
Force on a point charge in electric field $F = qE$.]

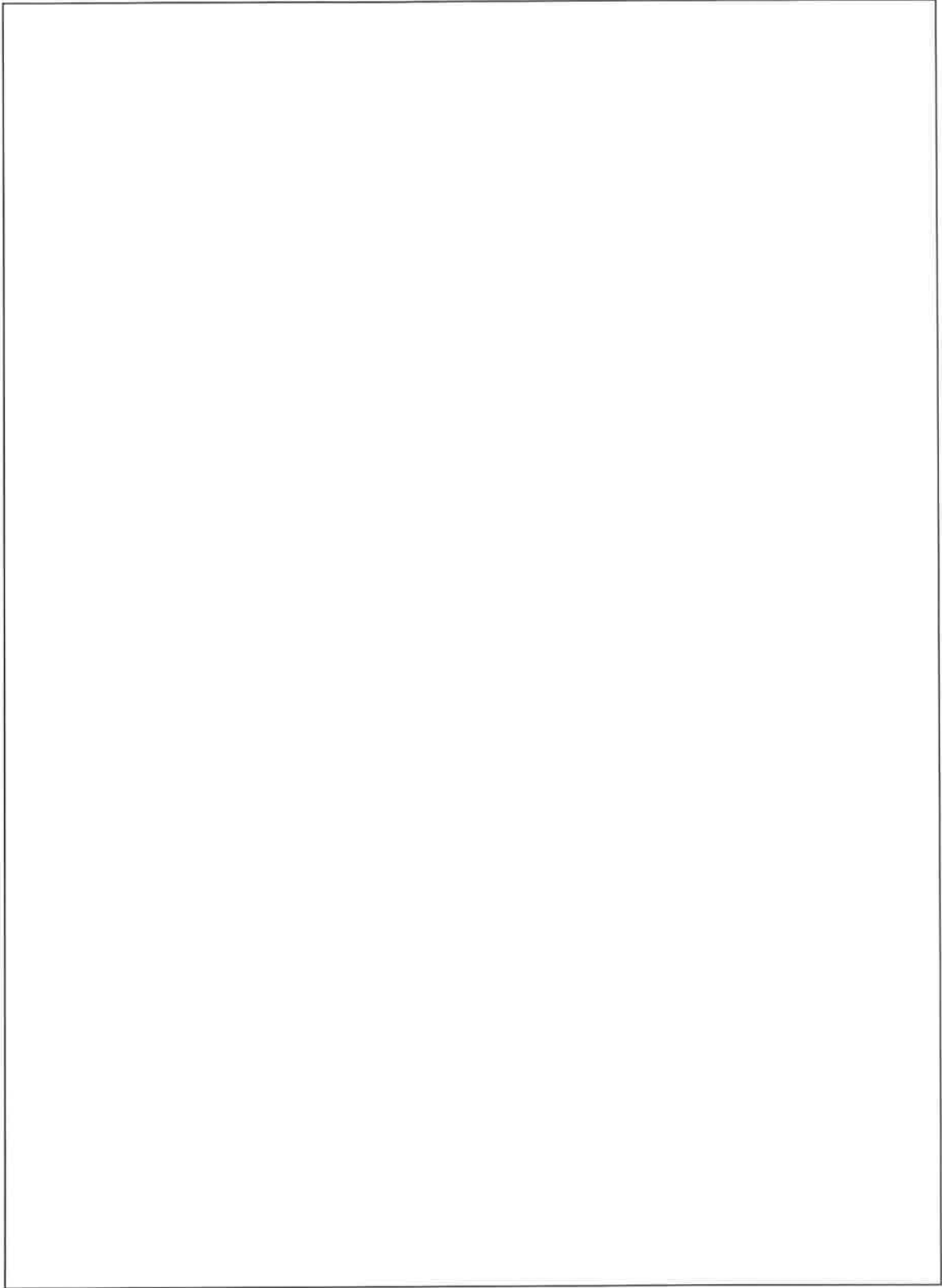




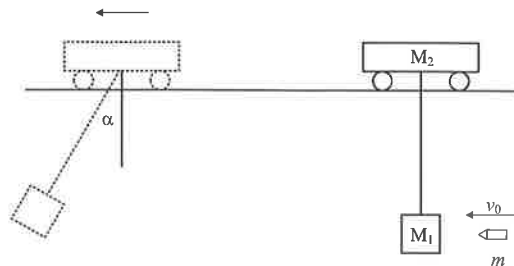
3. 質量為 m_1 和 m_2 的兩木塊，置於仰角為 θ 的斜面上，兩木塊之間的靜摩擦係數為 μ_s ，斜面與 m_1 之間的動摩擦係數為 μ_k ，力 F 與斜面平行。求兩木塊一起運動的最大加速度及此時的力 F 。

Two blocks of mass m_1 and m_2 are placed on an inclined plane with an elevation angle θ . The static frictional coefficient between the two blocks is μ_s , the kinetic frictional coefficient between the inclined plane and m_1 is μ_k , and the force F is parallel to the inclined plane. Find the maximum acceleration of the two wooden blocks moving together and the force F at this time.

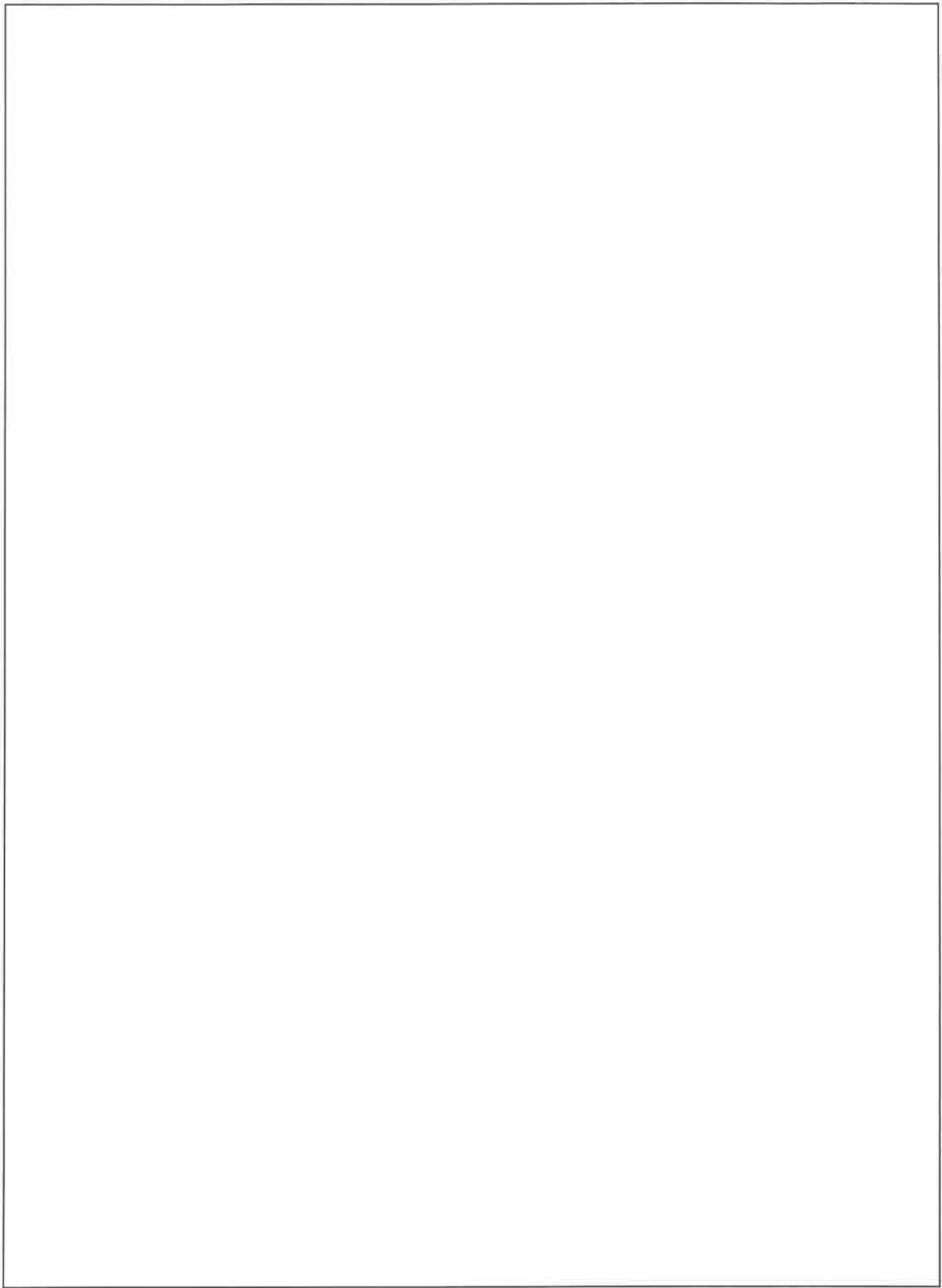




4. 如圖所示，軌道上的行車質量為 M_2 ，它下面用長為 L 的繩子繫一質量為 M_1 的砂袋。現有一質量為 m 的子彈水平地射入砂袋內，而與砂袋一起擺過一角度 α 。若不計行車與軌道間的摩擦，求子彈射入時的速度。



As shown in the figure, the mass of the vehicle on the track is M_2 , and a sand bag of mass M_1 is tied below the rope of length L . A bullet having a mass m is horizontally shot into the sand bag, and swings at an angle α along with the sand bag. If the friction between the vehicle and the track is not taken into account, find the speed of the bullet when it enters.

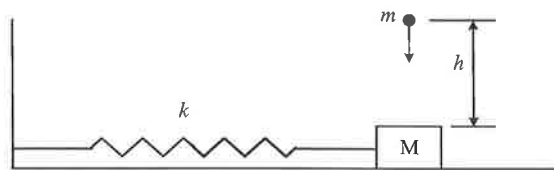


5. 一個水平面上的彈簧振子，彈簧係數為 k ，所繫物體質量為 M ，振幅為 A 。有一質量為 m 的小物體從高度 h 處自由下落。當振子在最大位移處，小物體正好落在物體 M 上，並粘在一起，這時系統的振動周期、振幅及振動能量有何變化？如果小物體是在振子到達平衡位置時落在 M 上，這些量又怎樣變化？

[提示：振子在最大位移處，速度為零。
振子在平衡位置時，速度最大（速度 = 振幅×角頻率）。

彈簧振子周期 $T = 2\pi\sqrt{\frac{M}{k}}$ 。

振動能量與振幅平方成正比。]



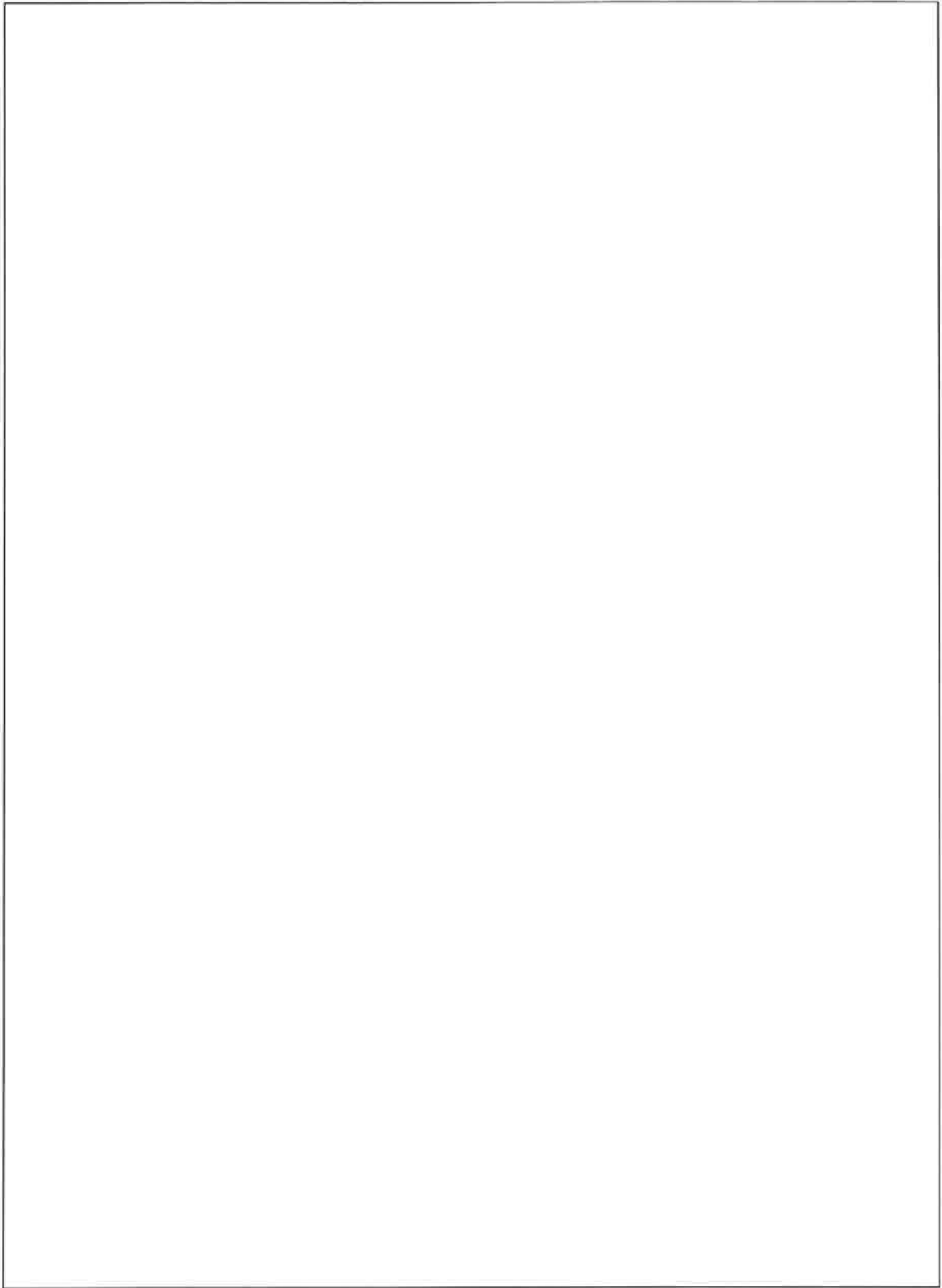
A spring oscillator on a horizontal plane has a spring constant k , an object mass M , and an amplitude A . There is a small object of mass m that falls freely from a height h . When the oscillator is at its maximum displacement, the small object just falls on the object M and sticks together. At this time, how do the vibration period, the amplitude and the vibration energy of the system change? If the small object falls on M when the oscillator reaches the equilibrium position, how do these quantities change?

[Hints: Velocity is zero when the oscillator is at its maximum displacement.

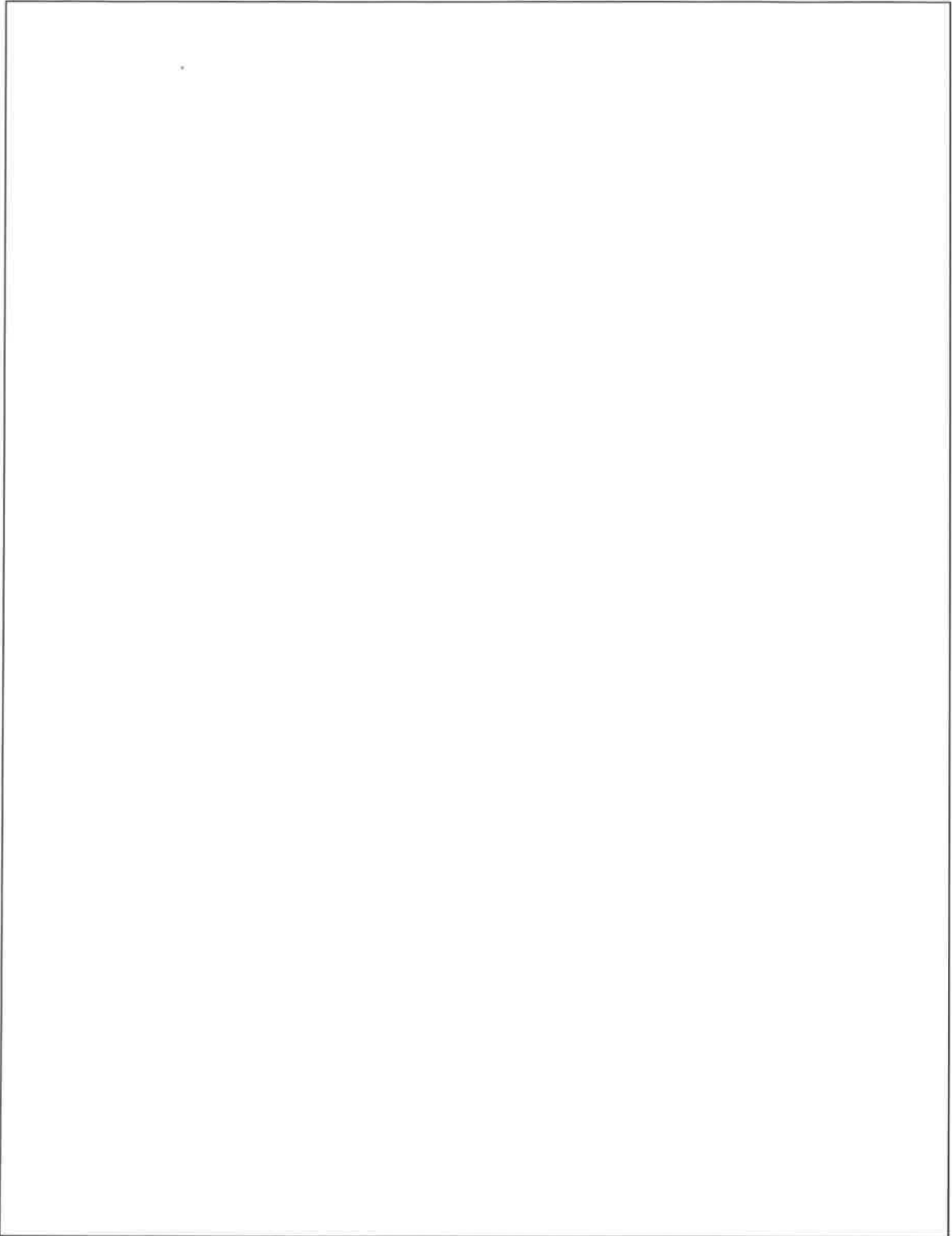
Velocity is maximum (velocity = amplitude × angular frequency) when the oscillator is at the equilibrium position.

Period of spring oscillator $T = 2\pi\sqrt{\frac{M}{k}}$.

Energy of vibration is proportional to the square of the amplitude.]



補充頁 1



補充頁 2

