

2015/2016 學年 入學考試試題 ADMISSION EXAMINATION PAPER**第一部分 Part 1 選擇題 Multiple Choice**

1. 當物質加熱時，其溫度
When you add heat to a substance, its temperature
(A) 總是上升。
always increases.
(B) 時而下降。
sometimes decreases.
(C) 可能保持不變。
might stay the same.
(D) 取決於溫度而上升或下降。
might go up or down, depending on the temperature.
2. 當弦以基頻振動時，其長度是波長的多少？
When a string is vibrated at fundamental frequency, what is its length in terms of wavelength?
(A) $\frac{1}{4}$
(B) $\frac{1}{2}$
(C) 1
(D) 2
3. 庫侖定律是指兩個_____間的相互作用力遵從_____關係。
Coulomb Law dictates that the interaction force between two _____ obeys the _____ relation.
(A) 電流；反平方
currents; inverse square
(B) 電流；反比例
currents; inversely proportional
(C) 靜電荷；反平方
static charges; inverse square
(D) 靜電荷；反比例
static charges; inversely proportional

4. 一帶電粒子以勻速進入一個帶有均勻磁場的空間。粒子的速度應與磁場的方向形成什麼角度才能使粒子所受的洛侖茲力為最大？

A charged particle with constant velocity enters a zone of uniform magnetic field. At what angle should be the velocity form with the direction of the magnetic field such that the Lorentz force experienced by the particle is maximum?

- (A) 0°
(B) 90°
(C) 45°
(D) 30°

5. 一質量為 m 的小球以速率 v 在光滑的地面沿一直線滾向牆壁。在與牆壁碰撞之後，該小球沿原來的直線以相同的速率滾離牆壁。下面哪個說法正確？

A ball of mass m rolls on a frictionless surface towards a wall along a straight line and with a speed v . After impacting the wall, it rolls away from the wall along the same straight line and with the same speed. Which of the following statement is correct?

- (A) 碰撞前和碰撞後，小球的動量是相同的。
Before and after impact, the momentum of the ball remains unchanged.
- (B) 小球的慣性因為碰撞而改變了。
Because of the impact, the inertia of the ball has been changed.
- (C) 小球與牆壁的碰撞過程是完全彈性的。
The impact between the ball and the wall is totally elastic.
- (D) 以上皆非。
None of the above.

6. 當光由第一介質進入第二介質時，其折射角取決於

When light direct from the first medium to the second medium, its refraction angle depends on

- (A) 入射角。
incident angle.
- (B) 第一介質的折射率。
refractive index of the first medium.
- (C) 第二介質的折射率。
refractive index of the second medium.
- (D) 以上所有。
all of the above.

第二部分 Part 2 概念題 Question – Concept

1. 在光的雙狹縫干涉實驗中，屏幕上可以看到哪樣的圖案？此實驗證實了光的哪種性質？

In double-slit interference experiment of light, what kind of pattern can be seen on the screen? What property of light is verified by this experiment?

(5 分/marks)

2. 什麼是放射物質的半衰期？

What is half-life of radiative materials ?

(5 分/marks)

3. 楞次定律描述了什麼？

What does Lenz's law state?

(6 分/marks)

4. 請比較動量和動能。

Please compare momentum and kinetic energy.

(6 分/marks)

第三部分 Part 3 計算題 Question – Calculation

1. 在 25°C 下，一鋼棒及一黃銅圈的直徑分別為 3.000 cm 和 2.988 cm 。在哪一溫度下，鋼棒能剛好放進黃銅圈中？(鋼的線膨脹係數為 $11 \times 10^{-6}\text{ }^{\circ}\text{C}^{-1}$ ；黃銅的線膨脹係數為 $19 \times 10^{-6}\text{ }^{\circ}\text{C}^{-1}$)

A steel rod is 3.000 cm in diameter at 25°C . A brass ring has an interior diameter of 2.988 cm at 25°C . At what common temperature will the ring just slide onto the rod? (linear expansion coefficient of steel is $11 \times 10^{-6}\text{ }^{\circ}\text{C}^{-1}$, linear expansion coefficient of brass is $19 \times 10^{-6}\text{ }^{\circ}\text{C}^{-1}$)

(12 分/marks)

2. 一玻璃透鏡的折射率為 1.5 。其中一面是平面而另一面是曲率半徑為 20 cm 的凸面。

- (a) 求此透鏡的焦距；(b) 若一物體置於此透鏡前 40 cm 處，所成像在哪裡？

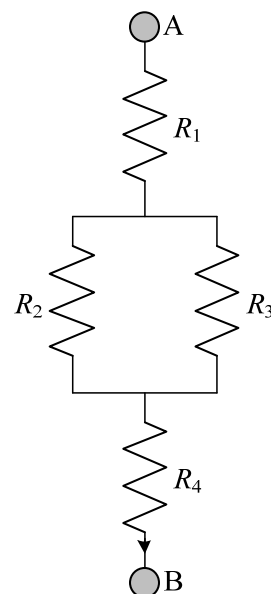
A lens is made of glass having an index of refraction of 1.5 . One side of the lens is flat, and the other is convex with a radius of curvature of 20 cm . (a) Find the focal length of the lens. (b) If an object is placed 40 cm in front of the lens, where is the image?

(10 分/ marks)

3. 在電路圖中，有一電流從 A 點經過四個電阻值分別為 $R_1 = 100\ \Omega$ 、 $R_2 = 40\ \Omega$ 、 $R_3 = 50\ \Omega$ 與 $R_4 = 200\ \Omega$ 的電阻，流向 B 點。如果穿過 R_2 的電流為 0.5 A ，求(a) 等效電阻；(b) 流經 R_1 、 R_3 及 R_4 的電流；(c) 各電阻(R_1 、 R_2 、 R_3 及 R_4) 兩端間的電壓；(d) AB 間的電壓。

In the circuit diagram as shown, a current is flowing from node A to node B through four resistors with values $R_1 = 100\ \Omega$, $R_2 = 40\ \Omega$, $R_3 = 50\ \Omega$, and $R_4 = 200\ \Omega$. The current running through resistor R_2 is 0.5 A . Find (a) equivalent resistance, (b) currents through R_1 , R_3 and R_4 (c) voltages across each resistors (R_1 , R_2 , R_3 and R_4), (d) voltage across A and B.

(18 分/ marks)



4. 一個汽球以速率 4 m/s 豎直地上升，當汽球高於某小孩正上方 14 m 時，小孩對準汽球以初速率 20 m/s 豎直地投出石塊。不計阻力，請問在石塊被投出 1 s 和 2 s 之後，它和汽球的距離是多少？汽球和石塊何時的距離最小？($g = 10 \text{ m/s}^2$)

A balloon goes vertically upwards with a speed of 4 m/s . When the balloon is 14 m directly above a kid, he catapults a stone strictly vertically towards the balloon. The initial speed of the stone is 20 m/s . Ignore air resistance; please determine the distance between the stone and the balloon after the stone has been catapulted for 1 s and 2 s , respectively. Please also determine the time when the distance between the stone and the balloon is the smallest? ($g = 10 \text{ m/s}^2$)

(20 分/marks)

2015/2016 學年 參考答案 MODEL ANSWER

第一部分 Part 1 選擇題 Multiple Choice

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

第二部分 Part 2 概念題 Question – Concept

1. 在光的雙狹縫干涉實驗中，可在屏幕上看到光暗條紋。此實驗證實了光的波動性質。
In double-slit interference experiment of light, bright and dark fringes can be seen on the screen and it verifies wave property of light.
2. 半衰期是指放射性物質衰減至原來一半數量所需的時間。
Half-life is the amount of time required for a quantity to fall to half its value as measured at the beginning of the time period.
3. 由感應電動勢所產生的電流的磁場方向與磁通量變化相反。
An induced electromotive force always gives rise to a current whose magnetic field opposes the change in magnetic flux.
4. 動能是與物體的運動狀態相關的一種能量及做功能力大小的物理量，動量是物體運動量大小和方向的物理量。它們都與物體的質量和速度有關，但動量為向量而動能為純量。一物體的動能變化時，其動量一定變化；而動量變化時，動能却不一定變化。
Kinetic energy is energy associated with state of motion of an object and physical quantity for ability of doing work. Momentum is physical quantity for magnitude and direction of quantity of motion. They are related to mass and velocity of an object. However, momentum is a vector quantity and kinetic energy is a scalar quantity. Momentum is being changed while changing of kinetic energy; kinetic energy may not be changed while changing of momentum.

第三部分 Part 3 計算題 Question – Calculation

1.

$$D_{s0} + \alpha_s D_{s0} \Delta T = D_{b0} + \alpha_b D_{b0} \Delta T$$

$$\Delta T = \frac{D_{s0} - D_{b0}}{\alpha_b D_{b0} - \alpha_{s0} D_{s0}}$$

$$\Delta T = \frac{3.000 - 2.988}{19 \times 10^{-6} \times 2.988 - 11 \times 10^{-6} \times 3.000} \approx 505(^{\circ}\text{C})$$

$$T = 505 + 25 = 530(^{\circ}\text{C})$$

2.

$$\frac{1}{f} = (n - 1) \left(\frac{1}{r_1} - \frac{1}{r_2} \right) = (1.5 - 1) \left(\frac{1}{\infty} - \frac{1}{-20} \right)$$

$$f = 40 \text{ cm}$$

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{i}$$

$$i = \left(\frac{1}{f} - \frac{1}{p} \right)^{-1} = \left(\frac{1}{40} - \frac{1}{40} \right)^{-1} = \infty$$

$$3. \quad (\text{a}) \quad R = R_1 + \frac{1}{1/R_2 + 1/R_3} + R_4 = 100 + \frac{1}{1/40 + 1/50} + 200 \approx 322(\Omega)$$

$$(\text{b}) \quad i_3 = \frac{V_3}{R_3} = \frac{V_2}{R_3} = \frac{i_2 R_2}{R_3} = \frac{0.5 \times 40}{50} = 0.4(\text{A})$$

$$i_1 = i_2 + i_3 = 0.5 + 0.4 = 0.9(\text{A})$$

$$i_4 = i_1 = 0.9 \text{ A}$$

$$(\text{c}) \quad V_1 = i_1 R_1 = 0.9 \times 100 = 90(\text{V})$$

$$V_2 = V_3 = i_2 R_2 = 0.5 \times 40 = 20(\text{V})$$

$$V_4 = i_4 R_4 = 0.9 \times 200 = 180(\text{V})$$

$$(\text{d}) \quad V_{AB} = V_1 + V_2 + V_4 = 90 + 20 + 180 = 290(\text{V})$$

4. 以石塊被投出時的地點作為原點，汽球的位置

Consider the point where the stone was catapulted to be origin, the position of balloon is,

$$y_1 = H + vt$$

而石塊的位置

The position of stone is,

$$y_2 = v_0t - \frac{1}{2}gt^2$$

在任一時刻 t ，汽球與石塊的距離

At any time t , the distance between the stone and balloon is,

$$\begin{aligned} h &= y_1 - y_2 \\ &= (H + vt) - (v_0t - \frac{1}{2}gt^2) \\ &= \frac{1}{2}gt^2 - (v_0 - v)t + H \\ &= 5t^2 - 16t + 14 \end{aligned}$$

當 $t = 1$ s 時

When $t = 1$ s,

$$h = 5t^2 - 16t + 14 = 5 - 16 + 14 = 3 \text{ (m)}$$

當 $t = 2$ s 時

When $t = 2$ s,

$$h = 5t^2 - 16t + 14 = 20 - 32 + 14 = 2 \text{ (m)}$$

對 h 的表達式求導數

Take derivative of h with respect to t ,

$$\frac{dh}{dt} = 10t - 16 = 0 \Rightarrow t = 1.6 \text{ s}$$

因 $\frac{d^2h}{dt^2} = 10 > 0$ ，故 h 為極小值，即 $t = 1.6$ s 時石塊和汽球的距離最小。

Because $\frac{d^2h}{dt^2} = 10 > 0$, h is minimum and the distance between the stone and the balloon is the smallest when $t = 1.6$ s.

2014/2015 學年 入學考試試題 ADMISSION EXAMINATION PAPER**第一部分 Part 1 選擇題 Multiple Choice**

1. 電力系統上的交流電壓為 220 V，此電壓值為系統的
AC voltage is 220 V in an electric system. This voltage in this system is
- (A) 平均值。
Average value.
- (B) 均方根值。
Root mean square value.
- (C) 高峯值。
Peak value.
- (D) 諧波值。
Harmonic value.
2. 一質量 m_1 以初速度 v_1 與另一靜止質量 m_2 作彈性碰撞。碰撞後， m_1 停止運動而 m_2 以速度 v_2 運動。假設 $m_1 > m_2$ ，下列哪一關於 v_2 的陳述正確？
A mass m_1 with initial velocity v_1 elastically collides with a mass m_2 at rest. After collision, m_1 stops and m_2 travels at velocity v_2 . Assuming $m_1 > m_2$, which statement about v_2 is correct?
- (A) $v_2 > v_1$
- (B) $v_2 < v_1$
- (C) $v_2 = v_1$
- (D) 不能確定。
It cannot be decided.
3. 分子間的熱傳遞為
The transfer of heat that takes place directly from molecule to molecule is
- (A) 傳導。
Conduction.
- (B) 對流。
Convection.
- (C) 輻射。
Radiation.
- (D) 昇華。
Sublimation.

4. 系統內能的變化等於輸入熱能減去系統所作的功。這說法描述了
The energy supplied to a system in the form of heat, minus the work done by the system, is equal to the change in internal energy. This statement describes the
- (A) 熱力學第一定律。
First law of thermodynamics.
- (B) 熱力學第二定律。
Second law of thermodynamics.
- (C) 熱力學第三定律。
Third law of thermodynamics.
- (D) 以上皆非。
None of the above.
5. 固體經相變成為液體，此固體
As a solid undergoes a phase change to a liquid, it
- (A) 在恆溫下釋放熱量。
Releases heat while remaining at a constant temperature.
- (B) 在恆溫下吸收熱量。
Absorbs heat while remaining at a constant temperature.
- (C) 隨著溫度的降低而釋放熱量。
Release heat as the temperature decreases.
- (D) 隨著溫度的上升而吸收熱量。
Absorbs heat as the temperature increases.
6. 光的折射發生在
Refraction of light happens
- (A) 當光經一表面作反射。
when light undergoes reflection from a surface.
- (B) 當光經過兩透明物質時速度出現改變。
when light undergoes a change of speed between two transparent materials.
- (C) 當光以臨界角移動。
when light undergoes movement through a critical angle.
- (D) 當光的入射角為 90° 。
when light undergoes a 90° angle of incidence.

第二部分 Part 2 概念題 Question – Concept

1. 試解釋為何溫度上升時大部分物質的密度會減低。 (6 分)
Explain why most materials become less dense as their (6 marks)
temperature is increased.

2. 何時發生全反射？為何全反射現象在鑽石中較在玻璃中顯著？ (6 分)
When does total internal reflection occur? Why does this occur in (6 marks)
the diamond more than glass?

3. 鈾-238 元素會經過 α (alpha) 衰變生成釷-234。這種 α 粒子是由 (5 分)
哪些基本粒子組成？ (5 marks)
Uranium-238 usually goes through α (alpha) decay to become
Thorium-234. What fundamental particles is this α particle
composed of?

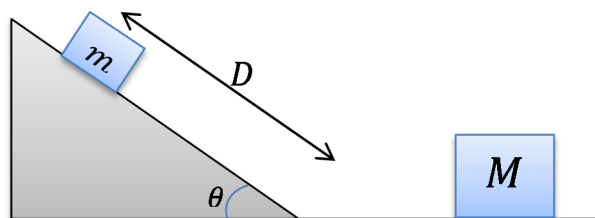
4. 產生磁場的條件是甚麼？ (5 分)
What are the conditions for generation of a magnetic field? (5 marks)

第三部分 Part 3 計算題 Question – Calculation

1. 如圖所示，一質量為 1 kg 的方塊 m 在無摩擦斜面上被釋放而下滑，斜面角度 θ 為 30° 。此方塊在斜面的滑動距離 D 為 10 cm ，當方塊 m 到達斜面底部時，與一靜止、質量為 10 kg 的方塊 M 碰撞後在斜面向上滑行。求碰撞後方塊 m 到達斜面的最大距離。(假設碰撞為彈性碰撞及水平平面為無摩擦。) (17 分)

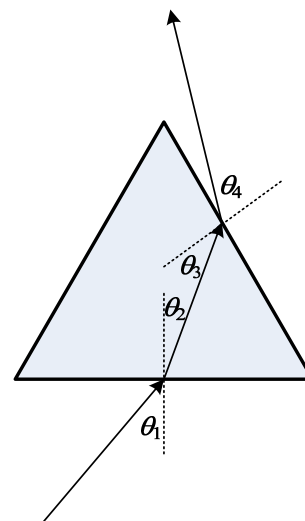
As shown in figure, a block m with mass of 1 kg is released on a frictionless slope and slides down. The angle of slope θ is 30° . This block reaches the end of the slope. It collides with a stationary block M with mass of 10 kg and then moves up the slope. After collision, what is the maximum distance that block m can reach up the slope? (Assume collision is elastic collision and flat section is frictionless.)

(17marks)



2. 一光線在空氣中入射三角棱鏡 (折射率 $n = 1.5$) 的一個表面上。(a) 若入射角 θ_1 為 45° ，在棱鏡與空氣的界面的折射角度 θ_4 為多少？(b) 若要在棱鏡與空氣的界面上發生全反射，最大的入射角 θ_1 為多少？ (16 分)

A ray is incident on one face of a triangular glass prism (index of refraction $n = 1.5$) in air. (a) The angle of incidence θ_1 is chosen to be 45° . What is the angle of refraction θ_4 at the interface between prism and air? (b) What is the maximum angle of θ_1 to occur total internal reflection on the interface between prism and air? (16 marks)



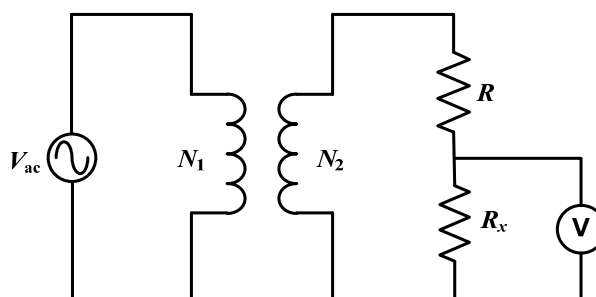
3. 一長 30 cm 的小提琴弦線的兩端被固定，以諧波數(n)為 2 的模式振動。在弦上的波速為 280 m/s，空氣中聲音的速度為 343 m/s。求所發出聲波的(a)頻率及(b)波長。(10 分)

A violin string with length of 30 cm is fixed at both ends and oscillates in the mode with harmonic number (n) of 2. The speed of waves on the string is 280 m/s, and the speed of sound in air is 343 m/s. What are the (a) frequency and (b) wavelength of the emitted sound wave? (10 marks)

4. 圖中為一理想變壓器，其原邊匝數 (N_1) 和副邊匝數 (N_2) 分別為 200 和 100，現以一內阻為 R_v 的電壓計測量電阻 R_x 兩端電壓差。 R 及 R_x 分別為 20 Ω 。
- (a) 若 $V_{ac} = 10$ V，變壓器的副邊電壓為多少？
- (b) 若 R_v 為 20 Ω ，計算出測量電阻 R_x 兩端電壓差時，由 R_v 所做成於百分比誤差。
- (c) 寫出理想電壓計的條件。
- (d) 當電壓計為理想時，計算出變壓器的輸入功率。(17 分)

Figure shows an ideal transformer. The number of turns of the primary side (N_1) and secondary side (N_2) of this transformer are 200 and 100 respectively. A voltmeter with internal resistance R_v is used to measure voltage difference across R_x . R and R_x are 20 Ω respectively.

- (a) If $V_{ac} = 10$ V, what will be the secondary side voltage of the transformer?
- (b) If R_v is 20 Ω , calculate percentage error in the measurement of voltage difference across R_x caused by R_v .
- (c) Write down condition for ideal voltmeter.
- (d) Calculate input power of transformer when voltmeter is ideal. (17 marks)



2014/2015 學年 參考答案 MODEL ANSWER

第一部分 Part 1 選擇題 Multiple Choice

1. (B)

2. (A)

$$m_1 v_1 = m_2 v_2$$

$$m_1 > m_2 \Rightarrow v_2 > v_1$$

3. (A)

4. (A)

5. (B)

6. (B)

第二部分 Part 2 概念題 Question – Concept

1. 若溫度上升，分子的運動變得劇烈，而令分子間的平均距離增加及物質膨脹。故其密度減低。

The motions of molecules become violent as the temperature increases. It results in larger average distance between them and material expands and thus, the density turns into lower.

2. 當折射角等於或大於 90° 時，全反射現象發生。鑽石的折射率較玻璃高，故光線經鑽石到空氣的臨界角較小，令全反射現象較明顯。

Total internal reflection occurs when the angle of refraction is equal to or greater than 90° . The diamond has a very higher index of refraction than glass. Therefore, total internal reflection occurs more in the diamond because the critical angle is smaller when a ray passes through interface between diamond and air.

3. α 粒子相等於氦原子的原子核，當中包括兩粒質子及兩粒中子。

The α particle is equivalent to the nucleus of a Helium atom, i.e. it consists of two protons and two neutrons.

4. 運動電荷、載流導線或磁石可產生磁場。

A magnetic field can be generated around a moving charge, current-carrying wire or magnet.

第三部分 Part 3 計算題 Question – Calculation

$$1. \quad \frac{1}{2}mv_0 = mgD \sin \theta$$

$$\begin{aligned} v_0 &= \sqrt{2gD \sin \theta} \\ &= \sqrt{2(9.8)(0.1)\sin 30^\circ} \\ &= 0.99 \text{ (m/s)} \end{aligned}$$

$$mv_0 = mv' + MV$$

$$0.99 = v' + 10V \dots\dots(1)$$

$$mgD \sin \theta = \frac{1}{2}mv'^2 + \frac{1}{2}MV^2$$

$$\begin{aligned} (1)(9.8)(0.1)\sin 30^\circ &= \frac{1}{2}(1)v'^2 + \frac{1}{2}(10)V^2 \\ 0.98 &= v'^2 + 10V^2 \dots\dots(2) \end{aligned}$$

由(1),

From (1),

$$V = \frac{0.99 - v'}{10}$$

代入(2)

Substitutes into (2)

$$0.98 = v'^2 + 10\left(\frac{0.99 - v'}{10}\right)^2$$

$$11v'^2 - 1.98v' - 8.82 = 0$$

$$v' \approx 0.99 \text{ (m/s)}$$

或 or

$$\approx -0.81 \text{ (m/s)}$$

由題目所知，方塊 m 碰撞後在斜面向上滑行，故運動方向與原方向相反， v' 應取 -0.81 m/s 。

From question, block m slides up incline after collision, thus the direction of motion is opposite to original. v' should be -0.81 m/s .

$$\frac{1}{2}mv'^2 = mgD' \sin \theta$$

$$D' = \frac{v'^2}{2g \sin \theta} = \frac{(-0.81)^2}{2(9.8)\sin 30^\circ} \\ \approx 0.067 \text{ (m)}$$

2. (a) $n_1 \sin \theta_1 = n_2 \sin \theta_2$

$$\theta_2 = \sin^{-1}\left(\frac{n_1 \sin \theta_1}{n_2}\right) = \sin^{-1}\left(\frac{\sin 45^\circ}{1.5}\right) = 28.1^\circ$$

$$\theta_3 = 90^\circ - [180^\circ - 60^\circ - (90^\circ - 28.1^\circ)] = 31.9^\circ$$

$$n_3 \sin \theta_3 = n_4 \sin \theta_4$$

$$\theta_4 = \sin^{-1}\left(\frac{n_3 \sin \theta_3}{n_4}\right) = \sin^{-1}\left(\frac{1.5 \sin 31.9^\circ}{1}\right) = 52.4^\circ$$

(b) $n_3 \sin \theta_3 = n_4 \sin \theta_4$

$$\theta_3 = \sin^{-1}\left(\frac{n_4 \sin \theta_4}{n_3}\right) = \sin^{-1}\left(\frac{\sin 90^\circ}{1.5}\right) = 41.8^\circ$$

$$\theta_2 = 90^\circ - [180^\circ - 60^\circ - (90^\circ - 41.8^\circ)] = 18.2^\circ$$

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

$$\theta_1 = \sin^{-1}\left(\frac{n_2 \sin \theta_2}{n_1}\right) = \sin^{-1}\left(\frac{1.5 \sin 18.2^\circ}{1}\right) = 27.9^\circ$$

3. (a) $f = \frac{nv}{2L} = \frac{2 \times 280}{2 \times 0.3} = 933 \text{ (Hz)}$

(b) $\lambda = \frac{v_{\text{sound}}}{f} = \frac{343}{933} = 0.368 \text{ (m)}$

$$4. \quad (a) \quad \frac{N_1}{N_2} = \frac{V_p}{V_s}$$

$$V_s = \frac{N_2}{N_1} \times V_p = \frac{100}{200} \times 10 = 5 \text{ (V)}$$

$$(a) \quad R'_x = \frac{R_x R_v}{R_x + R_v} = \frac{(20)(20)}{20 + 20} = 10 \text{ } (\Omega)$$

$$V_{R'_x} = \frac{R'_x}{R + R'_x} \times V_s = \frac{10}{20 + 10} \times 5 = 1.67 \text{ (V)}$$

$$V_{R_x} = \frac{R_x}{R + R_x} \times V_s = \frac{20}{20 + 20} \times 5 = 2.5 \text{ (V)}$$

$$\text{百分比誤差 (percentage error)} = \frac{2.5 - 1.67}{2.5} \times 100\% = 33\%$$

$$(b) \quad R_v \approx \infty$$

$$(d) \quad I_s = \frac{V_s}{R + R_x} = \frac{5}{20 + 20} = 0.125 \text{ (A)}$$

$$P_{input} = I_p V_p = I_s V_s = 0.125 \times 5 = 0.625 \text{ (W)}$$