# 高雄醫學大學 109 學年度學士後醫學系招生考試試題

## 科目：物理

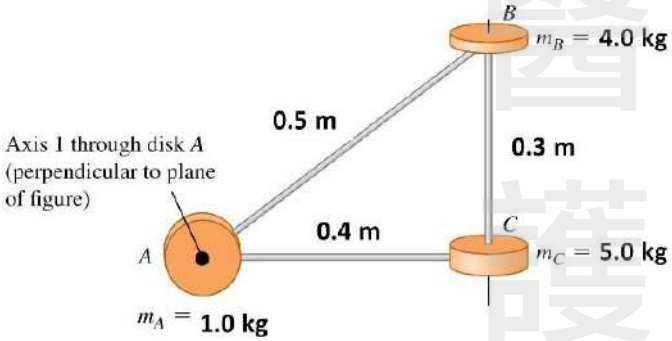
**Choose one best answer for the following questions**

**【單選題】每題 1 分，共計 30 分，答錯 1 題倒扣 0.25 分，倒扣至本大題零分為止，未作答，不給分亦不扣分。1~15 題為物理，16~30 題為化學。**

(E) 1. Consider the block and spring system shown in the drawing. On the earth's surface the natural frequency is ω. The system is then transported into moon's surface (Gravitational acceleration: $g_{Moon} = g_{Earth}/6$). How will the natural frequency of the system change?

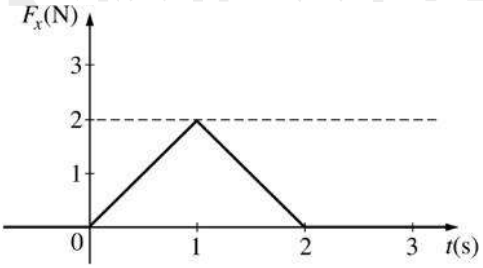
(A) 6 ω (B) $\sqrt{6}$ ω (C) ω/6
(D) ω/$\sqrt{6}$ (E) The frequency doesn't change.

(B) 2. What is this body's moment of inertia ***I*** about axis through disk *A*?



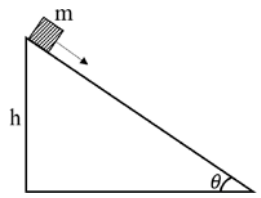

(A) 1.8 kg·m (B) 1.8 kg·m$^2$ (C) 4.0 kg·m (D) 4.0 kg·m$^2$ (E) 5.0 kg·m$^2$

(C) 3. The figure shows a plot of the time-dependent force $F_x(t)$ acting on a particle in motion along the x-axis. What is the total impulse delivered to the particle?




(A) 0 kg·m /s (B) 1 kg·m /s (C) 2 kg·m /s (D) 3 kg·m /s (E) 4 kg·m /s

(B) 4. Ablock of mass m sliding down an incline at constant speed is initially at a height h above the ground, as shown in the figure. The coefficient of kinetic friction between the mass and the incline is $\boldsymbol{\mu}$. If the mass continues to slide down the incline at a constant speed, how much energy is dissipated by friction by the time the mass reaches the bottom of the incline?




(A) mgh/μ (B) mgh (C) μmgh/sinθ (D) mgh sinθ (E) 0

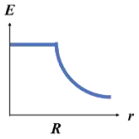
(D) 5. A baseball is thrown vertically upward and feels no air resistance. As it is rising
(A) both its momentum and its mechanical energy are conserved.
(B) both its momentum and its kinetic energy are conserved.
(C) its kinetic energy is conserved, but its momentum is not conserved.
(D) its momentum is not conserved, but its mechanical energy is conserved.
(E) its gravitational potential energy is not conserved, buts its momentum is conserved.

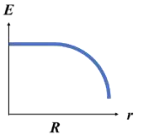
(C) 6. Which step is one of the Carnot cycle?
(A) Isobaric compression (B) Isochoric compression
(C) Isothermal compression (D) Isochoric expansion
(E) Isobaric expansion

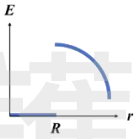
(B) 7. One surface is remained at temperature of 300 K and it's heat current in radiation is *H*. When it was heated to 600 K, what is the heat current in radiation of this surface comparing to that at 300 K?
(A) 32*H* (B) 16*H* (C) 8*H* (D) 4*H* (E) 2*H*

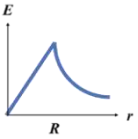
(B) 8. A conducting sphere is charged up such that the potential on its surface is 100 V (relative to infinity). If the sphere's radius were twice as large, but the charge on the sphere were the same, what would be the potential on the surface relative to infinity?
(A) 25 V (B) 50 V (C) 100 V (D) 200 V (E) 400 V

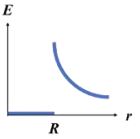
(D) 9. There is a solid insulating sphere with radius *R* and total charge *Q*. Which diagram is correct for electric field *E* at any point inside or outside the sphere?

(A) 

(B) 

(C) 

(D) 

(E) 


(D) 10. An object is placed at a distance 5.0 cm to the left of a concave mirror with a curvature radius 5.0 cm. Determine the location and magnification of the image formed by this image system.
(A) The image is formed 2.5 cm to the right of the mirror and it has a magnification of .1/2.
(B) The image is formed 5.0 cm to the right of the mirror and it has a magnification of .1.
(C) The image is formed 2.5 cm to the left of the mirror and it has a magnification of 1.
(D) The image is formed 5.0 cm to the left of the mirror and it has a magnification of .1.
(E) The image is formed 1.25 cm to the left of the mirror and it has a magnification of .1/4.

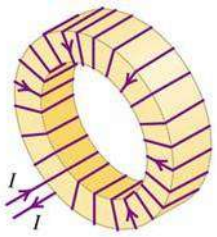
(C) 11. Soap bubble is colorful. What is the phenomenon of the colorful reflection appeared in the thin films?
(A) Diffraction (B) Dispersion (C) Interference
(D) Refraction (E) Total refraction

(C) 12. One rope with weight 2.0 kg and length 10.0 m is tied on a shelf and stretched taut by a 98 kg box at the bottom. What is the speed ***v*** of a transverse wave on the rope? (Gravitational acceleration g = 10 $m/s^2$)
(A) 10.0 m/s (B) 10.7 m/s (C) 70.0 m/s (D) 70.7 m/s (E) 100.0 m/s

(E) 13. A80 kg baseball player begins his slide into third base at speed of 5 m/s. The coefficient of friction between his clothes and ground is 0.8 to make him stopped when he reached the third base. How far does he slide?
(A) 1.22 m (B) 1.32 m (C) 1.41 m (D) 1.50 m (E) 1.59 m

(D) 14. Given that the wavelengths of visible light range from 400 nm to 700 nm, what is the highest frequency of visible light? ($c = 3.0 \times 10^8$ m/s)
(A) $3.1 \times 10^8$ Hz (B) $5.0 \times 10^8$ Hz (C) $4.3 \times 10^{14}$ Hz
(D) $7.5 \times 10^{14}$ Hz (E) $2.3 \times 10^{20}$ Hz

(A) 15. There is a doughnut-shaped toroidal solenoid with 200 turns of wires carrying current 0.02A. The inner radius of that is 1 m and outer radius is 5 m. What is the magnetic field ***B*** of this doughnut-shaped toroidal solenoid at the point with distance 0.5 m from center of that? ( $\mu_0$ is permeability constant )

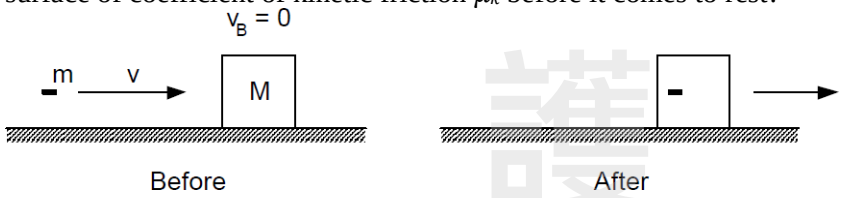



(A) 0 (B) $4\mu_0/\pi$ (C) $2\mu_0/\pi$ (D) $\mu_0/2\pi$ (E) $\mu_0/4\pi$

**【單選題】每題 2 分，共計 120 分，答錯 1 題倒扣 0.5 分，倒扣至本大題零分為止，未作答，不給分亦不扣分。 31~60 題為物理，61~90 題為化學。**

(D) 31. In a baseball game, the pitcher throw a ball (150 g) at a speed of 30.0 m/s. The batter hit it straight back with a speed of 40.0 m/s. What is the average force exerted by the bat if the bat-ball contact time is 0.005 sec?
(A) 300 N (B) 14000 N (C) 1200 N (D) 2100 N (E) 900 N

(E) 32. A bullet of mass m traveling at speed v strikes a block of mass M, initially at rest, and is embedded in it as shown below. How far will the block with the bullet embedded in it slide on a rough horizontal surface of coefficient of kinetic friction $\mu_k$ before it comes to rest?

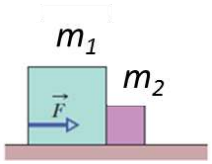



(A) $\left(\frac{m+M}{m}\right)\left(\frac{v^2}{2\mu_k g}\right)$ (B) $\left(\frac{m+M}{M}\right)\left(\frac{v^2}{2\mu_k g}\right)$ (C) $\left(\frac{m+M}{M}\right)^2\left(\frac{v^2}{2\mu_k g}\right)$
(D) $\left(\frac{m}{m+M}\right)\left(\frac{v^2}{2\mu_k g}\right)$ (E) $\left(\frac{m}{m+M}\right)^2\left(\frac{v^2}{2\mu_k g}\right)$



(E) 33. An unusual spring has a restoring force of magnitude $F = (2.00\ \text{N/m})x + (1.00\ \text{N/m}^2)x^2$, where x is the stretch of the spring from its equilibrium length. A 3.00 kg object is attached to this spring and released from rest after stretching the spring 1.50 m. If the object slides over a frictionless horizontal surface, how fast is it moving when the spring returns to its equilibrium length?
(A) 5.84 m/s (B) 4.33 m/s (C) 2.06 m/s (D) 5.48 m/s (E) 1.50 m/s

(B) 34. Two blocks are in contact on a frictionless table. A horizontal force is applied to the larger block. $F = 100$ N, $m_1/m_2 = 2$. The force acting on the small block from the larger one is,

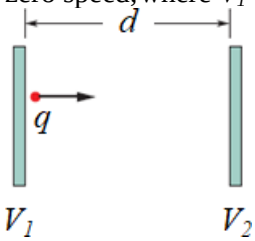



(A) 100/2 N (B) 100/3 N (C) 100/4 N (D) 100/6 N (E) 100/8 N

(B) 35. A uniform solid sphere of mass $M$ and radius $R$ rotates with an angular speed $\omega$ about an axis through its center. A uniform solid cylinder of mass $M$, radius $R$, and length $2R$ rotates through an axis running through the central axis of the cylinder. What must be the angular speed of the cylinder so it will have the same rotational kinetic energy as the sphere?
(A) $2\omega/5$ (B) $2\omega/\sqrt{5}$ (C) $\omega/\sqrt{5}$ (D) $\sqrt{2/5}\omega$ (E) $4\omega/5$

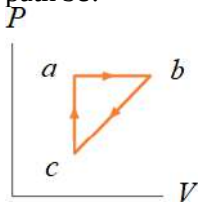
(B) 36. Two Earth satellites, A and B, of same mass $m$, are to be launched into circular orbits about Earth's center. Satellite A is to orbit at an altitude of Earth' radius, $h_A = R_E$. Satellite B is to orbit at an altitude of $2h_A$. The ratio of the total energy of satellite B to that of satellite Ais,
(A) 1/2 (B) 2/3 (C) 2 (D) 3/2 (E) 1/4

(D) 37. A charged dust particle of mass $m$ = 32 mg and charge value $q$ =100 nC is releasing from plate 1 with zero speed, where $V_1$ = 130 V, and $V_2$ = –30 V. The dust particle velocity when reaching plate 2 is,




(A) 0.03 m/s (B) 0.05 m/s (C) 0.75 m/s (D) 1.00 m/s (E) 1.25 m/s

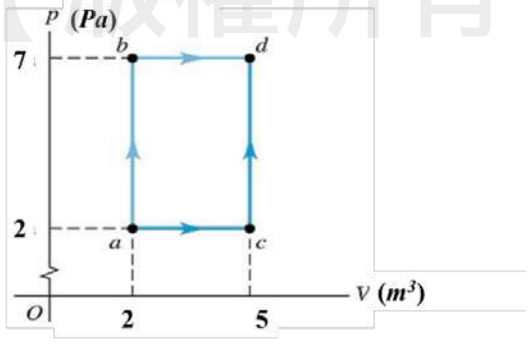
(E) 38. As a gas is held within a closed chamber, it passes through the cycle shown in the figure. Along path ab, the change in the internal energy is 3.0 J and the magnitude of the work done is 5.0 J. Along path ca, the energy transferred to the gas as heat is 2.5 J. How much the change in the internal energy along path bc?




(A) +5.5 J (B) +10.5 J (C) –0.5 J (D) –10.5 J (E) –5.5 J

(E) 39. A 30.0 g bullet shoot into an ice at speed of $2.4\times10^2$ m/s and stay inside. Assume the kinetic energy is transfer to thermal energy, and absorbed by the ice, what is the change in entropy of the ice?
(A) 86.4 J/K (B) 27.0 J/K (C) 31.6 J/K (D) 2.7 J/K (E) 3.16 J/K

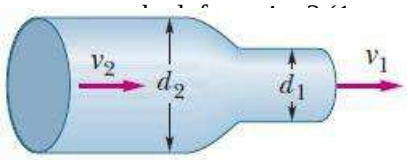
(D) 40. In process *ab*, 20 J of heat is added to the system. In process *bd*, 80 J of heat is added to the system. Find the internal energy change $\Delta U$ in process *acd*?




(A) 0 J (B) 20 J (C) 59 J (D) 79 J (E) 100 J

(×) 41. The density of wood, water and unknown liquid are 0.8 g/cm$^{33}$, 1.0 g/cm$^{33}$, and 1.2 g/cm$^{33}$, respectively. The volume ratio of the wood that can be seen in water and unknown liquid is
(A) 5/6 (B) 3/4 (C) 2/3 (D) 1/2 (E) 1/4

(×) 42. Water flows through a horizontal pipe and then out into the atmosphere, where $d_2/d_1 = 2$. The speed of the water at the output of the pipe is $v_1 = 10$ m/s. The desity of water is 1g/cm$^3$. What is the gauge = $1.01 \times 10^5$ Pa )

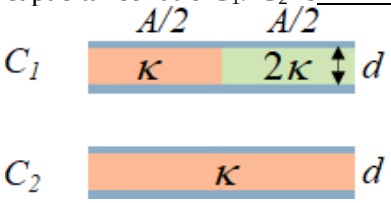



(A) 4.6 atm (B) 4.8 atm (C) 5.0 atm (D) 5.2 atm (E) 5.4 atm

(A) 43. A patient need an intravenous drip contains a glucose solution. If the average pressure in the vein is 1.30 kPa, what is the minimum height to hang the bag in order to infuse glucose into the vein? Assume the specific gravity of the solution is 1.02.
(A) 0.13 m (B) 1.30 m (C) 0.26 m (D) 2.6 m (E) 0.52 m

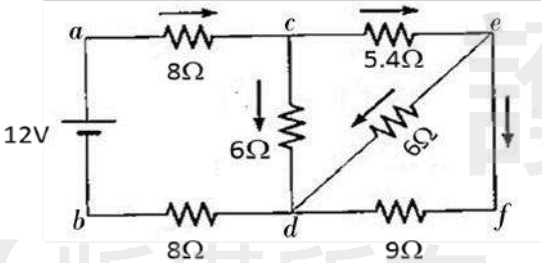
(D) 44. A balloon is to be filled with helium and used to suspend a mass of 300 kg in air. If the mass of the balloon is neglected, which of the following gives the approximate volume of helium required? (The density of air is 1.29 kg/m$^3$ and the density of helium is 0.18 kg/m$^3$)
(A) 50 $m^3$ (B) 95 $m^3$ (C) 135 $m^3$ (D) 270 $m^3$ (E) 540 $m^3$

(C) 45. There are two parallel-plate capacitors with same plate area $A$. As the figure illustrated, $C_1$ is filled with two materials of dielectric constants $\kappa$ and $2\kappa$, while $C_2$ is filled with only one material. The capacitance ratio $C_1/C_2$ is_____.




(A) 0.5 (B) 1 (C) 1.5 (D) 2 (E) 2.5

(E) 46. What is the equivalent resistance of the circuit in the figure?

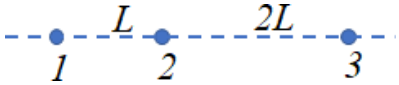



(A) 8.6 Ω (B) 13.8 Ω (C) 3.6 Ω (D) 42.4 Ω (E) 19.6 Ω

(×) 47. There is a straight current-carrying conductor with current $I$ =10 A and length $L$ = 2 m. What is the magnetic field $\boldsymbol{B}$ of this conductor at the distance 2 m from that? ( $\mu_0$ is permeability constant )
(A) $5\mu_0$ (B) $5\mu_0/\pi$ (C) $5\mu_0/2\pi$ (D) $\mu_0/2\pi$ (E) $\mu_0/\pi$

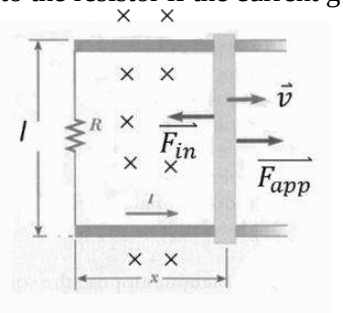
(B) 48. If the displacement current in a parallel-plate capacitor (0.5 μF) is 4.0A, at what rate is the potential difference varying across the plates?
(A) $2.0 \times 10^6$ V/s (B) $8.0 \times 10^6$ V/s (C) $4.0 \times 10^6$ V/s
(D) $1.25 \times 10^7$ V/s (E) The potential difference is not varying

(×) 49. Three charge particles are situated as illustrated. Particle 1 and 2 are fixed, while particle 3 is free to move. If there is no net force on the particle 3, what is the charge ratio $q_2/q_1$?




(A) 2 (B) 2/3 (C) 3 (D) –2/3 (E) –2

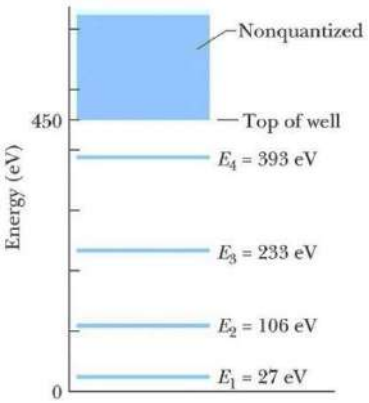
(D) 50. The sliding bar has a length of 1.0 m, and moves at 3.0 m/s in a magnetic field of magnitude 0.5 T. This could induced motional emf. If the resistance in the circuit is 1.0 Ω, what is the power delivered to the resistor if the current goes counterclockwise around the loop?




(A) 0.85 W (B) 1.35 W (C) 1.80 W (D) 2.25 W (E) 2.55 W

(B) 51. What is the critical angle when a ray passes from diamond into air? The index of refraction for air and diamond is 1.00 and 2.42, respectively.
(A) 0° (B) 24° (C) 30° (D) 36° (E) 66°

(E) 52. The figure shows the energy levels for an electron in a finite potential energy well. If the electron makes a transition from the $n = 3$ state to the ground state, what is the wavelength of the emitted photon?




(A) 2.3 nm (B) 3.0 nm (C) 5.3 nm (D) 5.7 nm (E) 6.0 nm

(B) 53. Light of wavelength 500 nm is incident upon a single slit with width $2 \times 10^{-4}$ m. The diffraction pattern is observed on a screen positioned 4 m from the slit. Determine the distance of the second dark fringe from the central peak.
(A) 0.01 m (B) 0.02 m (C) 0.03 m (D) 0.04 m (E) 0.05 m

(B) 54. Unpolarized light can be polarized, either partially or totally, by reflection. What is the polarizing angle when a ray passes from diamond into air? The index of refraction for air and diamond is 1.00 and 2.42, respectively.
(A) 0° (B) 22° (C) 31° (D) 42° (E) 66°

(B) 55. Monochromatic light is normally incident on a diffraction grating that is 1 cm wide and has 12,500 slits. The first order line is deviated at a 30° angle. What is the wavelength of the incident light?
(A) 300 nm (B) 400 nm (C) 500 nm (D) 600 nm (E) 1000 nm

(B) 56. The work function for a certain sample is 2.3 eV. The stopping potential for electrons ejected from the sample by $6.0 \times 10^{14}$ Hz electromagnetic radiation is ($c = 3.00 \times 10^8$ m/s):
(A) 0 V (B) 0.18 V (C) 0.36 V (D) 2.0 V (E) 3.6 V

(x) 57. A police car chases fugitives on the highway at 144 km/hr, its siren emitting sound at a frequency of 500 Hz. What frequency is heard by a passenger in a car traveling at 108 km/hr in the opposite direction as the police car and car approach each other? Assume the speed of sound in the air is 345 m/s.
(A) 420 Hz (B) 495 Hz (C) 545 Hz (D) 595 Hz (E) 625 Hz

(D) 58. Two cars are approaching to each other. Car A moves at speed $v_A$ = 108.0 km/hr, and the car B at $v_B$ = 72.0 km/hr. The car A sends out a horn sound traveling in air with speed of 343 m/s. The horn's sound frequency as detected by the car B is 1000 Hz. The horn's sound frequency that car A sends out is____.
(A) 1212 Hz (B) 1154 Hz (C) 948 Hz (D) 862 Hz (E) 821 Hz

(D) 59. The wave function of the string wave is given by $y(x,t)=0.2m\times h\left[(20m^{-1})x+(10s^{-1})t\right]$, where $h$ denotes a general function. The speed of a wave is_____.
(A) 2 m/s (B) 1.5 m/s (C) 1 m/s (D) 0.5 m/s (E) 0.25 m/s

(A) 60. A standing sound wave pattern on a long string is described by $y(x,t)=0.008\times\sin(10\pi x)\cos(20\pi t)$(all in SI unit). The distance between two nodes is_____.
(A) 0.1 m (B) 0.2 m (C) 0.3 m (D) 0.4 m (E) 0.5 m

# 物　理

程量子(陳宗德)老師提供

## 試題評析

以下針對109年學士後西醫物理考科之分析：

1. 在難易度方面，相較於108年物理考卷而言，今年的試題較著重物理觀念，若物理觀念了解，皆可以直接作答，完全不需要計算。極少數題目計算稍微複雜，但是數學指數運算部分若熟悉的話，皆可以快速作答。大部分95%以上的題目，於先修、正課、特訓班課堂中、作業練習中及七百題題庫皆教授過，且做過多次練習，只是題目換句話說，若物理觀念不錯，可直接作答，故一年班課程的同學們非常有可能在有限時間內寫作完成。
2. 在考題命中度方面，此次試卷內容與上課教材、平時作業、複習卷、七百題題庫、總複習課程題庫、實戰解析課程之題庫及高點建國所提供的模擬考有80％以上的命中度，若將來同學們平時訓練足夠，提升運算速度，則分數可以提升許多，並可增加上榜的機率。
3. 在命題範圍方面，相較於108年物理考卷而言，在今年物理試題，考題較為傳統，但值得注意的是，考題來自於原文書後面的習題，其比重比108年增加，出題老師會改其相關數字，也許出題老師太忙，忽略驗算，故此次考試，有五題送分。另一方面，同學在練習原文書後面的習題時，需要徹底理解其物理意義，不是只是背答案而已。此方面將會列入新年度課程主要教學部分。
4. 猜測預估物理考科平均分數，因有五題送分，滿分75分，65分以上則算不錯，平均應會落在60分上下。

程量子筆

## 試題詳解

【單選題】每題 1 分

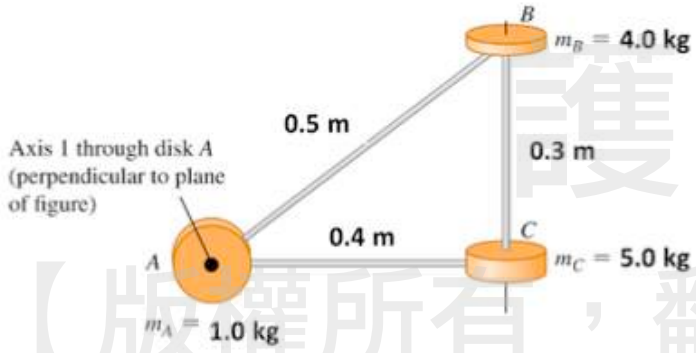
1. Consider the block and spring system shown in the drawing. On the earth's surface the natural frequency is $\omega$. The system is then transported into moon's surface (Gravitational acceleration: $g_{Moon} = g_{Earth}/6$). How will the natural frequency of the system change?

(A) $6\omega$ (B) $\sqrt{6}\omega$ (C) $\omega/6$
(D) $\omega/\sqrt{6}$ (E) The frequency doesn't change.

1. 解：(E)

$\omega = \sqrt{\frac{k}{m}}$，與重力加速度 g 無關

2. What is this body's moment of inertia ***I*** about axis through disk *A*?



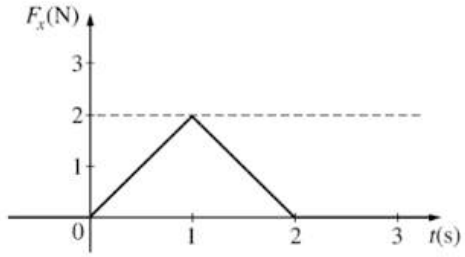

(A) $1.8kg\cdot m$ (B) $1.8kg\cdot m^2$ (C) $4.0kg\cdot m$ (D) $4.0kg\cdot m^2$ (E) $5.0kg\cdot m^2$

2. 解：(B)

由 $I = \sum_i m_i r_i^2$

$I = 4\times(0.5)^2 + 5\times(0.4)^2 = 1.8\left[kg\cdot m^2\right]$

3. The figure shows a plot of the time-dependent force $F_x(t)$ acting on a particle in motion along the x-axis. What is the total impulse delivered to the particle?



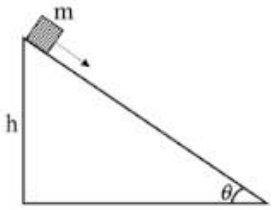

(A) $0kg\cdot m/s$ (B) $1kg\cdot m/s$ (C) $2kg\cdot m/s$ (D) $3kg\cdot m/s$ (E) $4kg\cdot m/s$

3. 解：(C)

total impulse $\Delta p = F_x(t)\text{-}t$ 所圍起來的面積

$$A = \frac{1}{2}\times(2\times 2) = 2\left[kg\cdot m/s\right]$$

4. A block of mass m sliding down an incline at constant speed is initially at a height h above the ground, as shown in the figure. The coefficient of kinetic friction between the mass and the incline is $\mu$. If the mass continues to slide down the incline at a constant speed, how much energy is dissipated by friction by the time the mass reaches the bottom of the incline?




(A) $mgh/\mu$ (B) $mgh$ (C) $\mu mgh/\sin\theta$ (D) $mgh\sin\theta$ (E) 0

4. 解：(B)

因題意說明木塊下滑為 constant speed，故外力和為零，則有

$$mg\sin\theta = f_k$$

動摩擦力所作的功為

$$W_{f_k} = f_k x = mg\sin\theta x$$

$$\Rightarrow W_{f_k} = f_k x = mg\sin\theta\left(\frac{h}{\sin\theta}\right) = mgh$$

5. A baseball is thrown vertically upward and feels no air resistance. As it is rising
(A) both its momentum and its mechanical energy are conserved.
(B) both its momentum and its kinetic energy are conserved.
(C) its kinetic energy is conserved, but its momentum is not conserved.
(D) its momentum is not conserved, but its mechanical energy is conserved.
(E) its gravitational potential energy is not conserved, buts its momentum is conserved.

5. 解：(D)

物體上拋運動有受重力影響，故線動量不守恆。

沒受空氣阻力，機械能守恆。

6. Which step is one of the Carnot cycle?
(A) Isobaric compression (B) Isochoric compression (C) Isothermal compression
(D) Isochoric expansion (E) Isobaric expansion

6. 解：(C)

卡諾循環由兩個等溫過程、兩個絕熱過程所構成

7. One surface is remained at temperature of 300 K and it's heat current in radiation is $H$. When it was heated to 600 K, what is the heat current in radiation of this surface comparing to that at 300 K?
(A) $32H$ (B) $16H$ (C) $8H$ (D) $4H$ (E) $2H$

7. 解：(B)

For thermal radiation, heat current is defined as

$$H = \sigma A T^4$$

, where the constant of proportionality $\sigma$ is the Stefan–Boltzmann constant, $A$ is the radiating surface area, and $T$ is temperature.

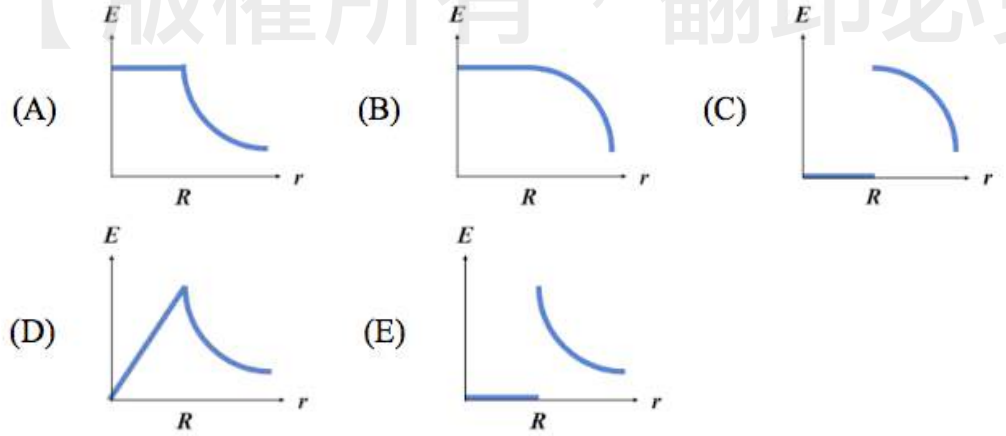
$$\frac{H}{H'} = \frac{T^4}{T'^4}$$
$$\Rightarrow \frac{H}{H'} = \frac{300^4}{600^4} = \frac{1}{16}$$
$$\Rightarrow H' = 16H$$

8. A conducting sphere is charged up such that the potential on its surface is 100 V (relative to infinity). If the sphere's radius were twice as large, but the charge on the sphere were the same, what would be the potential on the surface relative to infinity?
(A) 25 V (B) 50 V (C) 100 V (D) 200 V (E) 400 V

8. 解：(B)

$$V = \frac{K_e Q}{R} \Rightarrow 100 = \frac{K_e Q}{R}$$
$$V' = \frac{K_e Q'}{R'} \Rightarrow V' = \frac{K_e Q}{2R} = \frac{100}{2} = 50[V]$$

9. There is a solid insulating sphere with radius $R$ and total charge $Q$. Which diagram is correct for electric field $E$ at any point inside or outside the sphere?



9. 解：(D)

solid insulating sphere

$$E_{r<R}=\frac{Qr}{4\pi\varepsilon_0 R^3}\propto r$$

$$E_{r=R}=\frac{Q}{4\pi\varepsilon_0 R^2}=const.$$

$$E_{r>R}=\frac{Q}{4\pi\varepsilon_0 r^2}\propto\frac{1}{r^2}$$

10. An object is placed at a distance 5.0 cm to the left of a concave mirror with a curvature radius 5.0 cm. Determine the location and magnification of the image formed by this image system.

(A) The image is formed 2.5 cm to the right of the mirror and it has a magnification of −1/2.
(B) The image is formed 5.0 cm to the right of the mirror and it has a magnification of −1.
(C) The image is formed 2.5 cm to the left of the mirror and it has a magnification of 1.
(D) The image is formed 5.0 cm to the left of the mirror and it has a magnification of −1.
(E) The image is formed 1.25 cm to the left of the mirror and it has a magnification of −1/4.

10. 解：(D)

凹面鏡之焦點為實焦點，焦距為實焦距 $f>0$，曲率半徑 $R>0$

$$\frac{1}{p}+\frac{1}{q}=\frac{1}{f}=\frac{2}{R}$$

$$\Rightarrow\frac{1}{5}+\frac{1}{q}=\frac{2}{5}$$

$$\Rightarrow q=5>0$$（影像在鏡子的左邊）

放大率 $m=-\frac{q}{p}=-\frac{5}{5}=-1$

11. Soap bubble is colorful. What is the phenomenon of the colorful reflection appeared in the thin films?

(A) Diffraction (B) Dispersion (C) Interference (D) Refraction (E) Total refraction

11. 解：(C)

肥皂泡泡膜之色彩屬於干涉現象



12. One rope with weight 2.0 kg and length 10.0 m is tied on a shelf and stretched taut by a 98 kg box at the bottom. What is the speed $\boldsymbol{v}$ of a transverse wave on the rope? (Gravitational acceleration g = 10 m/s$^2$)

(A) 10.0 m/s (B) 10.7 m/s (C) 70.0 m/s (D) 70.7 m/s (E) 100.0 m/s

12. 解：(C)

由 $v=\sqrt{\frac{T}{\mu}}$

$$v=\sqrt{\frac{90\times10}{\frac{2}{10}}}=70\left[m/s^2\right]$$

【單選題】每題 2 分

31. In a baseball game, the pitcher throw a ball (150 g) at a speed of 30.0 m/s. The batter hit it straight back with a speed of 40.0 m/s. What is the average force exerted by the bat if the bat-ball contact time is 0.005 sec?

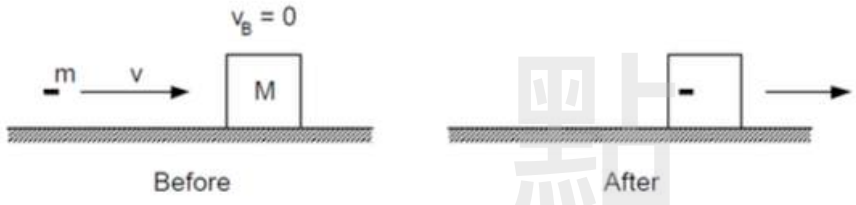
(A) 300 N (B) 14000 N (C) 1200 N (D) 2100 N (E) 900 N

31. 解：(D)

由 $F=\dfrac{\Delta p}{\Delta t}$

$$F=\frac{\left|-0.15\times 40-0.15\times 30\right|}{0.005}=2100[N]$$

32. A bullet of mass m traveling at speed v strikes a block of mass M, initially at rest, and is embedded in it as shown below. How far will the block with the bullet embedded in it slide on a rough horizontal surface of coefficient of kinetic friction $\mu_k$ before it comes to rest?




(A) $\left(\dfrac{m+M}{m}\right)\left(\dfrac{v^2}{2\mu_k g}\right)$ (B) $\left(\dfrac{m+M}{M}\right)\left(\dfrac{v^2}{2\mu_k g}\right)$ (C) $\left(\dfrac{m+M}{M}\right)^2\left(\dfrac{v^2}{2\mu_k g}\right)$

(D) $\left(\dfrac{m}{m+M}\right)\left(\dfrac{v^2}{2\mu_k g}\right)$ (E) $\left(\dfrac{m}{m+M}\right)^2\left(\dfrac{v^2}{2\mu_k g}\right)$

32. 解：(E)

由動量守恆

$$mv+0=(M+m)v_{M+m}\Rightarrow v_{M+m}=\frac{mv}{M+m}$$

由 $\vec{F}=m\vec{a}$

$$-\mu_k(M+m)g=(M+m)a\Rightarrow a=-\mu_k g$$

由 $v^2=v_0^2+2ax$

$$0=(\frac{mv}{M+m})^2+2(-\mu_k g)x\Rightarrow x=\left(\frac{m}{m+M}\right)^2\left(\frac{v^2}{2\mu_k g}\right)$$

33. An unusual spring has a restoring force of magnitude $F = (2.00\ \text{N/m})x + (1.00\ \text{N/m}^2)x^2$, where x is the stretch of the spring from its equilibrium length. A 3.00 kg object is attached to this spring and released from rest after stretching the spring 1.50 m. If the object slides over a frictionless horizontal surface, how fast is it moving when the spring returns to its equilibrium length?

(A) 5.84 m/s (B) 4.33 m/s (C) 2.06 m/s (D) 5.48 m/s (E) 1.50 m/s

33. 解：(E)

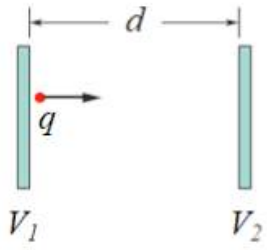
$$W=\int_i^f F dx=\int_0^{1.5}(2x+x^2)dx=3.375=-(U_f-U_i)=-(0-U_i)=U_i$$

由機械能守恆 $E=K+U$

$$0+3.375=\frac{1}{2}\times 3\times v^2+0$$

$$\Rightarrow v=1.5[m/s]$$

37. A charged dust particle of mass $m$ = 32 mg and charge value $q$ =100 nC is releasing from plate 1 with zero speed, where $V_1$=130 V, and $V_2$= –30 V. The dust particle velocity when reaching plate 2 is,



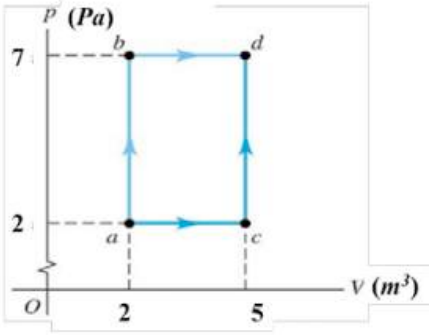

(A) 0.03 m/s (B) 0.05 m/s (C) 0.75 m/s (D) 1.00 m/s (E) 1.25 m/s

37. 解：(D)

$$qV = \frac{1}{2}mv^2$$

$$100\times10^{-9}(160) = \frac{1}{2}\times(32\times10^{-6})v^2 \Rightarrow v = 1[m/s]$$

40. In process *ab*, 20 J of heat is added to the system. In process *bd*, 80 J of heat is added to the system. Find the internal energy change $\Delta U$ in process *acd*?




(A) 0 J (B) 20 J (C) 59 J (D) 79 J (E) 100 J

40. 解：(D)

$$\Delta U_{abd} = \Delta Q_{abd} - \Delta W_{abd}$$
$$= 100 - 21 = 79$$

則 $\Delta U_{abd} = \Delta U_{acd} = 79$

41. The density of wood, water and unknown liquid are 0.8 g/cm$^3$, 1.0 g/cm$^3$, and 1.2 g/cm$^3$, respectively. The volume ratio of the wood that can be seen in water and unknown liquid is

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

41. 解：(D) 更改成(無答案)

$$B = W$$

$$V_{under-w(W)}\times1\times g = V_{O-W}\times0.8\times g \Rightarrow \frac{V_{under-w(W)}}{V_{O-W}} = \frac{0.8}{1} = \frac{4}{5}$$

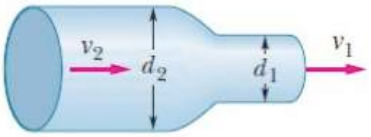
$$V_{under-unknown(W)}\times1.2\times g = V_{O-W}\times0.8\times g \Rightarrow \frac{V_{under-unknown(W)}}{V_{O-W}} = \frac{0.8}{1.2} = \frac{2}{3}$$

浮出比 $\frac{V_{under-w(W)}}{V_{O-W}} : \frac{V_{under-unknown(W)}}{V_{O-W}} = \frac{0.2}{1} : \frac{0.4}{1.2} = \frac{1}{5} : \frac{1}{3}$

The volume ratio of the wood that can be seen in water and unknown liquid is

$$\frac{V_{under-w(W)}}{V_{under-unknown(W)}} = \frac{3}{5}$$

42. Water flows through a horizontal pipe and then out into the atmosphere, where $d_2/d_1 = 2$. The speed of the water at the output of the pipe is $v_1 = 10$ m/s. The density of water is 1g/cm$^3$. What is the gauge pressure at the left section? (1 atm = $1.01 \times 10^5$ Pa )




(A) 4.6 atm (B) 4.8 atm (C) 5.0 atm (D) 5.2 atm (E) 5.4 atm

42. 解：(A) 更改成(無答案)

The speed in the left section of pipe is

$$v_2 = v_1(\frac{A_1}{A_2}) = v_1(\frac{d_1}{d_2})^2 = (10m/s)(\frac{1}{2})^2 = 2.5m/s$$

由白努利方程式 $p_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = p_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$

因為 horizontal pipe，則 $y_1 = y_2$

$$p_1 + \frac{1}{2}\rho v_1^2 = p_2 + \frac{1}{2}\rho v_2^2$$

$$\Rightarrow p_{atm} + \frac{1}{2} \times 1000 \times 10^2 = p_2 + \frac{1}{2} \times 1000 \times 2.5^2$$

gauge pressure at the left section $\Delta p$

$$\Delta p = p_2 - p_{atm} = \frac{1}{2} \times 1000 \times (10^2 - 2.5^2) = 46875[Pa] = 0.46[atm]$$

47. There is a straight current-carrying conductor with current $I$ =10 A and length $L$ = 2 m. What is the magnetic field $\boldsymbol{B}$ of this conductor at the distance 2 m from that? ( $\mu_0$ is permeability constant )

(A) 5 $\mu_0$ (B) 5 $\mu_0$ /π (C) 5 $\mu_0$ /2π (D) $\mu_0$/2π (E) $\mu_0$/π

47. 解：(C) 更改成(無答案)

The condition for the formula of $B = \frac{\mu_0 i}{2\pi r}$ is $r << L$

In this problem $L = 2$ m, $r = 2$m

若導線為無限長，則有

$$B = \frac{\mu_0 i}{2\pi r} = \frac{\mu_0 \times 10}{2\pi \times 2} = \frac{5\mu_0}{2\pi}$$



49. Three charge particles are situated as illustrated. Particle 1 and 2 are fixed, while particle 3 is free to move. If there is no net force on the particle 3, what is the charge ratio $q_2/q_1$?


(A) 2 (B) 2/3 (C) 3 (D) –2/3 (E) –2

49. 解：(D) 更改成(無答案)

$$F_3 = F_{13} + F_{23} = k\frac{q_1 q_3}{(L+2L)^2} + k\frac{q_2 q_3}{(2L)^2} = 0$$

$$\Rightarrow \frac{q_1}{(3L)^2} + \frac{q_2}{(2L)^2} = 0$$

$$\Rightarrow \frac{q_1}{9} = -\frac{q_2}{4}$$

$$\Rightarrow \frac{q_2}{q_1} = -\frac{4}{9}$$

57. A police car chases fugitives on the highway at 144 km/hr, its siren emitting sound at a frequency of 500 Hz. What frequency is heard by a passenger in a car traveling at 108 km/hr in the opposite direction as the police car and car approach each other? Assume the speed of sound in the air is 345 m/s.
(A) 420 Hz (B) 495 Hz (C) 545 Hz (D) 595 Hz (E) 625 Hz

57. 解：(D)更改成（無答案）

$$f' = \left(\frac{v + v_0}{v - v_s}\right) f = \left(\frac{345 + 108 \times \frac{1000}{3600}}{345 - 144 \times \frac{1000}{3600}}\right) \times 500 = 614.7[Hz]$$

58. Two cars are approaching to each other. Car A moves at speed $v_A$= 108.0 km/hr, and the car B at $v_B$= 72.0 km/hr. The car A sends out a horn sound traveling in air with speed of 343 m/s. The horn's sound frequency as detected by the car B is 1000 Hz. The horn's sound frequency that car A sends out is _____.
(A) 1212 Hz (B) 1154 Hz (C) 948 Hz (D) 862 Hz (E) 821 Hz

58. 解：(D)

$$f' = \left(\frac{v + v_0}{v - v_s}\right) f$$

$$1000 = \left(\frac{343 + 72 \times \frac{1000}{3600}}{343 - 108 \times \frac{1000}{3600}}\right) \times f$$

$$\Rightarrow f = 862[Hz]$$

（其他試題解析，歡迎同學參閱今年【物理歷屆試題解析】一書）

**命中事實**

高醫後西醫物理109年第六題　100% 命中

6. Which step is one of the Carnot cycle?
(A) Isobaric compression (B) Isochoric compression (C) Isothermal compression
(D) Isochoric expansion (E) Isobaric expansion

6. 解：(C)

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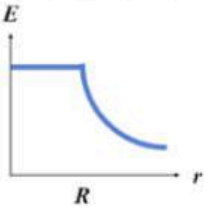
4. The Carnot cycle consists of
(A) two adiabatic processes and two isochoric processes
(B) two isothermal processes and two isobaric processes
(C) two isothermal processes and two adiabatic processes
(D) two isobaric processes and two isochoric processes
(E) None of the above.

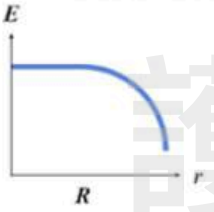
4. 解：(C)

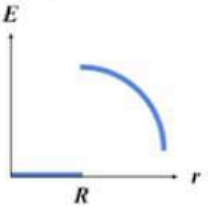
The Carnot cycle consists of two isothermal processes and two adiabatic processes.

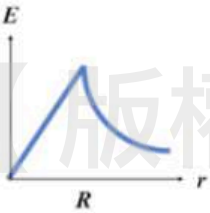
高醫後西醫物理109年第九題　95% 命中

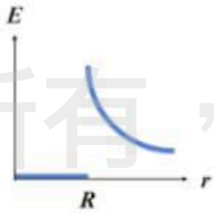
9. There is a solid insulating sphere with radius $R$ and total charge $Q$. Which diagram is correct for electric field $E$ at any point inside or outside the sphere?

(A) 

(B) 

(C) 

(D) 

(E) 


9. 解：(D)

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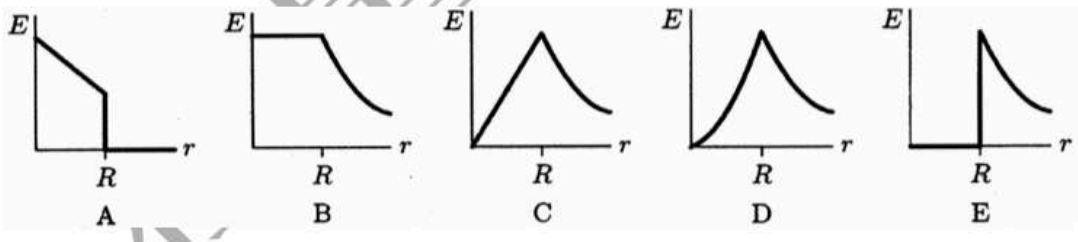
8. Which of the following graphs represents the magnitude of the electric field as a function of E the distance from the E center of a solid charged conducting sphere of radius R?




(A) (B) (C) (D) (E)

高醫後西醫物理109年第十四題 95% 命中

14. Given that the wavelengths of visible light range from 400 nm to 700 nm, what is the highest frequency of visible light? ($c = 3.0 \times 10^8$ m/s)

(A) $3.1 \times 10^8$ Hz (B) $5.0 \times 10^8$ Hz (C) $4.3 \times 10^{14}$ Hz
(D) $7.5 \times 10^{14}$ Hz (E) $2.3 \times 10^{20}$ Hz

14. 解：(D)

高點程量子物理作業28

1. The wavelength of light visible to the human eye is on the order of $5 \times 10^{-7}$ m. If the speed of light in air is $3 \times 10^8$ m/s, find the frequency of the lightwave.

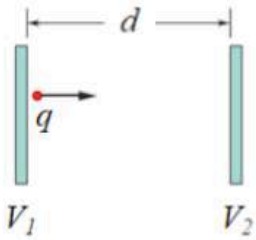
(A) $3 \times 10^7$ Hz (B) $4 \times 10^9$ Hz (C) $5 \times 10^{11}$ Hz (D) $6 \times 10^{14}$ Hz (E) $4 \times 10^{15}$ Hz

1. 解：(D)

$$v = f\lambda$$
$$3 \times 10^8 = f(5 \times 10^{-7})$$
$$\Rightarrow f = 6 \times 10^{14}[Hz]$$

高醫後西醫物理109年第三十七題 90% 命中

37. A charged dust particle of mass $m$ = 32 mg and charge value $q$ =100 nC is releasing from plate 1 with zero speed, where $V_1$=130 V, and $V_2$= –30 V. The dust particle velocity when reaching plate 2 is,




(A) 0.03 m/s (B) 0.05 m/s (C) 0.75 m/s (D) 1.00 m/s (E) 1.25 m/s

37. 解：(D)

高點程量子物理（七百題題庫）

9. What is the speed of a proton that has been accelerated from rest through a potential difference of 4.0 kV?

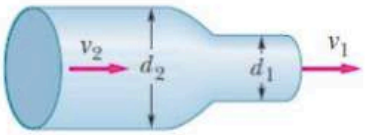
(A) $1.1 \times 10^6$ m/s (B) $9.8 \times 10^5$ m/s (C) $8.8 \times 10^5$ m/s
(D) $1.2 \times 10^6$ m/s (E) $6.2 \times 10^5$ m/s

9. 解：(C)

$$\frac{1}{2}mv^2 = qV$$
$$\Rightarrow \frac{1}{2}(9.11 \times 10^{-31} \times 1836)v^2 = (1.6 \times 10^{-19})(4000)$$
$$\Rightarrow v = 8.7 \times 10^5[m/s]$$

## 高醫後西醫物理109年第四十二題　90% 命中

42. Water flows through a horizontal pipe and then out into the atmosphere, where $d_2/d_1 = 2$. The speed of the water at the output of the pipe is $v_1 = 10$ m/s. The density of water is $1 g/cm^3$. What is the gauge pressure at the left section? (1 atm = $1.01 \times 10^5$ Pa )




(A) 4.6 atm　(B) 4.8 atm　(C) 5.0 atm　(D) 5.2 atm　(E) 5.4 atm

42. 解：(A) 更改成(無答案)

## 高點程量子物理（七百題題庫）

10. Water pressurized to $3.5 \times 10^5$ Pa is flowing at 5.0 m/s in a horizontal pipe which contracts to 1/3 its former area. What are the pressure and velocity of the water after the contraction?

(A) $2.5 \times 10^5$ Pa, 15 m/s　(B) $3.0 \times 10^5$ Pa, 10 m/s　(C) $3.0 \times 10^5$ Pa, 15 m/s
(D) $4.5 \times 10^5$ Pa, 1.5 m/s　(E) $5.5 \times 10^5$ Pa, 1.5 m/s

10. 解：(A)

由 $A_1 v_1 = A_2 v_2$

$A_1(5) = (\frac{1}{3}A_1)v_2 \Rightarrow v_2 = 15[m/s]$

由 $P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$

$3.5 \times 10^5 + \frac{1}{2} \times 1000 \times 5^2 = P_2 + \frac{1}{2} \times 1000 \times 15^2$

$\Rightarrow 3.5 \times 10^5 = P_2 + 100000$

$\Rightarrow P_2 = 2.5 \times 10^5 [Pa]$

80% 命中

高醫後西醫物理109年第四十八題

48. If the displacement current in a parallel-plate capacitor (0.5 μF) is 4.0 A, at what rate is the potential difference varying across the plates?

(A) $2.0 \times 10^6$ V/s (B) $8.0 \times 10^6$ V/s (C) $4.0 \times 10^6$ V/s

(D) $1.25 \times 10^7$ V/s (E) The potential difference is not varying

48. 解：(B)

高點程量子物理（七百題題庫）

26. A 1.2-m radius cylindrical region contains a uniform electric field along the cylinder axis. It is increasing uniformly with time. To obtain a total displacement current of $2.0 \times 10^{-9}$ A through a cross section of the region, the magnitude of the electric field should change at a rate of:

(A) 5.0 V/m·s (B) 12 V/m·s (C) 37 V/m·s

(D) 50 V/m·s (E) $4.0 \times 10^7$ V/m·s

26. 解：(D)

由 $i_d = \varepsilon_0 \frac{d\phi_E}{dt} = \varepsilon_0 \frac{d}{dt} EA$

$$2 \times 10^{-9} = \frac{1}{4\pi \times 9 \times 10^9} \pi (1.2)^2 \frac{dE}{dt}$$

$$\Rightarrow \frac{dE}{dt} = 50[V/m \cdot s]$$

90% 命中

高醫後西醫物理109年第五十一題

51. What is the critical angle when a ray passes from diamond into air? The index of refraction for air and diamond is 1.00 and 2.42, respectively.

(A) 0° (B) 24° (C) 30° (D) 36° (E) 66°

51. 解：(B)



高點程量子物理（七百題題庫）

8. A layer of water ($n = 1.333$) floats on carbon tetrachloride ($n = 1.461$) contained in an aquarium. To the nearest degree, what is the critical angle at the interface between the two liquids?

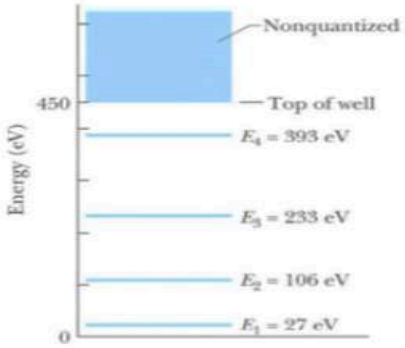
(A) 88° (B) 78° (C) 66° (D) 58° (E) 43°

8. 解：(C)

$$\theta_C = \sin^{-1}\left(\frac{n_1}{n_2}\right) = \sin^{-1}\left(\frac{1.333}{1.461}\right) = 65.78°$$

高醫後西醫物理109年第五十二題 100% 命中

52. The figure shows the energy levels for an electron in a finite potential energy well. If the electron makes a transition from the $n = 3$ state to the ground state, what is the wavelength of the emitted photon?

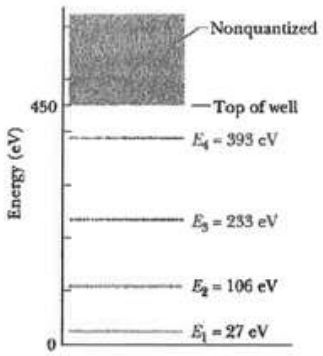



(A) 2.3 nm (B) 3.0 nm (C) 5.3 nm (D) 5.7 nm (E) 6.0 nm

52. 解：(E)

高點程量子物理（實戰解析）第三十七題

37. The right figure shows the energy levels for an electron in a finite potential energy well. If the electron makes a transition from the $n$= 3 state to the ground state, what is the wavelength of the emitted photon?




(A) 6.0 nm (B) 5.7 nm (C) 5.3 nm
(D) 3.0 nm (E) 2.3 nm

37. 解：(A)

$$233 - 27 = \frac{1240}{\lambda} \Rightarrow \lambda = 6.01[nm]$$

高醫後西醫物理109年第五十三題 80% 命中

53. Light of wavelength 500 nm is incident upon a single slit with width $2 \times 10^{-4}$ m. The diffraction pattern is observed on a screen positioned 4 m from the slit. Determine the distance of the second dark fringe from the central peak.

(A) 0.01 m (B) 0.02 m (C) 0.03 m (D) 0.04 m (E) 0.05 m

53. 解：(B)

高點程量子物理（總複習）複習題庫

37. For diffraction of waves by a single slit of width $a$ at a distance $D$ from the screen, which is right?
(A) the first maximum occurs at $a\sin\theta = \lambda$,
(B) smaller $a$ will result in larger separations between minima,
(C) the intensity of each maximum is the same,
(D) the diffraction is more easily observed for lights of shorter wavelength than those of longer wavelength,
(E) the first maximum occurs at $a\sin\theta = \lambda/2$.

37. 解：(B)

$$a\frac{y}{D} = m\lambda \Rightarrow y = \frac{Dm\lambda}{a}$$

高醫後西醫物理109年第五十四題 90% 命中

54. Unpolarized light can be polarized, either partially or totally, by reflection. What is the polarizing angle when a ray passes from diamond into air? The index of refraction for air and diamond is 1.00 and 2.42, respectively.
(A) 0° (B) 22° (C) 31° (D) 42° (E) 66°
54. 解：(B)

高點程量子物理（七百題題庫）

39. Sunlight reflected from a smooth ice surface is completely polarized. Determine the angle of incidence. ($n_{ice} = 1.31$.)
(A) 52.6° (B) 25.6° (C) 65.2° (D) 56.2° (E) 49.8°
39. 解：(A)

$$\theta_B = \tan^{-1}\left(\frac{n_2}{n_1}\right) = \tan^{-1}\left(\frac{1.31}{1}\right) = 52.6°$$

高醫後西醫物理109年第五十六題 100% 命中

56. The work function for a certain sample is 2.3 eV. The stopping potential for electrons ejected from the sample by $6.0 \times 10^{14}$ Hz electromagnetic radiation is ($c = 3.00 \times 10^8$ m/s):
(A) 0 V (B) 0.18 V (C) 0.36 V (D) 2.0 V (E) 3.6 V
56. 解：(B)

高點程量子物理（總複習）複習題庫

5. The work function for a certain sample is 2.3 eV. The stopping potential for electrons ejected from the sample by $7.0 \times 10^{14}$-Hz electromagnetic radiation is:
(A) 0 V (B) 0.60 V (C) 2.3 V (D) 2.9 V (E) 5.2 V
5. 解：(B)

$$eV = h\nu - e\phi$$

$$eV = \frac{6.63 \times 10^{-34} \times 7 \times 10^{14}}{1.6 \times 10^{-19}} - 2.3 = 0.6[eV]$$

高醫後西醫物理109年第五十七題 95% 命中

57. A police car chases fugitives on the highway at 144 km/hr, its siren emitting sound at a frequency of 500 Hz. What frequency is heard by a passenger in a car traveling at 108 km/hr in the opposite direction as the police car and car approach each other? Assume the speed of sound in the air is 345 m/s.
(A) 420 Hz (B) 495 Hz (C) 545 Hz (D) 595 Hz (E) 625 Hz
57. 解：(D)更改成(無答案)

$$f' = \left(\frac{v + v_0}{v - v_s}\right) f = \left(\frac{345 + 108 \times \frac{1000}{3600}}{345 - 144 \times \frac{1000}{3600}}\right) \times 500 = 614.7[Hz]$$

高點程量子物理（總複習）複習題庫

6. A speedboat moving at 20.6 m/s sounds a signal on its horn, producing a tone of 320 Hz. There is no wind, and the speed of sound in air is 329 m/s. The apparent frequency of the sound heard by an observer in another boat moving in the opposite direction and approaching the first at a speed of 15.4 m/s is
(A) 282 Hz (B) 287 Hz (C) 316 Hz (D) 357 Hz (E) 369 Hz.

6. 解：(D)

$$f' = \left(\frac{329 + 15.4}{329 - 20.6}\right) \times 320 = 357[H_z]$$

90% 命中

高醫後西醫物理109年第五十九題

59. The wave function of the string wave is given by $y(x,t) = 0.2m \times h\left[\left(20m^{-1}\right)x + \left(10s^{-1}\right)t\right]$, where h denotes a general function. The speed of a wave is _____.
(A) 2 m/s (B) 1.5 m/s (C) 1 m/s (D) 0.5 m/s (E) 0.25 m/s
59. 解：(D)



高點程量子物理練習卷28第二題

2. The following functional form, $A\sin(kx + \omega t)$, represents a wave traveling along a string on the $x$-axis with a linear density, $\mu$. What is the wave velocity?
(A) $-\omega/k$ (B) $k/\omega$ (C) $A/\mu$ (D) $(A/\mu)^{1/2}$ (E) None of the above.
2. 解：(A)

$$kx + \omega t = -(-kx - \omega t) \Rightarrow -\hat{x}$$
$$\vec{v} = -\omega/k\hat{x}$$

80% 命中

高醫後西醫物理109年第六十題

60. A standing sound wave pattern on a long string is described by $y(x,t)=0.008\times\sin(10\pi x)\cos(20\pi t)$ (all in SI unit). The distance between two nodes is ____.
(A) 0.1 m (B) 0.2 m (C) 0.3 m (D) 0.4 m (E) 0.5 m
60. 解：(A)

高點程量子物理（總複習）複習題庫

41. The transverse displacement of a standing wave on a string is given by
$$y(x,t) = 4\sin(0.5x)\cos(30t),$$
where $x$ and $y$ are in centimeters (cm). What is the wave speed of component waves?
(A) 10 cm/s (B) 15 cm/s (C) 30 cm/s (D) 60 cm/s (E) 120 cm/s.

41. 解：(D)

$$v=\frac{\omega}{k}=\frac{30}{0.5}=60[cm/s]$$