澳門大學
UNIVERSIDADE DE MACAU
UNIVERSITY OF MACAU

2018/2019 學年澳門大學入學考試
2018/2019 University of Macau Admission Examination

試題及參考答案 Examination Paper and Suggested Answers

物理 Physics

注意事項：

Instructions:

1. 此考卷分三部份；總分數為 100 分。全部答案必須在本考卷內作答。不按要求作答或把答案寫在草稿紙上不獲評分。
   There are three parts in this examination and total mark is 100. All answers must be put in this examination paper. No marks will be given to answers made on draft paper or not as instructed.

2. 第一部份為選擇題，分數為 18 分。此部份有 6 題，每題 3 分。每題只有一個正確答案。
   Part 1 is Multiple Choice for 18 marks. There are 6 questions in this part and 3 marks for each. Only one answer is correct for each question.

3. 第二部份為概念題，分數為 22 分。此部份有 4 題，分數在每題中顯示。
   Part 2 is Question – Concept for 22 marks. There are 4 questions and mark allocation is shown with each question.

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   You may use an electronic calculator, including a programmable one, provided that the calculator is silent in operation. You are strictly prohibited from using a calculator with print-out, graphic/word-display functions or dot-matrix technology in the main display.

6. 全卷請用藍色或黑色原子筆作答。可使用塗改液。
   Please write the answers with a blue or black ball-point pen. Correction fluid can be used.

7. 每人只限發一張草稿紙。
   Only one piece of draft paper is given to each candidate.

第一部份 Part 1　　選擇題 Multiple Choice

請用藍色或黑色原子筆把正確答案（A，B，C，D 或 E）寫在每題提供之方格內。
Write your answers (A, B, C, D or E) in the corresponding box provided with a blue or black ball-point pen.

1. 伽馬射綫的頻率是_____可見光的頻率。
The frequency of gamma rays is _____ the frequency of visible light.

(A) 低於
lower than
(B) 高於
higher than
(C) 等於
equal to
(D) 近似相等於
approximately the same as
(E) 不可比較於
not comparable to

2. 一圓柱形導體的電阻為 R。若導體的長度被拉伸為原來的兩倍，則它的電阻變爲
A cylindrical conductor has resistance R. What would be its resistance if it is stretched to twice of its original length?

(A) 2R

(B) R/2

(C) 4R

(D) R/4

(E) 以上皆非。
None of the above.

3. 一物體從靜止自由落體下降的過程是一個_____的能量轉換過程。
The process that an object undergoes a free fall from rest is a process of energy transformation _____.

(A) 從勢能到動能
from potential energy to kinetic energy
(B) 從動能到勢能
from kinetic energy to potential energy
(C) 從勢能到熱能
from potential energy to heat
(D) 從熱能到勢能
from heat to potential energy
(E) 以上皆非。
None of the above.

4. 甚麼是光發生全反射的條件？
What is the condition for total internal reflection of light?

(A) 入射光經過的介質的折射率比折射光經過的介質的折射率高。
The refractive index of medium through incident light passes is higher than that through refracted light.
(B) 入射光經過的介質的折射率比折射光經過的介質的折射率低。
The refractive index of medium through incident light passes is lower than that through refracted light.
(C) 入射光經過的介質的折射率相等於折射光經過的介質的折射率。
The refractive index of medium through incident light passes is equal to that through refracted light.
(D) 光的波長一定為 500 nm。
The wavelength of light must be 500 nm.
(E) 以上皆非。
None of the above.

5. 下列哪一為對理想氣體的正確陳述？
Which one of the following statements is true about ideal gas?

(A) 當密度足夠低，氣體遵守理想氣體定律。
When density is low enough, gases tend to obey ideal gas law.
(B) 當壓力足夠高，氣體遵守理想氣體定律。
When pressure is high enough, gases tend to obey ideal gas law.
(C) 當溫度足夠低，氣體遵守理想氣體定律。
When temperature is low enough, gases tend to obey ideal gas law.
(D) 當體積足夠小，氣體遵守理想氣體定律。
When volume is small enough, gases tend to obey ideal gas law.
(E) 以上皆非。
None of the above.

6. 以下列哪因素可判斷波為縱波或橫波？
To identify a wave to be transverse or longitudinal, which one of the following factors is true?

(A) 波長。
Wavelength.
(B) 頻率。
Frequency.
(C) 速度。
Speed.
(D) 介質折射率。
Refractive index of medium.
(E) 以上皆非。
None of the above.

第二部份 Part 2　　概念題 Question – Concept

將答案寫在每題所提供的橫線上，寫在該處以外的答案不會被評分。
Write your answers on the lines provided for each question. Answers written elsewhere will not be marked.

1. 描述跳傘運動員在下降過程中其垂直速度的變化。
   Describe the variation of the vertical velocity of a skydiver during his descent.

(5 分/ marks)

2. 簡單地描述法拉第定律的意義。
   Describe Faraday's law in brief terms.

(5 分/ marks)

3. 在相同溫度下，感覺一塊金屬比一木塊冷。為甚麼？

A piece of metal feels colder than a piece of wood at the same temperature. Please explain?

(6 分/ marks)

4. 行進波與駐波有甚麼分別？

What is the difference between traveling wave and standing wave?

(6 分/ marks)

第三部份 Part 3　　計算題 Question – Calculation

將答案（包括有需要的解釋、公式、計算過程及最後答案）寫在每題所提供的空白位置內，寫在其他地方的答案不會被評分。

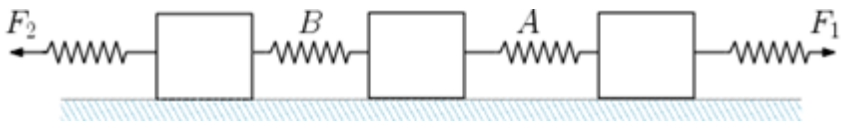
Write your answers (include necessary explanation, formula, calculation and final result) in the space provided for each question. Answers written elsewhere will not be marked.

1. 有 2 公斤、4 公斤和 6 公斤的三個物體按順序沿一直線排列。其中，2 公斤和 6 公斤的兩個物體間的距離為 1 米。那麼 4 公斤的物體應放於何處可使它與其餘兩物體間的萬有引力為零？

   Three mass bodies of 2 kg, 4 kg, and 6 kg are placed along a line in order. The distance between the 2 kg body and the 6 kg body is 1 m. Where should the 4 kg body be placed such that its gravitational force to the other two bodies becomes zero?　　(15 分/ marks)

2. 如圖所示，右端的彈簧受力 F_1 牽引，被拉長 5 cm，而左端的彈簧受力 F_2 牽引，被拉長 1 cm。假設各彈簧的彈簧係數及各箱的質量相等，並可忽略摩擦力，求 *A*、*B* 兩彈簧伸長量之比。（提示：考慮外部淨力對整個系統產生的運動。）

   As shown in the figure, the spring at the right end under force F_1 is stretched by 5 cm and the spring at the left end under force F_2 is stretched by 1 cm. Assuming all springs have the same spring constants, all boxes have the same mass and friction is negligible, what is the ratio of the stretched length at spring *A* to the stretch length at spring *B*? (Hints: Consider how the net force would contribute to the motion of the entire system.)(15 分 / marks)



3. 一激光在未知物質中行進。在遇到空氣邊界時，反射角和折射角分別為25°及37°，(a) 未知物質的折射率是多少？(b)光在此未知物質的速度是多少？(c)發生全反射的最小入射角是多少？

A laser beam is traveling through an unknown substance. When it encounters a boundary with air, the angle of reflection is 25°and the angle of refraction is 37°, (a) what is the index of refraction of the substance? (b) what is the speed of light in substance? (c) at what minimum angle of incidence would the light be totally internally reflected?

(15 分/ marks)

4. P 點及 S 點的電位分別為500.0 kV及200.0 kV。當一 $+2e$的電荷 (質量為3.35×10^{-27} kg) 由 P 點移到 S 點，(a) 動能改變了多少？(b) 若此電荷在 P 點時為靜止，在 S 點的速率為何？

Point P is at potential of 500.0 kV and point S is at potential of 200.0 kV. When a charge of $+2e$ (mass of 3.35×10^{-27} kg) moves from P to S, (a) by how much does its kinetic energy change? (b) what is the speed at point S if the charge is stationary at point P?

(15 分/ marks)

參考答案 Suggested Answers

第一部分 Part 1　　選擇題 Multiple Choice

1. (B)
2. (C)
3. (A)
4. (A)
5. (A)
6. (E)

第二部分 Part 2　　概念題 Question – Concept

1. 速度由零開始加速，當重力與空氣阻力平衡時，物體會達到一終端速度。
   The velocity accelerates from zero until it reaches a constant terminal velocity when the gravity force strikes a balance with the air friction.

2. 一金屬線圈中的磁通量改變時，會產生感應電動勢。
   The change of magnetic flux inside a metal loop would generate an electric potential called electromotive force across the loop.

3. 當金屬和木塊均為室溫時，皮膚較為溫暖，熱能由皮膚傳到金屬和木塊，由於金屬有較高的導熱係數，較多的熱能會由皮膚傳到金屬，而令手的感覺較冷。
   Since the metal or wood is at room temperature and your skin is warmer, heat is conducted away from your hand into the wood or metal. Because the metal has a much higher thermal conductivity, it drains heat fast out of your hand, and thus feels cooler.

4. 駐波中有節點及波腹，而行進波沒有。
   The nodes and antinodes in a standing wave remain in position; traveling waves do not have nodes and antinodes.

第三部分 **Part 3** 計算題 **Question – Calculation**

1.

$$F_{24} = F_{64}$$
$$\frac{Gm_2m_4}{r_{24}^2} = \frac{Gm_6m_4}{r_{64}^2}$$
$$\frac{m_2}{x^2} = \frac{m_6}{(1-x)^2}$$
$$2x^2 + 2x - 1 = 0$$
$$x = \frac{-1+\sqrt{3}}{2} \approx 0.366\ (m)$$

2.

$$F_1 - F_2 = 3ma$$
$$5k - k = 3ma$$
$$a = \frac{4k}{3m}$$
$$F_1 - F_A = ma$$
$$5k - kx = m\left(\frac{4k}{3m}\right)$$
$$x = \frac{11}{3}(cm)$$

$$F_B - F_2 = ma$$
$$ky - k = m\left(\frac{4k}{3m}\right)$$
$$y = \frac{7}{3}(cm)$$

$$\frac{x}{y} = \frac{11}{7}$$

3.

(a)

$$n_1 sin\theta_1 = n_2 sin\theta_2$$

$$n_1 = \frac{n_2 sin\theta_2}{sin\theta_1} = \frac{(1)sin37°}{sin25°} \approx 1.42$$

(b)

$$v = \frac{c}{n} = \frac{3 \times 10^8}{1.42} \approx 2.1 \times 10^8 (m/s)$$

(c)

$$\theta_c = sin^{-1}\frac{n_2}{n_1} = sin^{-1}\frac{1}{1.42} \approx 44.8°$$

4.

(a)

$$\Delta K + \Delta U = 0$$

$$\Delta K = -\Delta U = -q\Delta V$$

$$= -2(1.6 \times 10^{-19})(200 \times 10^3 - 500 \times 10^3)$$

$$\approx 9.6 \times 10^{-14} (J)$$

(b)

$$\Delta K = \frac{1}{2} m v_s^2$$

$$v_s = \sqrt{\frac{2\Delta K}{m}} = \sqrt{\frac{2 \times 9.6 \times 10^{-14}}{3.35 \times 10^{-27}}} \approx 7.6 \times 10^6 (m/s)$$

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第一部分 **Part 1** 選擇題 **Multiple Choice**

1. 兩物體進行彈性碰撞，以下哪一為正確陳述？
   A collision between two objects is elastic. Which one of the following statements concerning this situation is true?

(A) 兩物體的總動能在碰撞前、後保持不變。
The total kinetic energy of the objects is the same before and after the collision.
(B) 碰撞後兩物體的總動量為零。
The total momentum of the objects is zero after the collision.
(C) 碰撞後兩物體合二為一運動。
The objects stick together and move as one object after the collision.
(D) 碰撞後兩物體的總動能為零。
The kinetic energy of the objects is zero after the collision.
(E) 碰撞後兩物體速度的向量和為零。
The vector sum of the velocities of the two objects is equal to zero after the collision.

2. 駐波是怎樣疊加而成？
   How to produce standing wave by superposition?

(A) 兩相同振幅、相同頻率、相同傳播方向的波。
Two waves with the same amplitude, frequency, and direction of propagation.
(B) 兩相同振幅、相同頻率、相反傳播方向的波。
Two waves with the same amplitude, frequency, and opposite propagation directions.
(C) 兩相同振幅、相同傳播方向、不同頻率的波。
Two waves with the same amplitude and direction of propagation, but different frequencies.
(D) 兩相同振幅、不同頻率、相反傳播方向的波。
Two waves with the same amplitude, different frequencies, and opposite directions of propagation.
(E) 以上皆非。
None of the above.

3. 複合顯微鏡是由兩透鏡組成。以下哪一為複合顯微鏡操作的正確陳述？
The compound microscope is made up of two lenses. Which statement is true concerning the operation of the compound microscope?

(A) 兩透鏡均形成實像。
Both lenses form real images.
(B) 兩透鏡均形成虛像。
Both lenses form virtual images.
(C) 接近物件的透鏡形成虛像；另一透鏡形成實像。
The lens closest to the object forms a virtual image; the other lens forms a real image.
(D) 接近物件的透鏡形成實像；另一透鏡形成虛像。
The lens closest to the object forms a real image; the other lens forms a virtual image.
(E) 以上皆非。
None of the above.

4. 下列哪一關於水和金屬的熱力學性質是正確的？
Which one of the following statements about the thermal properties of water and metal is correct?

(A) 金屬的比熱比較大。
The specific heat of metal is higher.
(B) 水的比熱比較大。
The specific heat of water is higher.
(C) 水和金屬的比熱相同。
Water and metal have the same specific heat.
(D) 水和金屬的比熱由環境溫度所決定。
Their specific heats depend on the environmental temperature.
(E) 以上皆非。
None of the above.

5. 下列哪一為對庫侖力的正確陳述？
Which one of the following statements about Coulomb force is correct?

(A) 隨距離的平方成反比。
Inversely proportional to distance squared.
(B) 隨距離成反比。
Inversely proportional to distance.
(C) 隨距離的平方成正比。
Proportional to distance squared.
(D) 隨距離成正比。
Proportional to distance.
(E) 以上皆非。
None of the above.

6. 原子的原子數是以下列哪數目來排序？
Atomic number of atom is sequenced according to which one of the following numbers?

(A) 電子數目。
The number of electrons.
(B) 中子數目。
The number of neutrons.
(C) 質子數目。
The number of protons.
(D) 微中子數目。
The number of neutrinos.
(E) 以上皆非。
None of the above.

第二部分 Part 2　　概念題 Question – Concept

1. 變壓器的運作是基於甚麼定律？
   What is the operation of transformer based on?

   (5 分/ marks)

2. 為甚麼湖水是由湖面開始結冰？
   Why does the water freezing start from surface of lake?

   (6 分/ marks)

3. 縱波與橫波的區別是什麼？
   What is the difference between longitudinal wave and transverse wave?

   (5 分/ marks)

4. 假設有一個一端封閉、一端活動的針筒。其中氣體與大氣平衡。然後，氣體被壓縮至原體積的一半，它的壓力是多少帕斯卡？
   Suppose a syringe is sealed at one end and has a piston at the other. The gas it contains is originally balanced with the atmospheric pressure. Then, it is compressed to half of its original volume, what is the pressure of the gas in Pascal?

   (6 分/ marks)

第三部分 **Part 3** 計算題 **Question – Calculation**

1. (a) 一漂浮物體有 80%的體積淹沒在水 (密度為 1000 kg/m^3) 中，求此物體的密度。(b) 若此物體放在甘油 (密度為 1260 kg/m^3) 中，淹沒的體積比率是多少？(c) 此物體在不同流體中漂浮時，浮力有否改變？

   (a) What is the density of an object that is 80% submerged when floating in water (density of 1000 kg/m^3)? (b) If it is placed in glycerin (density of 1260 kg/m^3), what percentage of the object will be submerged? (c) Will the buoyant force on this object be changed when it is floating in different fluids?

   (15 分/ marks)

2. 白光燈照射在閘板中兩狹縫上，在距離 3.4 m 的屏幕上可看到第一階色譜。其中紅光 (波長為 700 nm) 與紫光 (波長為 400 nm) 在屏幕上相距 7.00 mm。兩狹縫的距離是多少？(提示：當角度小時，$\theta \approx sin\theta \approx tan\theta$)

   White light is shined on two slits of a slide and first-order color spectrum is created on a screen 3.40 m away. On the screen, the red light with a wavelength of 700 nm is separated from the violet light with a wavelength of 400 nm by 7.00 mm. What is the separation of the two slits? (Hint: when angle is small, $\theta \approx sin\theta \approx tan\theta$)

   (15 分/ marks)

3. 一質量為 m_1 的物體以速度 v_1 滑行在無摩擦的平面上，並與另一質量為 m_2 的靜止物體作彈性碰撞。 碰撞後，在什麼條件下，物體 m_1 會向相反方向運動？答案必須由公式推導出。

   A mass m_1 is sliding on a frictionless surface at velocity v_1 and collides with another mass m_2 at rest elastically. What is the condition for m_1 to reverse its direction after collision？ Answer must be obtained from derivation of formula.

   (15 分/ marks)

4. 一 2 nA 電流均勻地為一平行板電容充電。平行板的面積為 0.2 cm^2，間距為0.5 mm。要令電容板間的電場達到 2 kV/m，需多少時間？($\epsilon_0 = 8.85 \times 10^{-12}\ \mathrm{C^2/N \cdot m^2}$)

   A parallel-plate capacitor of area 0.2 cm^2 and separation of 0.5 mm is being charged constantly by a current of 2 nA. How long would the electric field between the capacitor plates be 2 kV/m? ($\epsilon_0 = 8.85 \times 10^{-12}\ \mathrm{C^2/N \cdot m^2}$)

   (15 分/ marks)

參考答案 Suggested Answers

第一部分 Part 1　　選擇題 Multiple Choice

1. (A)
2. (B)
3. (D)
4. (B)
5. (A)
6. (C)

第二部分 Part 2　　概念題 Question – Concept

1. 變壓器的運作是基於法拉第定律。
   The operation of transformer is based on Faraday law.

2. 當外界温度降低時，湖水也會降温，但是 4°C 的水因為密度最大，會沉到水底，而冰的密度比水小很多，浮在上面。所以結冰總是從湖面開始。
   Water temperature in lake will drop as temperature of environment decreases. Density of water with temperature of 4°C is the largest and sink to bottom of lake. Density of ice is smaller than water of 4°C and it floats on the top. Therefore, the freezing of water in a lake is from surface.

3. 縱波的介質振動方向與波的行進方向平衡；橫波的介質振動方向與波的行進方向垂直。
   The direction of medium oscillation is parallel to the propagation direction for longitudinal wave, while transverse wave has direction of medium oscillation perpendicular to the propagation direction.

4. 約 202 kPa，為大氣壓力的兩倍。
   It is about 202 kPa, twice of atmospheric pressure.

第三部分 **Part 3** 計算題 **Question – Calculation**

1.

(a)

$$F_g = F_b$$

$$\rho V g = \rho_w V' g$$

$$\rho = \frac{V'}{V}\rho_w = (0.8)(1000) = 800(kg/m^3)$$

(b)

$$F_g = F_b$$

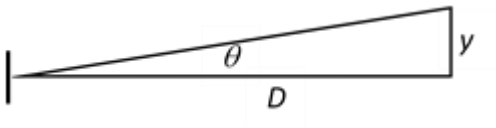
$$\rho V g = \rho_{Gly} V' g$$

$$\frac{V'}{V} = \frac{\rho}{\rho_{Gly}} = \frac{800}{1260} = 0.63 = 63\%$$

(c) 一漂浮物體在不同流體中的浮力是不變的。

The buoyant force of a floating object in different fluids will not be changed.

2.



$$y_{Red} = D\ tan\,\theta_{Red} \approx D\theta_{Red}$$
$$y_{Violet} = D\ tan\,\theta_{Violet} \approx D\theta_{Violet}$$

$$\lambda_{Red} = d\ sin\,\theta_{Red} \approx d\theta_{Red}$$
$$\lambda_{Violet} = d\ sin\,\theta_{Violet} \approx d\theta_{Violet}$$

$$y_{Red} - y_{Violet} = D(\theta_{Red} - \theta_{Violet}) = \frac{D}{d}(\lambda_{Red} - \lambda_{Violet})$$

$$d = \frac{D(\lambda_{Red} - \lambda_{Violet})}{(y_{Red} - y_{Violet})} = \frac{3.4(700 \times 10^{-9} - 400 \times 10^{-9})}{0.007} = 146 \times 10^{-6}(m)$$

3.

在彈性碰撞中，動能及動量均守恆，

For elastic collision, both momentum and energy are conserved.

$$m_1u_1 = m_1v_1 + m_2v_2 \quad (1)$$

$$\frac{1}{2}m_1u_1^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 \quad (2)$$

由(1)，$v_2 = \frac{m_1}{m_2}(u_1 - v_1)$代入(2)

From (1), $v_2 = \frac{m_1}{m_2}(u_1 - v_1)$ and substitutes into (2),

$$u_1^2 = v_1^2 + \frac{m_2}{m_1}\left[\frac{m_1}{m_2}(u_1 - v_1)\right]^2$$

其合理答案為

whose only reasonable solution is

$$v_1 = \frac{m_1 - m_2}{m_1 + m_2}u_1$$

因m_1及m_2均大於零，若$m_1 < m_2$，m_1在碰撞後會往相反方向運動。

Since m_1 and m_2 are all greater than zero, m_1 moves to opposite direction after collision when $m_1 < m_2$.

4.

電場要達到 2 kV/m，所需電荷為

The required charge to achieve electric field of 2 kV/m is

$$\begin{aligned} q = CV &= \epsilon_0\frac{A}{d}(Ed) = \epsilon_0 AE \\ &= (8.85 \times 10^{-12})(0.2 \times 10^{-4})(2 \times 10^3) \\ &= 3.54 \times 10^{-13}\ (C) \end{aligned}$$

累積電荷所需的時間為

The time required to reach this amount of charge is

$$t = \frac{q}{i} = \frac{3.54 \times 10^{-13}}{2 \times 10^{-9}} = 1.77 \times 10^{-4}(s)$$