



馬來西亞留台成功大學校友會
主 辦
2025 年
第四十屆成大數理比賽

考生指示：

- (一) 解答所有問題。
- (二) 將正確答案在答案紙上的圓圈內“塗黑”，每題只准給一個答案。
- (三) 正確的答案得三分，錯誤的答案扣一分，不做答的零分。

INSTRUCTIONS TO CANDIDATES

1. Attempt all questions.
2. Pick the correct answer and make a mark “●” 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 be given to each question not attempted.

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1. 一輛加速行駛的賽車，在 60 米的距離內將速度從 10 米/秒提高到 30 米/秒。這需要多長時間？

A racing car traveling with constant acceleration increases its velocity from 10 m/s to 30 m/s over a distance of 60 m. How long does this take?

(A) 2.0 s (秒) (B) 3.0 s (秒) (C) 4.0 s (秒) (D) 5.0 s (秒) (E) 6.0 s (秒)

2. 一塊質量為 $m_1 = 2 \text{ kg}$ 的物體被放置在質量為 $m_2 = 4 \text{ kg}$ 的物體上面。下方的物體位於無摩擦力的表面，有 1 水平力 $F_0 = 30 \text{ N}$ 施在 m_2 上。防止上方物體相對於下方物體滑動，所需的靜摩擦係數 μ_s 的最小值是多少？（取 $g = 10 \text{ m/s}^2$ ）

A block of mass $m_1 = 2 \text{ kg}$ is placed on top of another block of mass $m_2 = 4 \text{ kg}$. The lower block rests on a frictionless horizontal surface and is subject to a horizontal force $F_0 = 30 \text{ N}$. What is the minimum value of the coefficient of static friction μ_s required to prevent the top block from slipping relative to the lower block? (take $g = 10 \text{ m/s}^2$)

(A) 0.5 (B) 1.0 (C) 1.5 (D) 2.0 (E) No such minimum exists

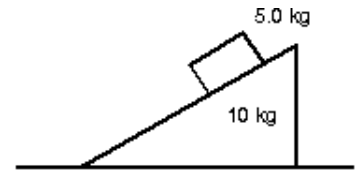
3. 質量為 m 的物體，最初以 v 的速度在水平無摩擦表面上向右移動。然後它壓縮了彈簧常數 k 的彈簧。此刻，當物體的動能等於彈簧的勢能時，彈簧被壓縮的距離：

A block of mass m is initially moving to the right on a frictionless horizontal surface with velocity v . It then compresses a spring with spring constant k . At the instant when the kinetic energy of the block is equal to the potential energy of the spring, the spring is compressed by a distance:

(A) $v\sqrt{m/2k}$ (B) $v\sqrt{m/k}$ (C) $v\sqrt{2m/k}$ (D) $\sqrt{m/k} v/2$ (E) $(1/4)\sqrt{mv/k}$

4. 一個質量為 10 公斤的木塊放在水平無摩擦力的表面上。如圖所示，一個質量為 5.0 公斤的物體從靜止開始滑下木塊的粗糙傾斜表面。在某一時刻，該物體的垂直速度分量為向下 3.0 米/秒，水平速度分量為向左 6.0 米/秒（相對於地面）。那一刻，木塊的速度是多少？

A wedge of mass 10 kg rests on a horizontal, frictionless surface. A block of mass 5.0 kg starts from rest and slides down the rough inclined surface of the wedge, as shown in the figure. At a certain instant, the block's vertical velocity component is 3.0 m/s downward, and its horizontal velocity component (relative to the ground) is 6.0 m/s towards the left. What is the velocity of the wedge at that instant?



- (A) 3.0 m/s, towards left (米/秒, 向左)
(B) 3.0 m/s, towards right (米/秒, 向右)
(C) 6.0 m/s, towards right (米/秒, 向右)
(D) 6.0 m/s, towards left (米/秒, 向左)
(E) 4 m/s, towards left (米/秒, 向左)

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5. 如圖所示，溜溜球置於水平無摩擦力的表面上。將繩子纏繞在轉軸上，並切向延伸超過頂部。向圖中所示方向拉動繩子施加水平力 $\vec{F}$ 。溜溜球：

A yo-yo rests on a horizontal, frictionless surface, with its string wrapped around the axle and extending tangentially over the top, as shown in the diagram. A horizontal force $\vec{F}$ is applied by pulling the string in the direction as shown. The yo-yo:

- (A) 向左移動並逆時針旋轉
moves to the left and rotates counterclockwise
- (B) 向右移動並逆時針旋轉
moves to the right and rotates counterclockwise
- (C) 向左移動並順時針旋轉
moves to the left and rotates clockwise
- (D) 向右移動並順時針旋轉
moves to the right and rotates clockwise
- (E) 向右移動無轉動
moves to the right and does not rotate



6. 在行星運動中，從恆星到行星的連線在相等的時間內會掃過相等的面積。這個結果源於以下哪一項原理？

In planetary motion, the line connecting the star and the planet sweeps out equal areas during equal time intervals. This is a direct consequence of:

- (A) 能量守恆 the conservation of energy
- (B) 動量守恆 the conservation of momentum
- (C) 角動量守恆 the conservation of angular momentum
- (D) 質量守恆 the conservation of mass
- (E) 以上皆非 none of the above

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7. 一顆人造衛星從半徑為 R 的圓形軌道轉移到半徑為 $2R$ 的圓形軌道。在此過程中：

An artificial Earth satellite is moved from a circular orbit with radius R to a circular orbit with radius $2R$. During this transition:

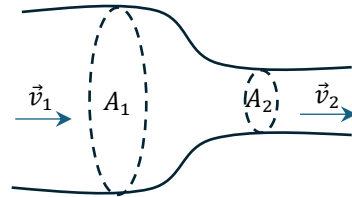
- (A) 重力做正功，衛星的動能增加，地球-衛星系統的位能增加
the gravitational force does positive work, the kinetic energy of the satellite increases, and the potential energy of the Earth-satellite system increases
- (B) 重力做正功，衛星的動能增加，地球-衛星系統的位能減少
the gravitational force does positive work, the kinetic energy of the satellite increases, and the potential energy of the Earth-satellite system decreases
- (C) 重力做正功，衛星的動能減少，地球-衛星系統的位能增加
the gravitational force does positive work, the kinetic energy of the satellite decreases, and the potential energy of the Earth-satellite system increases
- (D) 重力做負功，衛星的動能增加，地球-衛星系統的位能減少
the gravitational force does negative work, the kinetic energy of the satellite increases, and the potential energy of the Earth-satellite system decreases
- (E) 重力做負功，衛星的動能減少，地球-衛星系統的位能增加
the gravitational force does negative work, the kinetic energy of the satellite decreases, and the potential energy of the Earth-satellite system increases
8. 一個裝滿密度為 ρ 不可壓縮液體的水桶，靜置在電梯的地板上。若電梯以加速度 a 向上加速，則在液體中兩點垂直距離為 Δh 的壓力差是多少？
A bucket filled with an incompressible fluid of density ρ rests on the floor of an elevator. If the elevator accelerates upward with acceleration a , what is the pressure difference between two points in the fluid separated by a vertical distance Δh ?
- (A) $\rho a \Delta h$ (B) $\rho g \Delta h$ (C) $\rho(g + a) \Delta h$ (D) $\rho(g - a) \Delta h$ (E) $\rho g a \Delta h$
9. 水流經水平放置的縮口水管。當水進入縮口時，水的：
Water flows through a constriction in a horizontal pipe. As it enters the constriction, the water's:
- (A) 速率增加壓力減少 speed increases and pressure decreases
- (B) 速率增加壓力保持常數 speed increases and pressure remains constant
- (C) 速率增加壓力增加 speed increases and pressure increases
- (D) 速率減少壓力增加 speed decreases and pressure increases
- (E) 速率減少壓力減少 speed decreases and pressure decreases
10. 設 U 為簡諧振子的勢能（以位移為零為零勢能的基準）而 K 為其動能。 U_{avg} 與 K_{avg} 分別表示一個週期內的平均勢能與平均動能。則：
Let U be the potential energy (with zero potential energy at zero displacement), and K be the kinetic energy of a simple harmonic oscillator. U_{avg} and K_{avg} are the average values over a cycle. Then:
- (A) $K_{\text{avg}} > U_{\text{avg}}$ (B) $K_{\text{avg}} < U_{\text{avg}}$ (C) $K + U = 0$ (D) $K = 0$ when (當) $U = 0$ (E) $K_{\text{avg}} = U_{\text{avg}}$

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11. 如圖所示，一種不可壓縮的液體沿著管道流動。其流速比 v_2/v_1 為：

An incompressible liquid flows along the pipe, as shown in the diagram. The ratio of the speeds v_2/v_1 :

- A) A_1/A_2 B) A_2/A_1 C) $\sqrt{A_1/A_2}$ D) $\sqrt{A_2/A_1}$ E) 1



12. 當某條弦的兩端固定時，其最低的四個共振頻率為 50、100、150 和 200 赫茲。若該弦的中點也被固定，則其最低的四個共振頻率為：

When a certain string is clamped at both ends, the lowest four resonant frequencies are 50, 100, 150, and 200 Hz. When the string is also clamped at its midpoint, the lowest four resonant frequencies are:

- (A) 50, 100, 150, and (和) 200 Hz (赫茲)
 (B) 50, 150, 250, and (和) 300 Hz (赫茲)
 (C) 100, 200, 300, and (和) 400 Hz (赫茲)
 (D) 25, 50, 75, and (和) 100 Hz (赫茲)
 (E) 75, 150, 225, and (和) 300 Hz (赫茲)

13. 都卜勒效應中，接收到的頻率公式為：

$$f' = f \frac{v_0 \pm v_D}{v_0 \mp v_S}$$

其中， f 是發射頻率， v_0 是靜止空氣中的聲速， v_D 是偵測器的速度，而 v_S 是聲源的速度。所有的速度都是相對於慣性系的地球。現在假設聲源以每秒 5 公尺的速度遠離偵測器，偵測器則以每秒 7 公尺的速度朝向聲源移動，並且有每秒 3 公尺的風從聲源方向吹向偵測器。請問在使用都卜勒頻移公式時， v_D 和 v_S 應該代入哪些數值？

The Doppler shift formula for the detected frequency is

$$f' = f \frac{v_0 \pm v_D}{v_0 \mp v_S},$$

where f is the emitted frequency, v_0 is the speed of sound in still air, v_D is the speed of the detector, and v_S is the speed of the source. All speeds are measured relative to the inertial frame of the Earth. Suppose the source is traveling at 5 m/s away from the detector, the detector is traveling at 7 m/s toward the source, and there is a 3 m/s wind blowing from the source toward the detector. What values should be substituted for v_D and v_S in this Doppler shift equation?

- (A) $v_D = 7$ m/s (米/秒) and (和) $v_S = 5$ m/s (米/秒)
 (B) $v_D = 10$ m/s (米/秒) and (和) $v_S = 8$ m/s (米/秒)
 (C) $v_D = 4$ m/s (米/秒) and (和) $v_S = 2$ m/s (米/秒)
 (D) $v_D = 10$ m/s (米/秒) and (和) $v_S = 2$ m/s (米/秒)
 (E) $v_D = 4$ m/s (米/秒) and (和) $v_S = 8$ m/s (米/秒)

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14. 物體的熱能與下列哪一項有關？

The thermal energy of an object is associated with:

- (A) 它的動能 its kinetic energy
- (B) 它的位能 its potential energy
- (C) 它的慣性 its inertia
- (D) 分子的隨機運動 the random motions of its molecules
- (E) 分子的集體運動 the collective motions of its molecules

15. 氬氣樣本（莫耳質量為 40 克）的絕對溫度是氫氣樣本（莫耳質量為 2 克）的四倍。請問氬氣分子的均方根速率與氫氣分子的均方根速率的比值為何？

The absolute temperature of a sample of argon gas (molar mass 40 g) is four times that of a sample of hydrogen gas (molar mass 2 g). The ratio of the root-mean-square (rms) speed of the argon molecules to that of the hydrogen molecules is:

- (A) 1 (B) 5 (C) 1/5 (D) $\sqrt{5}$ (E) $1/\sqrt{5}$

16. 在絕熱膨脹過程中：

In an adiabatic expansion,

- (A) 氣體溫度不變
the temperature of the gas does not change.
- (B) 氣體對外界做功，且氣體的內能減少
the gas does work on the environment, and the internal energy of the gas decreases.
- (C) 外界對氣體做功，且氣體的內能增加
the environment does work on the gas, and the internal energy of the gas increases.
- (D) 氣體體積不變
the volume of the gas does not change.
- (E) 氣體壓力不變
the pressure of the gas does not change.

17. 一個玻璃透鏡（折射率 $n = 1.6$ ）表面鍍上一層薄膜（折射率 $n = 1.3$ ），用以減少某特定入射光的反射。若 λ 是該光在薄膜中的波長，則最小的薄膜厚度為多少？

A glass lens (refractive index $n = 1.6$) is coated with a thin film ($n = 1.3$) to reduce the reflection of certain incident light. If λ is the wavelength of the light in the film, the least film thickness is:

- (A) less than (小於) $\lambda/4$ (B) $\lambda/4$ (C) $\lambda/2$ (D) λ (E) more than (大於) λ

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18. 當一束波長為 λ 的光照射到單狹縫上時，會在屏幕上產生繞射圖樣。如果在其他條件皆保持不變的情況下減少狹縫的寬度，將會產生什麼結果？

A diffraction pattern appears on a screen when a long, narrow slit is illuminated with light of wavelength λ . If the slit width is decreased while all other conditions remain unchanged, what is the resulting effect?

(A) 圖案中央的強度不變，整個圖案向中央亮紋收縮

The intensity of the central maximum remains unchanged, and the pattern contracts toward the central maximum.

(B) 圖案中央的強度增加，整個圖案向中央亮紋收縮

The intensity of the central maximum increases, and the pattern contracts toward the central maximum.

(C) 圖案中央的強度不變，整個圖案向遠離中央亮紋的方向擴展

The intensity of the central maximum remains unchanged, and the pattern spreads away from the central maximum.

(D) 圖案中央的強度減弱，圖案從明亮的中心向外擴散

The intensity of the central maximum decreases, and the pattern spreads away from the central maximum.

(E) 圖案中央的強度與整體圖案皆無變化

Neither the intensity of the central maximum nor the pattern changes.

19. 電荷 Q 均勻地分佈在半徑為 R 的絕緣球體中。距球心為 $R/2$ 處的電場強度大小為多少？

Charge Q is distributed uniformly throughout an insulating sphere of radius R . The magnitude of the electric field at a point $R/2$ from the center is:

(A) $Q/(4\pi\epsilon_0 R^2)$ (B) $Q/(\pi\epsilon_0 R^2)$ (C) $3Q/(4\pi\epsilon_0 R^2)$ (D) $3Q/(8\pi\epsilon_0 R^2)$ (E) $Q/(8\pi\epsilon_0 R^2)$

20. 將一個帶電且與外界絕緣的電容器的電極板拉開時：

Pulling the plates of an isolated charged capacitor apart:

(A) 電容增加 increases the capacitance

(B) 電位增加 increases the potential difference

(C) 電位不變 does not affect the potential difference

(D) 電位減少 decreases the potential difference

(E) 電容不變 does not affect the capacitance

21. 某導線的電阻為 R 。另一條由相同材料製成的導線，其長度為原來的一半、直徑也為原來的一半。第二條導線的電阻為多少？

A wire has resistance R . Another wire, made of the same material, has half the length and half the diameter of the first wire. The resistance of the second wire is:

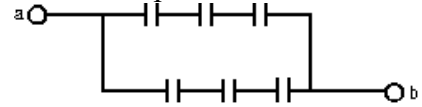
(A) $R/4$ (B) $R/2$ (C) R (D) $2R$ (E) $4R$

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22. 圖中顯示了六個 $6\text{-}\mu\text{F}$ 的電容器。a 點與 b 點之間的等效電容為：

The diagram shows six $6\text{-}\mu\text{F}$ capacitors. The equivalent capacitance between points a and b is:

- (A) $1\text{ }\mu\text{F}$ (B) $3\text{ }\mu\text{F}$ (C) $4\text{ }\mu\text{F}$ (D) $6\text{ }\mu\text{F}$ (E) $9\text{ }\mu\text{F}$



23. 一個矩形線圈的面積為 A ，它垂直置於一個均勻磁場 B 中，然後繞著其中一邊以頻率 f 旋轉。產生的最大感應電動勢為：

A rectangular loop of wire has area A . It is placed perpendicular to a uniform magnetic field B and then rotated around one of its sides at frequency f . The maximum induced emf is:

- (A) $BAf/2\pi$ (B) BAf (C) $2BAf$ (D) $4\pi BAf$ (E) $2\pi BAf$

24. 在一個光電效應實驗中，當入射光的頻率高於臨閾頻率時，遏止電壓 (stopping potential) 與下列哪一項成正比？

In a photoelectric effect experiment using light of frequency higher than the threshold frequency, the stopping potential is proportional to:

- (A) 逸出前能量最小的電子的能量
the energy of the least energetic electron before it is ejected
- (B) 逸出後能量最小的電子的能量
the energy of the least energetic electron after it is ejected
- (C) 逸出前能量最大的電子的能量
the energy of the most energetic electron before it is ejected
- (D) 逸出後能量最大的電子的能量
the energy of the most energetic electron after it is ejected
- (E) 樣品表面電子的電勢能
the electron potential energy at the surface of the sample

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25. 愛因斯坦特殊相對論的一項結果是：

A consequence of Einstein's theory of special relativity is:

(A) 運動中的時鐘看起來比靜止時走得更快

moving clocks appear to run faster than when they are at rest

(B) 一切都是相對的

everything is relative

(C) 光具有波動與粒子的雙重性

light has both wave and particle properties

(D) 所有以勻速相對運動的觀察者都必須看到不同的物理定律

the laws of physics must appear different to all observers moving with uniform velocity relative to each other

(E) 運動中的尺看起來比靜止時短

moving rods appear shorter than when they are at rest

END OF PAPER