

中央警察大學 114 學年度碩士班入學考試試題

所 別：鑑識科學研究所

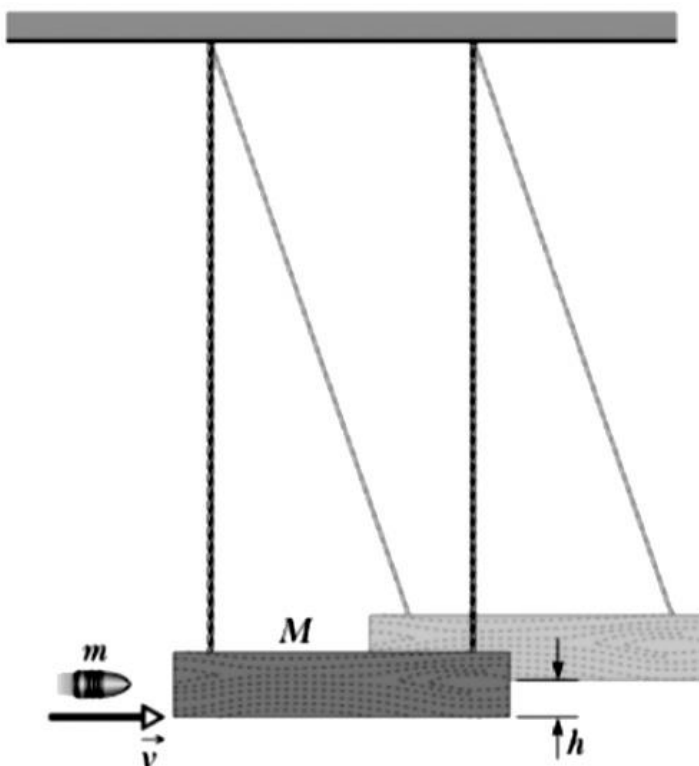
科 目：自然科學

作答注意事項：

1. 本試題共 10 題，每題各占 10 分；共 5 頁。
2. 不用抄題，可不按題目次序作答，但應書寫題號。
3. 禁用鉛筆作答，違者不予計分。

一、The ballistic pendulum was used to measure the speeds of bullets before electronic timing devices were developed. The figure below shows a large block of wood of mass $M = 6.4$ kg, hanging from two long cords. A bullet of mass $m = 9.6$ g is fired into the block, coming quickly to rest. The “block+bullet” then swing upward, their center of mass rising a vertical distance $h = 6.3$ cm before the pendulum comes momentarily to rest at the end of its arc. What is the speed v of the bullet just prior to the collision?

【Hint】：the magnitude of the free-fall acceleration $g = 9.8$ m/s².



二、The figure below shows the essentials of a mass spectrometer, which can be used to measure the mass of an ion; an ion of mass m (to be measured) and charge q is produced in source S . The initially stationary ion is accelerated by the electric field due to a potential difference V . The ion leaves S and enters a separator chamber in which a uniform magnetic field \vec{B} is perpendicular to the path of the ion. A wide detector lines the bottom wall of the chamber, and the \vec{B} causes the ion to move in a semicircle and thus strike the detector. Suppose that $B=80.000 \text{ mT}$, $V=1000.0 \text{ V}$, and ions of charge $q=+1.6022 \times 10^{-19} \text{ C}$ strike the detector at a point that lies at $x=1.6254 \text{ m}$. What is the mass m of the individual ions, in atomic mass units?

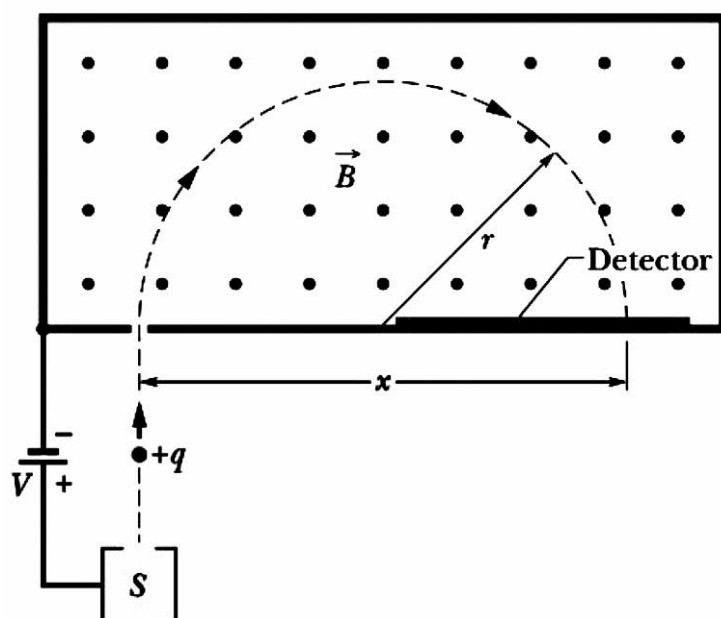
【Hint】：

1. atomic mass units: $1\text{u}=1.6605 \times 10^{-27} \text{ kg}$.

2. The SI unit for \vec{B} : $1 \text{ T} = 1 \frac{\text{newton}}{(\text{coulomb/second})(\text{meter})} = 1 \frac{\text{N}}{\text{A} \cdot \text{m}}$.

3. $F_B = |q|vB \sin \varphi$.

4. $F = m \frac{v^2}{r}$.

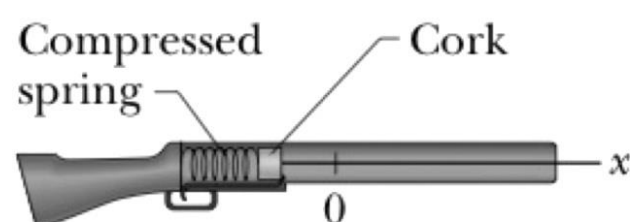
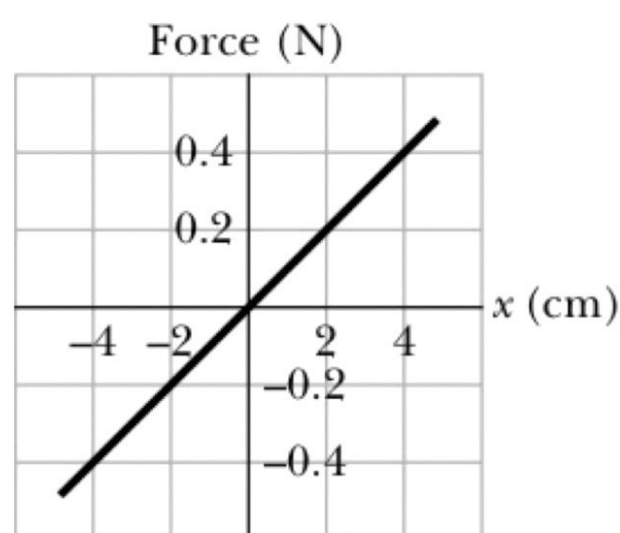


三、The figure below shows the spring force as a function of the stretch or compression of the spring. The spring is compressed by 5.5 cm and used to propel a 3.8 g cork from the gun. (A) What is the speed of the cork if it is released as the spring passes through its relaxed position? (B) Suppose, instead, that the cork sticks to the spring and stretches it 1.5 cm before separation occurs. What now is the speed of the cork at the time of release?

【Hint】：

1.Hooke's law: $F_x = -kx$.

2.Work by a spring force: $W_s = \frac{1}{2} kx_i^2 - \frac{1}{2} kx_f^2$.



四、請回答下列問題：

(A) How much heat is needed to warm 250 g of water from 20°C to 96°C?

(B) What is the molar heat capacity of water?

【Hint】：

1.The SI unit of the molar heat capacity is joule per kelvin per mole, $\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$.

2.The Specific Heat for $\text{H}_2\text{O} (l)$ is $4.18 (\text{J}\cdot\text{g}^{-1}\cdot\text{K}^{-1})$.

五、Please explain what is the PCR(Polymerase Chain Reaction)? And explain the testing procedures of PCR.

六、請簡述傅立葉轉換紅外光譜儀（FTIR）的基本工作原理，並說明邁克生干涉儀（Michelson interferometer）中移動鏡子的移動距離與紅外光波長之間的關係。

七、發生地震時，同時會產生 P 波與 S 波，P 波是縱波，其速度約 10000 m/s；S 波是橫波，其波速為 6000 m/s。A 觀測站在某次大地震中測得 P 波抵達後的 12 秒，S 波也抵達，若這兩種波沿著同一路徑傳到觀測站，則震源與觀測站的距離約為多少公里？

八、在有硫酸的條件之下，甲苯與硝酸反應會生成哪一個主要產物？請寫出完整的化學反應機構。

九、在進行實驗射擊時，如果槍托沒有與實驗者的肩膀緊密接觸，則會導致瞬間衝擊。假設某次射擊實驗中，實驗者手中的槍與肩膀之間存在間隙。若槍的質量為 4.5 公斤，子彈質量為 12 公克，發射後子彈的速度為 250 m/s。槍在接觸實驗者肩膀後，經過 0.015 秒才完全停止，則此期間肩膀所受到的平均力最大約為多少牛頓（N）？

十、請繪出下列和 DNA 與 RNA 相關的化學結構：

(一) Adenine

(二) Guanine

(三) Cytosine

(四) Thymine

(五) Uracil