



澳門大學  
UNIVERSIDADE DE MACAU  
UNIVERSITY OF MACAU

**2022/2023 學年澳門大學入學考試**  
**2022/2023 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。  
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2. 第一部份為選擇題。此部份有 6 題，每題 3 分，合 18 分。每題只有一個正確答案。  
Part 1 contains Multiple Choice questions. There are 6 questions, each worth 3 points for a total of 18 points. Only one answer is correct for each question.
3. 第二部份為概念題。此部份有 4 題，分數在每題中顯示，合 22 分。  
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第一部分 Part 1 選擇題 Multiple Choice

請把答案 (A, B, C 或 D) 寫在每題提供之方格內。

Write your answers (A, B, C, or D) in the corresponding box provided.

1. 一束單色光由空氣進入水中，則該光線在空氣和水中傳播時：  
A beam of monochromatic light transmits from air to the water. When the light was transmitting in the air and water, which statement below is correct?

- (A) 速度相同，波長相同  
Both the speed and wavelength are the same
- (B) 速度不同，波長相同  
The wavelength is the same, while the speed is different
- (C) 相等於速度相同，頻率相同  
Both the speed and frequency are the same
- (D) 速度不同，頻率相同  
The frequency is the same, while the speed is different

2. 如圖，考慮一直流電流在線圈中以逆時針方向流動。其所產生的磁場的方向為何？  
As illustrated, consider a DC current flowing along the counter-clockwise direction of a wire loop. What is the direction of the generated magnetic field?

- (A) 垂直出於紙平面  
Perpendicularly out of the plane of the paper
- (B) 垂直入向紙平面  
Perpendicularly into the plane of the paper
- (C) 以 45 度角出於紙平面  
At 45-degree angle out of the plane of the paper
- (D) 依賴於電流的強度  
It depends on the magnitude of the current



3. 氣體分子熱運動的平均動能主要取決於氣體的\_\_\_\_\_。  
The average kinetic energy of the thermal dynamic motion of gas molecules are mainly determined by the \_\_\_\_\_ of the gas.

(A) 溫度  
Temperature

(B) 體積  
Volume

(C) 壓強  
Pressure

(D) 以上皆非  
None of the above

4. 下述哪項關於黑體輻射的描述為正確？  
Which of the following descriptions regarding black-body radiation is correct?

(A) 它描述了輻射是怎麼依賴物體的溫度分佈的

It describes how radiation is distributed according to the temperature of an object

(B) 它的分佈取決於震盪的頻率

Its distribution depends on frequency of vibrations

(C) 它的發現與量子力學的建立有關

Its discovery is related to the establishment of quantum mechanics

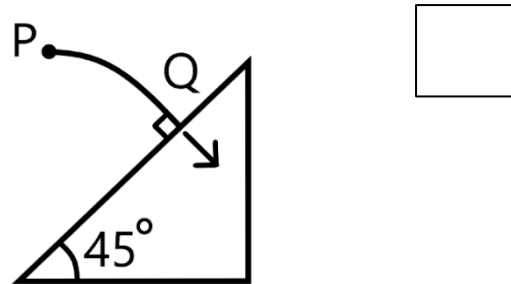
(D) 上述三敘述皆正確

All of the three statements are correct

5. 如圖所示，一物體從 P 點開始，以初速度 10 m/s 做平拋運動，恰好垂直打到傾斜角為 45 度的斜面上的 Q 點 ( $g=10 \text{ m/s}^2$ )。則 P 與 Q 兩點之間的距離為 \_\_\_\_\_。

The figure shows a particle is moving with a horizontal velocity of 10 m/s from point P. The particle hits the inclined surface perpendicularly at the point Q. Take  $g$  as  $10 \text{ m/s}^2$ . What is the distance between points P and Q?

- (A) 5 m  
 (B) 10 m  
 (C)  $5\sqrt{5}$  m  
 (D)  $10\sqrt{5}$  m



6. 水與空氣擁有不同密度。聲波在水中傳播的速度\_\_\_\_\_在空氣中的速度。  
 Water and air have different densities. Sound wave travels \_\_\_\_\_ in water \_\_\_\_\_ in air.

- (A) 慢於  
 Slower ... than  
 (B) 快於  
 Faster ... than  
 (C) 等於  
 At the same speed ... as  
 (D) 以上皆不正確  
 None of the above is correct



## 第二部分 Part 2      概念題 Concept Questions

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 graded.

1. 為何我們要在雪上撒鹽來融化雪？這個現象根據何種熱力學定律產生？試簡單解釋。

Why do we scatter salt on snow to melt it? What thermodynamic law does this phenomenon follow? Briefly explain.

(6 分/ marks)

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2. 考慮一光線從玻璃射入空氣時發生了全反射。玻璃的折射率會怎樣影響臨界角？試簡單解釋。

Consider a light ray traveling from glass into air where full reflection occurs. How will the refractive index of the glass affect the critical angle? Briefly explain.

(5 分/ marks)

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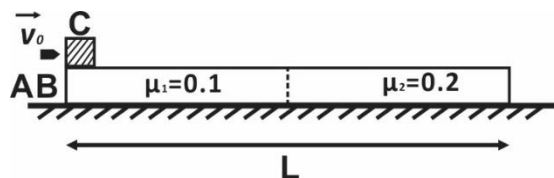
### 第三部分 Part 3 計算題 Calculation Questions

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Write your answers (include necessary explanations, formulae, calculations and final results) in the space provided. Answers written elsewhere will not be graded.

1. 如圖所示，長為  $L$  的木板  $AB$  靜止、固定放置在水平面上，在  $AB$  的左端表面有一質量為  $M=0.48\text{ kg}$  的小木塊  $C$ （可視為質點）。現有一質量為  $m=20\text{ g}$  的子彈以  $v_0=75\text{ m/s}$  的速度射向小木塊  $C$  並留在小木塊中，假設該動態過程極短。已知小木塊  $C$  與木板  $AB$  的左半側之間的動摩擦因數為  $\mu_1=0.1$ ，與右半側的動摩擦因素為  $\mu_2=0.2$ 。請問， $AB$  的長度  $L$  至少應為多少，才能保證小木塊  $C$  不會從木板上掉落。（重力加速度  $g=10\text{ m/s}^2$ ）

As shown in the figure, a board  $AB$  with length of  $L$  is placed statically and fixed on a horizontal surface. On the left end of  $AB$ , a small block  $C$  with a mass of  $M=0.48\text{ kg}$  was placed on top. The block can be considered as a particle. A bullet with a mass of  $m=20\text{ g}$  shoots towards the block  $C$  with speed of  $v_0=75\text{ m/s}$  and finally stays in the block. Assume that the dynamic collision process is very short. The frictional factor between the block  $C$  and the left half of the board  $AB$  is  $\mu_1=0.1$ , and the frictional factor between the block  $C$  and the right half of the board  $AB$  is  $\mu_2=0.2$ . What is the minimum length  $L$  of  $AB$  so that the block  $C$  can stay on the board without falling out from the board. (The gravitational acceleration is  $g=10\text{ m/s}^2$ .)

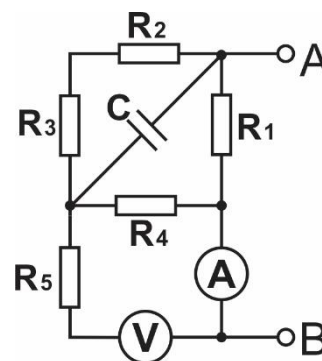


2. 圖中所示電路中，電阻值  $R_1=5\ \Omega$ ， $R_2=7\ \Omega$ ， $R_3=8\ \Omega$ ， $R_4=10\ \Omega$ ， $R_5=10\ \Omega$ ，電容值  $C=20\ \mu\text{F}$ 。 $AB$  兩端的電壓為  $U=15\text{ V}$ 。電壓表與電流表均為理想電表。求電路穩定後：

- (1) 電流表、電壓表的示數；
- (2) 單個電容器極板上所帶的電荷量。

The figure shows a circuit, where the resistances  $R_1$  is  $5\ \Omega$ ,  $R_2$  is  $7\ \Omega$ ,  $R_3$  is  $8\ \Omega$ ,  $R_4$  is  $10\ \Omega$ ,  $R_5$  is  $10\ \Omega$ , and the capacitance  $C$  is  $20\ \mu\text{F}$ . The voltage between nodes  $A$  and  $B$  is  $15\text{ V}$ . The voltmeter and ammeter are ideal meters. After the stabilization of the circuit, please figure out:

- (1) The values of the voltmeter and the ammeter;
- (2) The charge on each plate of the capacitor.



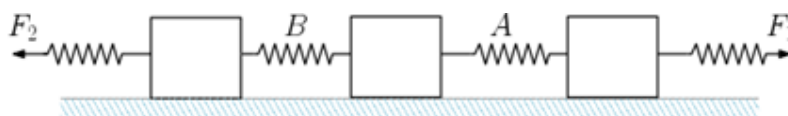


3. 一開口風琴管的基音頻率為 250Hz，另有一閉口風琴管的第一泛音與開管的第一泛音頻率相同，求開管長對閉管長的比值。

An open-end organ tube has a fundamental pitch of frequency 250Hz. Another closed-end organ tube has its first harmonic be equal to the first harmonic of the open-end tube. Find the ratio of open-end to closed-end tube lengths.

4. 如圖所示，右端的彈簧受力 $F_1$ 牽引，被拉長 8 cm，而左端的彈簧受力 $F_2$ 牽引，被拉長 3 cm。假設各彈簧的彈簧係數及各箱的質量相等，並可忽略摩擦力和彈簧質量，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 8 cm and the spring at the left end under force  $F_2$  is stretched by 3 cm. Assume that all springs have the same spring constants, all boxes have the same mass, and friction and spring mass are negligible. What is the ratio of the stretched length of spring A to the stretch length of spring B? (Hints: Consider how the net force would contribute to the motion of the entire system.)



## 參考答案 Suggested Answers

### 第一部分 Part 1 選擇題 Multiple Choice

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

### 第二部分 Part 2 概念題 Concept Questions

1. 根據熱力學第二定律，一物理系統的熵趨向於隨時間增加 ( $\Delta S > 0$ )。當鹽遇雪時，較低熵值的鹽晶體和冰晶體溶解化合成液態的鹽水溶液，來取得熵增。在零度以下時，雪不會自己溶解，因為這個過程中熵增不足以抵消焓值的變化 ( $T\Delta S < \Delta H$ )；但當鹽溶解時，熵增足夠 ( $T\Delta S > \Delta H$ )。

According to the second law of thermodynamics, the entropy of a physical system tends to increase ( $\Delta S > 0$ ) along with time. When salt meets snow, the crystalline salt and ice having lower entropy dissolves into saline solution to gain higher entropy. When sub-zero temperature, snow does not melt on its own because during this process the entropy gain is not enough to offset the enthalpy change ( $T\Delta S < \Delta H$ ); but when salt dissolves with water, it is enough ( $T\Delta S > \Delta H$ ).

2. 根據斯涅爾定律，臨界角  $\theta_c$  滿足公式  $\sin \theta_c = n_a/n_g$ ，其中  $n_a$  是空氣的折射率、 $n_g$  是玻璃的折射率。若  $n_a$  保持不變， $n_g$  的增加會使臨界角變小。

According to Snell's law, the critical angle  $\theta_c$  obeys the formula  $\sin \theta_c = n_a/n_g$  where  $n_a$  is the index for air and  $n_g$  that for glass. With  $n_a$  keeping constant, the increase of  $n_g$  will decrease the critical angle.

3. 物塊-彈簧組成的系統，其運動週期主要由物塊的質量以及彈簧的彈性係數共同決定。

The period is mainly determined by the spring constant of the spring and the mass of the block.

4. 軌道量子化：電子繞核運動的軌道是不連續的。  
能量量子化：原子只能處於一系列不連續的能量狀態中。

Quantization of the orbit: The orbit trajectory of electrons surrounding the nucleus is discrete.

Quantization of energy: The atom can only have energy status which is discrete.

### 第三部分 Part 3 計算題 Calculation Questions

1. 由於子彈射入木塊 C 的時間極短，根據動量守恆，最終子彈與木塊達到共同速度  $v_1$  時，有：

As the interaction duration is quite short, based on the conservation of momentum, we can have the final velocity  $v_1$  of the block and the bullet is:

$$mv_0 = (M + m)v_1$$
$$v_1 = \frac{mv_0}{M + m} = 3 \text{ m/s}$$

如果要木塊與子彈不從木板上掉落，則應其運動到最右端的時候速度減小為 0。根據能量守恆，有

If the system of the block and the bullet will not fall down from the board, they should have the zero velocity when reaching the right end of the board. Based on the conservation of energy, we can have:

$$\frac{1}{2}(M + m)v_1^2 - \frac{1}{2}(M + m) \times 0^2 = \mu_1(M + m)g \frac{L}{2} + \mu_2(M + m)g \frac{L}{2}$$

可得 L 的最小值為：L=3 m

The minimum of L should be: L=3 m.

2. (1) 等效電路為  $R_2$ ， $R_3$  和  $R_4$  串聯後與  $R_1$  並聯。 $R_5$  上無電流通過。等效電阻為：

The equivalent circuit is that the resistors  $R_2$ ,  $R_3$  and  $R_4$  are in series and then parallel with  $R_1$ . There is no current passing through  $R_5$ . We thus have the equivalent resistance:

$$R = \frac{R_1(R_2 + R_3 + R_4)}{R_1 + R_2 + R_3 + R_4} = \frac{25}{6} \Omega$$

由歐姆定律，得電流表示數為：

Based on Ohm's law, we can have the current is:

$$I = \frac{U}{R} = 3.6 \text{ A}$$

電壓表示數等於  $R_4$  兩端電壓，經過  $R_4$  電流為

The value of the voltmeter is equal to the voltage across  $R_4$ , and thus we have the current passing  $R_4$  is:

$$I_4 = \frac{U}{R_2 + R_3 + R_4} = 0.6 \text{ A}$$

得  $U_4 = I_4 R_4 = 6 \text{ V}$

(2) 電容器兩極板之間電壓為：

The voltage between the two plates is:

$$U_c = I_4(R_2 + R_3) = 9 \text{ V}$$

電容器極板所帶電荷量為

The charges on each plate are thus:

$$Q = CU_c = 1.8 \times 10^{-4} \text{ C}$$

3. 開管與閉管的駐波頻率公式為

The frequencies of standing waves in an open-end tube and a closed-end tube are, respectively,

$$f = \frac{nv}{2L} \quad (n = 1, 2, 3, \dots), \quad f' = \frac{\left(n + \frac{1}{2}\right)v}{2L'} \quad (n = 0, 1, 2, \dots)$$

$L$  和  $L'$  分別為開管與閉管之長。題目的條件為

$L$  and  $L'$  are, respectively, the lengths of the two tubes. From the conditions of the question, we have

$$250 = \frac{v}{2L}, \quad \frac{\left(1 + \frac{1}{2}\right)v}{2L'} = \frac{2v}{2L}$$

可得（上述第一條件其實無用）：

We can get (the first condition above is not useful):

$$\frac{L}{L'} = \frac{4}{3}$$

4. 對於左箱體的受力來說（以右方為正方向）：

From the perspective of the forces on left box (right as the positive direction):

$$T - \mu_L mg = ma$$

對於右箱體的受力來說：

From the perspective of the forces on right box:

$$F_1 - T - \mu_R mg = ma$$

合併兩式，利用 $T = kx$  可得：

Combining the two formulas above, we get with  $T = kx$ :

$$F_1 - kx - \mu_R mg = kx - \mu_L mg$$

$$x = \frac{F_1 + (\mu_L - \mu_R)mg}{2k}$$



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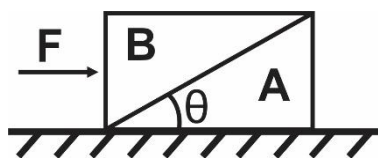
第一部分 Part 1 選擇題 Multiple Choice

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Write your answers (A, B, C, or D) in the corresponding box provided.

1. 完全相同的直角三角形滑塊 A 和 B 如圖疊放。設 A 與 B 接觸之間的斜面為光滑，A 與桌面的動摩擦因素為  $\mu$ 。現在 B 上施加一水平往右推力 F，使得 A 與 B 恰好一起在桌面上做勻速運動。已知運動過程中 A 與 B 保持相對靜止，則  $\mu$  與斜面傾角  $\theta$  的關係為\_\_\_\_\_。

Two right triangles, A and B, are identical as shown in the figure. The interface between A and B is frictionless. The kinetic frictional coefficient between A and the table surface is  $\mu$ . An external force, F, is applied on B so that A and B are moving under uniform velocity together. During the motion, A and B are under the related static condition. Please indicate the relationship between  $\mu$  and the inclined angle,  $\theta$ , of the ramp.



- (A)  $\mu = \tan\theta$   
(B)  $\mu = \tan\theta/2$   
(C)  $\mu = \sin\theta$   
(D)  $\mu = \sin\theta/2$

2. 下列說法正確的是

Please select the correct statement from the list below.

- (A) 熱量不能由低溫物體傳遞到高溫物體

Heat cannot be transferred from the low-temperature object to the high-temperature one.

- (B) 外界對物體做功，物體的內能一定增加

The internal energy of the object must increase if the environment is doing work to the object.

- (C) 理想氣體溫度升高的過程中，其壓強也一定不斷增大

The pressure of the ideal gas should increase if the temperature of the gas is increasing.

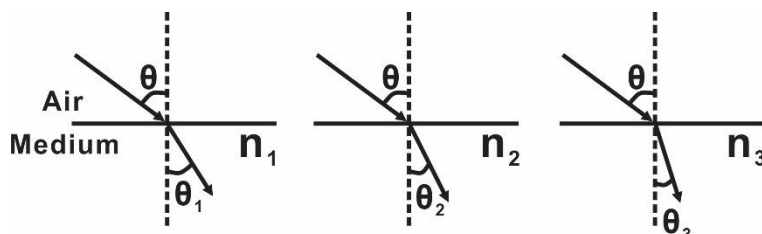
- (D) 不可能從單一熱源吸收熱量並將其全部用來做功，而不引起其他變化

It is impossible to absorb the heat from the sole heat source to do work and without any other changes.



3. 一光束以入射角  $\theta$  由空氣射向不同的介質中。已知折射角  $\theta_1, \theta_2, \theta_3$  的關係為  $\theta_1 > \theta_2 > \theta_3$ 。則三種介質的折射率組合有可能是下列哪種情況？

A light ray is travelling from air to another medium under an incidence angle of  $\theta$ . The three refractive angles have the relationship of  $\theta_1 > \theta_2 > \theta_3$ . Please select the possible combination of the refractive indices of the different media.



- (A)  $n_1=1.3, n_2=1.5, n_3=1.8$   
 (B)  $n_1=1.8, n_2=1.5, n_3=1.3$   
 (C)  $n_1=1.3, n_2=1.8, n_3=1.5$   
 (D)  $n_1=1.5, n_2=1.3, n_3=1.8$

4. 若一質塊沿一有摩擦的斜坡滑下，下述關於質塊的描述哪個正確？

If a block is sliding down a frictional slope, which of the following statements about the block during sliding is correct?

- (A) 其動量和機械能皆守恆  
 Both its momentum and its mechanical energy are conserved.  
 (B) 其動量守恆，但機械能不守恆  
 Its momentum is conserved but not its mechanical energy.  
 (C) 其機械能守恆，但動量不守恆  
 Its mechanical energy is conserved but not its momentum.  
 (D) 其動量和機械能皆不守恆  
 Neither its momentum nor its mechanical energy is conserved.

5. 一個元素的原子量基本上取決於它的  
The atomic weight of an element is generally determined by its

- (A) 電子的數目  
Number of electrons
- (B) 質子的數目  
Number of protons
- (C) 中子的數目  
Number of neutrons
- (D) 質子和中子的數目  
Number of protons and number of neutrons

6. 若將一長直電線置於一指南針頂部並接上一固定電流，則指南針的指向為何？  
If a long straight wire is placed on top of a compass and let flow a constant electric current, what would be the pointing direction of the compass?

- (A) 垂直於電線  
Perpendicular to the wire
- (B) 平行於電線  
Parallel with the wire
- (C) 與電線成  $45^\circ$  角  
Forming a  $45^\circ$  angle with the wire
- (D) 隨時間一直旋轉  
Rotating along with time

## 第二部分 Part 2      概念題 Concept Questions

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 graded.

1. 兩個質量相同的小球朝相同方向做勻速直線運動，其動量分別為  $8 \text{ kg}\cdot\text{m/s}$  及  $6 \text{ kg}\cdot\text{m/s}$ 。從能量守恆與動量守恆的角度，試分析兩小球發生碰撞後，其動量是否可能變為  $2 \text{ kg}\cdot\text{m/s}$  和  $12 \text{ kg}\cdot\text{m/s}$ 。

Two balls, with the same mass, are moving in a straight line under constant velocity. Their linear momentum is  $8 \text{ kg}\cdot\text{m/s}$  and  $6 \text{ kg}\cdot\text{m/s}$ . According to the conservation of energy and momentum, please analyze whether it is possible that after the collision, their momentums would change to  $2 \text{ kg}\cdot\text{m/s}$  and  $12 \text{ kg}\cdot\text{m/s}$ .

(6 分/ marks)

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2. 請簡述放射性衰變的定義。

Please briefly explain the definition of radioactive decay.

(5 分/ marks)

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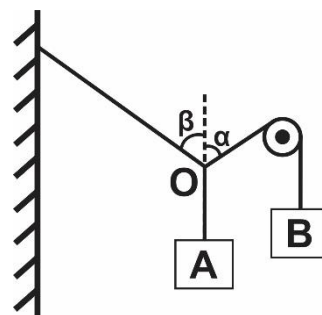
### 第三部分 Part 3 計算題 Calculation Questions

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 explanations, formulae, calculations and final results) in the space provided. Answers written elsewhere will not be graded.

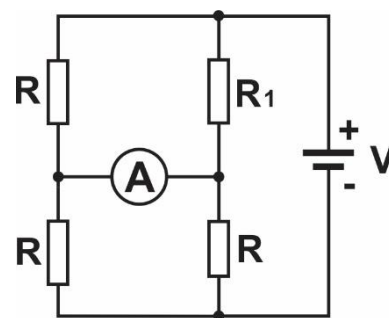
1. 如圖，懸掛物體 A 的細線拴牢在一不可伸長的輕質細繩上 O 點處。繩子的一端固定在牆上，另一端通過光滑定滑輪與物體 B 相連。A、B 兩物體的質量相等。當系統達到平衡時，O 點兩側的繩子與豎直方向的夾角分別為  $\alpha$  和  $\beta$ 。若  $\alpha=70^\circ$ ，求  $\beta$  的數值？

A block (A) was hung at the O point of a light, and un-stretchable string. One end of the string was fixed on the wall, and the other end was connected with block B via a fixed pulley. The mass of A and B is the same. When the system is static, the angle of  $\alpha$  is  $70^\circ$ . Please find the value of  $\beta$ .



2. 圖中所示電路中，電阻值  $R_1$  與  $R$  的關係為  $R_1 = 3R$ 。電流錶的電阻為零，電源為理想電源（內阻為零）。電源的電壓值為  $V$ 。試分析經過電流錶的電流與  $V/R$  的比值？

In the figure,  $R_1 = 3R$ , the resistance of the ammeter (A) is zero, and the battery is ideal (internal resistance of zero). What is the ratio between the current in the ammeter and  $V/R$ ?



3. 考慮一質量為  $5.0 \times 10^4 \text{ kg}$  的車廂在水平鐵軌上以  $0.3 \text{ m/s}$  的速度運動，其尾部連接有一繩纜。(a) 若繩纜上施加  $250\text{N}$  的拉力，則讓車廂完全停止需時多久？(b) 如果在離拉力施加開始位置  $10$  米數放有另一車廂，那麼兩個車廂在停止前會否相撞？忽略摩擦和空氣阻力。

Consider a railroad carriage of mass  $5.0 \times 10^4 \text{ kg}$  is running on a horizontal track at  $0.3 \text{ m/s}$ . A rope is attached to the tailing end of the carriage. (a) If a pulling force of  $250 \text{ N}$  is applied to the rope, how long does it take for the carriage to come to a full stop? (b) If another carriage is placed on the track  $10 \text{ m}$  away from the point where the pulling force is applied, will the two carriages hit each other before stopping? Ignore friction and air resistance.

4. 考慮一 RC 電路，其中的電容從滿充的  $5\text{V}$  開始放電。設電阻的阻值為  $10\text{k}\Omega$ ，那麼若要一分鐘內放電至原來的  $10\%$ ，電容相應的電容值為多少？

Consider an RC circuit in which the capacitor is discharging from a full charge of  $5\text{V}$ . If the resistor has a value of  $10\text{k}\Omega$ , what would be the capacitance of the capacitor if one wants to discharge to  $10\%$  in one minute?

## 參考答案 Suggested Answers

### 第一部分 Part 1 選擇題 Multiple Choice

1. B
2. D
3. A
4. B
5. D
6. A

### 第二部分 Part 2 概念題 Concept Questions

1. 不可能。根據動能與動量的關係  $E=p^2/2m$ ，該情況下碰撞後的動能大於初始動能。因此不可能發生該情況。

This phenomenon is impossible. Based on the relationship between kinetic energy and momentum,  $E=p^2/2m$ , the kinetic energy after the collision will be larger than that before the collision. It is thus impossible to occur.

2. 放射性衰變是指某種核素的原子核不穩定時，會自發性地放射出電離輻射的現象。

Radioactive decay is the process by which an unstable atomic nucleus loses energy by ionizing radiation.

3. 空調和冰箱的製冷利用了冷媒在氣化和凝聚時吸熱和放熱的過程，這過程涉及熱力學裡關於氣體的體積、壓強和溫度變化的守恆公式，例如波義爾定律。多數冷媒利用的是氣-液相變時的潛熱，所以好的冷媒需要在沸點的大比潛熱，同時熔點低，使其不容易固化，方便流動。

The cooling process of air-conditioners and refrigerators makes use of the endothermic and exothermic processes during the evaporation and condensation of the refrigerants. These processes involve the conservation laws concerning volume, pressure, and temperature of the thermodynamics of gases, such as Boyle's law. Since most refrigerants utilize the latent heat of gas-liquid phase transition, a good refrigerator should have large specific latent heat while having a low melting point to avoid solidification so that it is easy to flow around.

4. 近視眼鏡是凹透鏡，入射的光線會被它發散，即焦點在透鏡前。遠視眼鏡是凸透鏡，入射的光線被它聚焦，即焦點在透鏡後。

Lenses treating myopia are concave lenses: incident light rays would be dispersed, i.e. the focus point is front of the lens. Lenses treating hyperopia are convex lenses: incident light rays would be focused, i.e. the focus point is behind the lens.

### 第三部分 Part 3 計算題 Calculation Questions

1. 由於物塊 A 與 B 質量相等，根據力的合成，右邊的三角形中除了  $\alpha$  之外的兩個角度應該相等，可得到

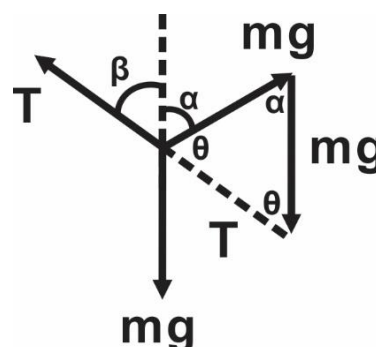
The mass of A and B is the same. So, based on the force compositions, the two angles (except  $\alpha$ ) in the right triangle should be the same. We thus can have

$$\theta = \frac{180 - 70}{2} = 55^\circ$$

因此，

Consequently,

$$\beta = 180^\circ - \alpha - \theta = 180^\circ - 70^\circ - 55^\circ = 55^\circ$$



2. 電流錶中的壓降為 0。電路的整體等效電阻值為

Note that there is no voltage drop across the ammeter. The equivalent resistance of the circuit is

$$R_{eq} = \frac{RR}{R + R} + \frac{R_1 R}{R_1 + R} = \frac{5}{4} R$$

假定經過底部兩電阻的電流均為  $i$ ，則有

We assume that the current passing the lower resistances is  $i$ , then

$$V = (2i)R_{eq} = \frac{5}{2} Ri$$

假定經過  $R_1$  的電流為  $i_1$ ，則在右邊迴路中有

We assume that the current passing  $R_1$  is  $i_1$ , then in the right loop, we have

$$V = R_1 i_1 + Ri = 3Ri_1 + Ri = \frac{5}{2} Ri$$

因此

So



$$3Ri_1 = \frac{3}{2} Ri$$

$$i_1 = \frac{1}{2} i$$

則經過電流錶的電流為

We thus have the current passing the ammeter is

$$i - i_1 = \frac{1}{2} i = \frac{1}{2} \times \frac{2V}{5R} = \frac{V}{5R}$$

經過電流錶的電流與  $V/R$  的比值為  $1/5$ 。

The ratio between the current in the ammeter and  $V/R$  is thus  $1/5$ .

3. RC 電路的放電過程符合下列指數衰減的公式

The discharging process of RC circuits obey the following decay formula

$$V = V_0 e^{-t/RC}$$

其中  $V_0$  為原電壓， $RC$  乘積為所謂時間常數。帶入已知參數，即

where  $V_0$  is the original voltage and the  $RC$  product is the so-called time constant.

Substituting the known parameters, that is

$$0.5 = 5e^{-\frac{60}{10 \times 10^3 C}}$$

可得電容  $C$  應為  $2.61 \text{ mF}$

we obtain the capacitance  $C$  to be  $2.61 \text{ mF}$ .

4. (a) 利用动量与冲量的关系可得

Using the relationship between momentum and impulse, we can obtain

$$\Delta t = \frac{mv}{F} = \frac{5.0 \times 10^4 \times 0.3}{250} = 60$$

即用时  $60$  秒可使车厢停下。

That is, it takes  $60$  seconds for the carriage to stop.

(b) 在拉拽過程中，移動的車廂不斷減速，按照過程中平均速度可得走行距離為

During the rope pulling, the moving carriage is always decelerating. Using the average velocity during this deceleration, we find the traveling distance to be

$$v_{\text{avg}} \Delta t = \frac{0.3 - 0}{2} \times 60 = 9 < 10$$

所以不會與另一車廂相撞。

Therefore, it won't collide with the other carriage.

從減速度考慮，加速度為 $-0.3/60 = -0.005$ 。那麼代入運動學公式，也可得

If we consider from the perspective of deceleration, the magnitude of acceleration is  $-0.3/60 = -0.005$ . Then substituting into the kinematic formula, we also obtain

$$v_0 t + \frac{1}{2} a t^2 = 0.3 \times 60 - \frac{1}{2} \times 0.005 \times 60^2 = 9$$