马来西亚留台成功大学校友会

主　办

2013 年

第三十届全国华文独中数理学识比赛

考生指示：

(一) 解答所有问题。

(二) 将正确答案在答案纸上的圆圈内「塗黑」，每题只准给一个答案。

(三) 正确的答案得三分，错误的答案扣一分，不做答的零分。

INSTRUCTIONS TO CANDIDATES

1. **Attempt all questions.**

2. **Pick the correct answer and make a mark "X" in the circle provided in the answer sheet. Only one answer is allowed for each question.**

3. **Three marks for a correct answer, one mark will be deducted for each wrong answer. No mark will given to each question not attempted.**

2013　全国华文独中数理学识比赛　物理考题

(1) 物體以初速 $\vec{v}_0 = 3\hat{x} + 4\hat{y}$ (m/s) 運動. 如果重力加速度為 $\vec{g} = -9.8\hat{y}$ (m/s^2) 而且開始物體的位置為原點 $\vec{x}(0) = \vec{0}$. 它的速度 $v_y = 0$ 時的位置為:

(a) $(1.2, 0.81)$　(b) $(1.4, 0.81)$　(c) $(0.6, 0.63)$　(d) $(1.2, 2.40)$　(e) 以上皆非.

An object in moving above ground with initial velocity $\vec{v}_0 = 3\hat{x} + 4\hat{y}$ (m/s). Assuming the gravitational acceleration $\vec{g} = -9.8\hat{y}$ (m/s^2) and the starting position $\vec{x}(0) = \vec{0}$. Its position at $v_y = 0$ is

(a) $(1.2, 0.81)$　(b) $(1.4, 0.81)$　(c) $(0.6, 0.63)$　(d) $(1.2, 2.40)$　(e) None of the above.

(2) 月球繞地球作圓周運動, 其週期 T 為 28 天. 已知它與地球的距離為 4×10^5 (km), 則地球所造成月球的重力加速度為:

(a) 2×10^4 (km/s^2)　(b) 165 (m/s^2)　(c) 7.2×10^{-4} (km/s^2)

(d) 2.7×10^{-6} (m/s^2)　(e) 1.6×10^{-8} (km/s^2).

The moon is moving around the Earth with a period $T = 28$ (days). If the distance between the moon and the Earth is 4×10^5 (km). The gravitational acceleration produced by the earth on the moon's position is

(a) 2×10^4 (km/s^2)　(b) 165 (m/s^2)　(c) 7.2×10^{-4} (km/s^2)

(d) 2.7×10^{-6} (m/s^2)　(e) 1.6×10^{-8} (km/s^2).

(3) 一個物體作簡諧振盪 $x(t) = x_0 \sin \omega t$. 則 $t = \dfrac{7\pi}{2\omega}$ 時該物體的加速度為:

(a) ωx_0　(b) $\dfrac{1}{2}\omega^2 x_0$　(c) $-\dfrac{1}{2}\omega^2 x_0$　(d) $-\dfrac{\sqrt{3}}{2}\omega^2 x_0$　(e) $\omega^2 x_0$.

An object is vibrating with frequency f. Its position is given by $x(t) = x_0 \sin \omega t$. Its acceleration at $t = \dfrac{7\pi}{2\omega}$ is

(a) ωx_0　(b) $\dfrac{1}{2}\omega^2 x_0$　(c) $-\dfrac{1}{2}\omega^2 x_0$　(d) $-\dfrac{\sqrt{3}}{2}\omega^2 x_0$　(e) $\omega^2 x_0$.

(4) 一個球在直線上做運動, 如果它的位能為 $V(x) = \lambda x^4$, 則 λ 的單位為 (J = Joule)

(a) J　(b) J $\cdot$ s　(c) J/m^4　(d) J^2　(e) 以上皆非.

A ball is moving on a straight line. If its potential energy is $V(x) = \lambda x^4$, the unit of λ is (J = Joule)

(a) J　(b) J $\cdot$ s　(c) J/m^4　(d) J^2　(e) None of the above.

(5) 兩個球在一個平面上進行彈性碰撞. 如果它們的質量相等, $m_A = m_B$, 而且碰撞之前 $\vec{v}_A \cdot \vec{v}_B = 0$. 以下哪一個敘述為不正確

(a) $v_A^2+v_B^2=v_A'^2+v_B'^2$ (b) $\vec{v}_A+\vec{v}_B=\vec{v}_A'+\vec{v}_B'$ (c) $\vec{v}_A'\cdot\vec{v}_B'\neq 0$ (d) $\vec{v}_A'\cdot\vec{v}_B'=0$ (e) 如果 $\vec{v}_B=0$, 則 $\vec{v}_A'\cdot\vec{v}_B'=0$.

Two billiard balls moving on a flat surface are colliding elastically. It $m_A=m_B$ and before colliding their velocities satisfy $\vec{v}_A\cdot\vec{v}_B=0$. The incorrect statement is

(a) $v_A^2+v_B^2=v_A'^2+v_B'^2$ (b) $\vec{v}_A+\vec{v}_B=\vec{v}_A'+\vec{v}_B'$ (c) $\vec{v}_A'\cdot\vec{v}_B'\neq 0$ (d) $\vec{v}_A'\cdot\vec{v}_B'=0$ (e) If $\vec{v}_B=0$, then $\vec{v}_A'\cdot\vec{v}_B'=0$.

(6) 一質量懸掛在一根繩子上作單擺運動, 其週期為 T(ℓ 為繩子的長度). 假設現在把 ℓ 改為 2ℓ, 則新的週期 T' 為:

(a) T (b) $2T$ (c) $\dfrac{T}{2}$ (d) $4T$ (e) $\sqrt{2}T$

A mass suspended on a string is swinging like a pendulum with period T (ℓ is the length of the string). If the string length become 2ℓ, then the new period T' is

(a) T (b) $2T$ (c) $\dfrac{T}{2}$ (d) $4T$ (e) $\sqrt{2}T$

(7) 一靜止物體突然爆裂成兩個相同的碎片 A 與 B. 下列敘述何者正確:

(a) $\vec{v}_A=\vec{v}_B$ (b) $|\vec{v}_A|=-|\vec{v}_B|$ (c) $\vec{v}_A=-\vec{v}_B$ (d) $v_A^2=-v_B^2$ (e) 以上皆非.

A object at rest is suddenly explored into two identical pieces A and B. Which of the following statements is correct

(a) $\vec{v}_A=\vec{v}_B$ (b) $|\vec{v}_A|=-|\vec{v}_B|$ (c) $\vec{v}_A=-\vec{v}_B$ (d) $v_A^2=-v_B^2$ (e) None of the above.

(8) 一質量 1 (kg) 的物體在 $t=0$ 時受一個定力 $\vec{F}=3\hat{x}+4\hat{y}$ (N) 運動. 如果它的初速為 0 則一秒後的位移 $\vec{x}$ 為

(a) $3\hat{x}+4\hat{y}$ (b) $1.5\hat{x}-8\hat{y}$ (c) $6\hat{x}+4\hat{y}$ (d) $1.5\hat{x}+2\hat{y}$ (e) $1.5\hat{x}-2\hat{y}$ (m).

A object with mass 1 (kg) starting at the origin is under the influence of a constant force $\vec{F}=3\hat{x}+4\hat{y}$ (N). If it starts from rest, its displacement $\vec{x}$ after 1 second is

(a) $3\hat{x}+4\hat{y}$ (b) $1.5\hat{x}-8\hat{y}$ (c) $6\hat{x}+4\hat{y}$ (d) $1.5\hat{x}+2\hat{y}$ (e) $1.5\hat{x}-2\hat{y}$ (m).

(9) 1 (kg) 的質點在地球表面上運動 (假設沒有摩擦力) 了 10 (m). 則萬有引力對它所作的功為:

(a) 98 (J) (b) 0 (c) 9.8 (J) (d) 49.5 (J) (e) 以上皆非.

A piece of mass (1 kg) is moving on a horizontal frictionless floor. If it travels a distance 10 (m), the work done by gravity is

(a) 98 (J) (b) 0 (c) 9.8 (J) (d) 49.5 (J) (e) None of the above.

(10) 質量為 m 及電荷為 q 的粒子在均匀磁場 $\vec{B} = B\hat{z}$ 中運動. 如果運動被限制在 xy 平面上則粒子的角速率為

(a) $-\dfrac{qB}{m}$ (b) $\dfrac{qm}{B}$ (c) $\dfrac{qB}{m}$ (d) mqB (e) 以上皆非.

A particle with mass m and charged q is moving in an uniform magnetic field $\vec{B} = B\hat{z}$. If the motion is confined on the xy plane, the angular speed of the particle is

(a) $-\dfrac{qB}{m}$ (b) $\dfrac{qm}{B}$ (c) $\dfrac{qB}{m}$ (d) mqB (e) None of the above.

(11) 三個電荷 q_1, q_2, 及 q_3 的座標分別為 $(0, a)$, $(0, -a)$ 及 $(0, 0)$. 如果 $q_1 > 0$, $q_1 = q_2 = -\dfrac{q_3}{2}$, 則在正 x 軸上任何一點的電場方向為

(a) $\hat{x}$ (b) $\hat{x} + \hat{y}$ (c) $\hat{x} - \hat{y}$ (d) $-\hat{x}$ (e) $\hat{y}$

Three charges q_1, q_2 and q_3 are located at $(0, a)$, $(0, -a)$ and $(0, 0)$ respectively. If $q_1 > 0$ and $q_1 = q_2 = -\dfrac{q_3}{2}$, the direction of the electric field of any point on the positive x-axis is

(a) $\hat{x}$ (b) $\hat{x} + \hat{y}$ (c) $\hat{x} - \hat{y}$ (d) $-\hat{x}$ (e) $\hat{y}$

(12) 一個導體實心電荷球的半徑為 R 及電荷為 Q, 則在球心的電場為:

(a) $\vec{E} = 0$ (b) $\vec{E} = \dfrac{Q\vec{R}}{4\pi\epsilon_0 R^3}$ (c) $\vec{E}$ 為均匀的 (d) $\vec{E} = \dfrac{Q\vec{R}}{4\pi\epsilon_0 R^2}$ (e) 以上皆非.

A conducting solid sphere of radius R has a charge Q, the electric field at the center is

(a) $\vec{E} = 0$ (b) $\vec{E} = \dfrac{Q\vec{R}}{4\pi\epsilon_0 R^3}$ (c) $\vec{E}$ is uniform (d) $\vec{E} = \dfrac{Q\vec{R}}{4\pi\epsilon_0 R^2}$ (e) None of the above.

(13) 三個相等的電荷 q 被放在一個等邊三角形 (邊長為 L) 的頂點上, 則在三角形的中心點上的電位為

(a) 0 (b) $\dfrac{3Q}{4\pi\epsilon_0 L}$ (c) $\dfrac{\sqrt{3}Q}{4\pi\epsilon_0 L}$ (d) $\dfrac{Q}{4\pi\epsilon_0\sqrt{3}L}$ (e) $\dfrac{3\sqrt{3}Q}{4\pi\epsilon_0 L}$.

Three equal charges (q) are located at the vertices of an equilateral triangle and the length of each side is L. The electric potential at the center of the triangle is

(a) 0 (b) $\dfrac{3Q}{4\pi\epsilon_0 L}$ (c) $\dfrac{\sqrt{3}Q}{4\pi\epsilon_0 L}$ (d) $\dfrac{Q}{4\pi\epsilon_0\sqrt{3}L}$ (e) $\dfrac{3\sqrt{3}Q}{4\pi\epsilon_0 L}$.

(14) 在 xy 平面上有兩個相等半徑的電流環 (半徑為 R). 如果它們的圓心距離為 $d(d > 2R)$ 而且電流均為順時鐘方向. 則他們之間的磁力為

(a) 吸引的 (b) 排斥的 (c) 零 (d) 在 $\hat{z}$ 方向 (e) 以上皆非.

Two current rings of the same radius R which are located on the xy plane has a distance d between their center ($d > 2R$). If the currents are both flowing clockwise, the magnetic force between them is

(a) attractive (b) repulsive (c) zero (d) in the $\hat{z}$ direction (e) None of above.

(15) 兩個電阻 R_1 及 R_2 以並聯連接. 若 $R_1 = 2R_2$, 則每一個電阻上所消耗的功率 P_1 及 P_2 有以下關係:

(a) $P_1 = P_2$ (b) $P_1 > P_2$ (c) $P_1 < P_2$ (d) $P_1 = 2P_2$ (e) $P_1 = \dfrac{P_2}{4}$.

Two resistors R_1 and R_2 are connected in parallel. If $R_1 = 2R_2$, the power dissipated on each of them is P_1 and P_2. Then we have

(a) $P_1 = P_2$ (b) $P_1 > P_2$ (c) $P_1 < P_2$ (d) $P_1 = 2P_2$ (e) $P_1 = \dfrac{P_2}{4}$.

(16) 已知電磁波具有電場及磁場. 如果電磁波照射在金屬表面上, 則表面上的電子所受的電力 F_e 及磁力 F_m 有以下關係:

(a) $F_e = F_m$ (b) $F_e > F_m$ (c) $F_b > F_e$ (d) $\vec{F}_e \cdot \vec{F}_m = 0$ (e) 以上皆非.

We know that electromagnetic wave contains electric field and magnetic field. If the electromagnetic wave is shining on the electrons on the surface of a conductor (metal). The relation between the electric force F_e and magnetic force F_m on the electrons is

(a) $F_e = F_m$ (b) $F_e > F_m$ (c) $F_b > F_e$ (d) $\vec{F}_e \cdot \vec{F}_m = 0$ (e) None of the above.

(17) 正電荷 q_1 以 $\dfrac{1}{2}mv^2$ 的能量從無窮遠處與一個原子核 (電荷為 $q_2 > 0$) 作正面碰撞. 則兩電荷之間的最小距離 R_m 為

(a) $\dfrac{q_1 q_2}{4\pi\epsilon_0 mv^2}$ (b) $\dfrac{q_1 q_2}{v^2}$ (c) $\dfrac{mv^2}{4\pi\epsilon_0 q_1 q_2}$ (d) $\dfrac{q_1 q_2}{2\pi\epsilon_0 mv^2}$ (e) 以上皆非.

A positive charge q_1 of energy $\dfrac{1}{2}mv^2$ is coming from infinity to collide with a nucleus of charge $q_2 > 0$. The closest distance R_m between these charges is

(a) $\dfrac{q_1 q_2}{4\pi\epsilon_0 mv^2}$ (b) $\dfrac{q_1 q_2}{v^2}$ (c) $\dfrac{mv^2}{4\pi\epsilon_0 q_1 q_2}$ (d) $\dfrac{q_1 q_2}{2\pi\epsilon_0 mv^2}$ (e) None of the above.

(18) 兩片平行導體板 A 與 B 之間有一個電位差 V. 如果板之間的距離為 d, 則板間任何一點的電場為 (x 為對 A 板的距離):

(a) Vd (b) $\dfrac{V}{d}$ (c) $\dfrac{Vx}{d^2}$ (d) $\dfrac{Vd}{x^2}$ (e) $\dfrac{Vd}{x}$.

Two parallel conducting plates A and B have a potential difference V between them. If the distance between the plates is d them, the n the electric field $\vec{E}$ in between the plates is (where x is the distance measured from plate A)

(a) Vd (b) $\dfrac{V}{d}$ (c) $\dfrac{Vx}{d^2}$ (d) $\dfrac{Vd}{x^2}$ (e) $\dfrac{Vd}{x}$.

(19) 一個半徑為 R 的金屬環上帶有電流 I. 則環心上的磁場為:

(a) 0 (b) $\dfrac{\mu_0 I}{R}$ (c) $\dfrac{\mu_0 I^2}{R}$ (d) $\dfrac{\mu_0 I}{2R}$ (e) $\dfrac{\mu_0 I}{2\pi R}$.

A conducting ring of radius R carries eletric current I. The magnetic field at the center of

the ring is

(a) 0 (b) $\frac{\mu_0 I}{R}$ (c) $\frac{\mu_0 I^2}{R}$ (d) $\frac{\mu_0 I}{2R}$ (e) $\frac{\mu_0 I}{2\pi R}$.

(20) 溫度為 T 的一莫耳理想氣體的能量為 $E = \frac{3}{2}RT$, 其中 R 為理想氣體常數. 則它的比熱為:

(a) $\frac{3}{2}R$ (b) $\frac{1}{2}R$ (c) $\frac{2}{3}R$ (d) R (e) 以上皆非.

The energy of one mole of ideal gas is $E = \frac{3}{2}RT$, where R is the ideal gas constant and T is its temperature. The specific heat per mole is

(a) $\frac{3}{2}R$ (b) $\frac{1}{2}R$ (c) $\frac{2}{3}R$ (d) R (e) None of the above.

(21) 把 1 (kg) 的 0°C 冰融化並加熱至 100°C 的水所需要的熱量為

(a) 10^5 (cal) (b) 1.8×10^5 (cal) (c) 8×10^5 (cal) (d) 1.8×10^3 (cal) (e) 10^3 (cal).

To melt 1 (kg) of ice at 0°C and then heating the water to 100°C, the amount of heat absorbs in this process is

(a) 10^5 (cal) (b) 1.8×10^5 (cal) (c) 8×10^5 (cal) (d) 1.8×10^3 (cal) (e) 10^3 (cal).

(22) 愛因斯坦提出每一個頻率為 f 的光子其能量 $E = hf$, 其中 $h = 6.6 \times 10^{-34}$ (J-s) (普朗克常數). 則一個 60 (W) 的燈泡而言, 假設發出光的頻率為 10^{15} (Hz), 則每秒發出的光子數約為:

(a) 10 (b) 10^{18} (c) 10^2 (d) 10^{20} (e) 10^{30}.

Einstein propose that each photon carries energy $E = hf$ where $h = 6.6 \times 10^{-34}$ (J-s) (Planck's constant) and f is the frequency of the electromagnetic wave. For a 60 (W) light bulb, if the frequency of the emitting light is 10^{15} (Hz) then the number of photons emitted per second is about

(a) 10 (b) 10^{18} (c) 10^2 (d) 10^{20} (e) 10^{30}.

(23) 波可以傳送能量. 則波的功率 P 與波的振幅 A 的關係為

(a) A^2 (b) A (c) A^3 (d) $\sqrt{A}$ (e) 以上皆非.

Wave can transport energy. The power of wave P is related to the wave amplitude A as

(a) A^2 (b) A (c) A^3 (d) $\sqrt{A}$ (e) None of the above.

(24) 德波意 (de Broglie) 提出物質也有波的性質. 對能量為 E 動量為 p 的粒子, 它所對應的頻率 f 及波長 λ 為 $f = \frac{E}{h}$ 及 $\lambda = \frac{h}{p}$, 其中 $h = 6.6 \times 10^{-34}$ (J-s). 如果質量 $m = 9.1 \times 10^{-31}$ (kg) 的電子, 它的波長 $\lambda = 10^{-10}$ (nm), 則它對應的能量數量級為

(a) 10^{-17} (J) (b) 10 (eV) (c) 10^3 (eV) (d) 10^{-12} (J) (e) 10^{-24} (J).

de Broglie propose that matter also behaves as a wave. For a particle of energy E and

momentum p, the corresponding frequency f and wave length λ are given by $f = \dfrac{E}{h}$ and $\lambda = \dfrac{h}{p}$ where $h = 6.6 \times 10^{-34}$ (J-s). For an electron of mass $m = 9.1 \times 10^{-31}$ (kg) if $\lambda = 10^{-10}$ (nm) the corresponding energy for that electron is the order of

(a) 10^{-17} (J) (b) 10 (eV) (c) 10^{3} (eV) (d) 10^{-12} (J) (e) 10^{-24} (J).

(25) 氦原子核中有兩個質子. 要能克服它們之間的靜電排斥力, 則質子之間應該還有一個吸引力來維持他們留在原子核中. 這個力被稱為核力. 則核力的大小約為:

(a) $100 \sim 10^{3}$ (N) (b) $10^{-3} \sim 10^{-4}$ (N) (c) 10^{10} (N) (d) 1 (N) (e) 以上皆非.

Two protons are bound inside the Helium nucleus. In order to balance the electric repulsive force, there must be an extra attractive force between the protons. This is known as nucleus force. The magnitude range of this nuclear force for these protons is

(a) $100 \sim 10^{3}$ (N) (b) $10^{-3} \sim 10^{-4}$ (N) (c) 10^{10} (N) (d) 1 (N) (e) None of the above.