

# 2015 年第三十二届全国华文独中数理学识比赛 - 物理

## 适用的常数表 List of useful constants

光速 Speed of light:  $c = 3 \times 10^8$  m/s

普朗克常数 Planck constant:  $h = 6.626 \times 10^{-34}$  Js

重力加速度 Gravitational acceleration on earth:  $g = 9.8$  m/s<sup>2</sup>

水的比热 Specific heat of water:  $c_{\text{water}} = 4180$  J/kg.K

声波在空气中的速度 Speed of sound in air = 343 m/s

重力常数 Gravitational constant:  $G = 6.674 \times 10^{-11}$  Nm<sup>2</sup>/kg<sup>2</sup>

- (1) 物体从粗糙的斜面下滑，如果斜面与地面的角度为  $\theta$ ，摩擦系数为  $\mu$ ，则该物体之加速度为：(g 为重力加速度)

An object is sliding down from inclined rough plane surface. Suppose the angle of the plane with the floor is  $\theta$  and the friction coefficient is  $\mu$ . The acceleration of the object is: (g is gravitational acceleration)

- (a)  $\mu g(1 + \cos\theta)$       (b)  $\mu g \sin\theta$       (c)  $\mu \tan\theta$       (d)  $g(\sin\theta - \mu \cos\theta)$   
(e) None of the above.

- (2) 不挂重物时弹簧长度为  $L_0$ 。当质量  $m$  之物体悬挂后它的长度变为  $L_1$ ，如果  $k$  为力常数则  $\Delta L = L_1 - L_0$  为：

A spring has a length  $L_0$  when it is unloaded. By hanging an object of mass  $m$  on the spring then its length is stretched to  $L_1$ . If the mass of the object is  $m$  and the force constant of the spring is  $k$ , the length difference  $\Delta L = L_1 - L_0$  is:

- (a)  $mg$       (b)  $mg/k$       (c)  $mgL_0/k$       (d)  $kgL$   
(e) None of the above.

- (3) 一物体以水平速度  $v_0$  从高度为  $H$  的建筑物往下运动，则在  $H/2$  高度时物体之速度为：

An object is free falling from the top of a building with height  $H$  and initial horizontal speed  $v_0$ . The speed of the object when it is half way from the ground is:

- (a)  $v_0 + \sqrt{2gH}$       (b)  $\sqrt{2g/H}$       (c)  $v_0 + gH/2$       (d)  $\sqrt{Hg + v_0^2}$   
(e) None of the above.

- (4) 质量为  $m$  之物体在無摩擦力的平面上連結在弹簧的一端做简谐振荡（其另一端固定在牆上），如果力常数为  $k$  则振荡的频率为：

An object of mass  $m$  lying horizontally on a frictionless surface is connected to a spring which has its end fixed on the wall. What is the frequency of the harmonic motion if the spring's force constant is  $k$ ?

- (a)  $\frac{1}{2\pi} \sqrt{k/m}$       (b)  $\sqrt{m/k}$       (c)  $\sqrt[4]{k/m}$       (d)  $\sqrt[3]{m/k}$   
(e) None of the above.

- (5) 已知地球的半径为 6400km，则地球的质量约为：

By knowing that the radius of the earth is 6400km, the mass of the earth is approximate equal to:

- (a)  $6 \times 10^{54} \text{kg}$       (b)  $6 \times 10^{39} \text{kg}$       (c)  $6 \times 10^{48} \text{kg}$       (d)  $6 \times 10^{67} \text{kg}$   
(e) None of the above.

- (6) 質量為  $m$  之物體在地球表面的位能為：(設  $R$  為地球之半徑)

The potential energy of an object of mass  $m$  at the surface of the earth is:  
(assuming  $R$  is the radius of the earth)

- (a)  $mgR$     (b)  $-mg/R$     (c)  $-GMm/R$     (d)  $-GM/R$     (e) None of the above.

- (7) 質量分別為  $m$  及  $M$  的兩物體如果它們之間的距離為  $R$ ，則它們之間重力位能為：

The gravitational potential between two objects of masses  $m$  and  $M$  separated by a distance  $R$  is:

- (a)  $-GMmR$       (b)  $GMm/R$       (c)  $-GMm/R$       (d)  $GM/mR$   
(e) None of the above.

- (8) 假設所有行星的軌道皆為圓形，則在軌道上的速率  $v \propto$  ( $R$  為軌道半徑)

Assuming all planets are in circular orbits around the sun. Then the orbital speed  $v \propto$ : (where  $R$  is the orbital radius)

- (a)  $\sqrt{R}$     (b)  $R$     (c)  $1/R$     (d)  $\sqrt{1/R}$     (e)  $\sqrt[3]{R^2}$ .

- (9) 一顆子彈以速度  $v$  打在一塊靜止的木頭上 (設木頭的質量為  $M$ )，假如子彈停在木頭內，而且  $m/M=0.1$  則木頭的速度為：

A bullet of mass  $m$  moving with a speed  $v$  collides with a piece of wood at rest (mass  $M$ ). Suppose that the bullet stays inside the wood after the collision and their mass ratio  $m/M=0.1$ , the final speed of the wood is:

- (a)  $0.9v$       (b)  $10v/11$       (c)  $v/11$       (d)  $v/12$       (e)  $9v/10$ .

- (10) 把 10 公升的水由 273K 加熱至 373K 所需要的熱量為：

The amount of heat needed to raise the temperature of 10 liters water from 273K to 373K is :

- (a)  $10^4 \text{cal}$       (b)  $80000\text{J}$       (c)  $4180 \text{J}$       (d)  $4180 \text{cal}$   
(e) None of the above.

- (11) 一根 10 公尺長的金屬棍子夾在溫度為 600K 及 1000K 的兩個火爐中，則離高溫爐子 4 公尺處的溫度為：

A 10m metal rod is placed between two furnaces with temperatures 600K and 1000K. The temperature at the position which is 4m away from the higher temperature furnace is:

- (a) 800K    (b) 670K    (c) 840K    (d) 720K    (e) 240K.

- (12) 聲速在空氣中的速率為 340m/s (在 303K 的溫度中)，則聲速在鋼鐵中約為：

The speed of sound in the air is about 340m/s at 303K. The speed of sound in steel is in the order of :

- (a) 500m/s      (b) 5000m/s      (c) 50000m/s      (d) 50m/s  
(e) None of the above.

- (13) 急救車在靜止時它的警笛頻率為  $f$ ，當它衝入醫院時，門口等待的醫護人員

所聽到它頻率是：( $v$  為急救車的速率)

- (a) 一樣 (b) 低於  $f$  (c) 高於  $f$  (d)  $\propto \sqrt{v}f$ ,  
(e) 以上皆非

The siren of the ambulance at rest has a frequency  $f$ . When the ambulance is approaching toward the emergency center the medical staff will hear a different frequency which is: ( $v$  is the speed of the ambulance)

- (a) the same as  $f$  (b) Lower than  $f$  (c) higher than  $f$  (d)  $\propto \sqrt{v}f$ ,  
(e) None of the above

- (14) 兩個相等的電荷  $Q$  被約束在距離  $D$  的位置上，如果外力被去掉以後它們因互相排斥而在直線上分離，假如它們也有一樣的質量  $m$ ，則在 $\infty$ 遠處每一個物體的速率為：( $k$  為常數)

2 positive charges (they carry the same charge  $Q$ ) are held at rest with a distance  $D$  between them. When they are released then they will be flying apart on a straight line. If they have equal mass  $m$  then the speed at infinity for each mass is: ( $k$  is a constant)

- (a)  $\frac{kQ}{4mD^2}$  (b)  $kQ^2/2mD$  (c)  $kQ^2/2mD^2$   
(d)  $\sqrt{kQ^2/mD}$  (e)  $\sqrt{kQ^2/2mD}$ .

- (15) 三個相等的電荷  $q$  被放在一個等邊三角形的頂角上，假如把另外一個電荷  $-Q$  放在三角形的中心上，則以下敘述哪一個是正確的：

- (a) 電位能為正的 (b)  $-Q$  上的力為 0 (c)  $-Q$  的力 $\neq 0$   
(d)  $-Q$  上的電場 $\neq 0$  (e) 以上皆非

3 equal charges (denoted by  $q$ ) are located at the vertices of an equilateral triangle. If another negative charge  $-Q$  is now sitting at the center of the triangle. Then which of the following statements is true:

- (a) the potential energy is positive  
(b) the force on  $-Q$  is zero  
(c) the force on  $-Q$  is non-vanishing  
(d) The electric field is not zero on  $-Q$   
(e) none of the above.

- (16) 兩個電阻分別為  $R$  及  $r$  並聯並且與電池連接，如果  $r/R=0.25$  則它們的功率比  $\frac{P_R}{P_r}$  為：

Two resistors  $R$  and  $r$  are connected in parallel and attached to a battery. If

$r/R=0.25$ , then the ratio of their dissipated powers  $\frac{P_R}{P_r}$  is :

- (a) 4 (b) 2 (c) 1/4 (d) 8 (e) 1/8.

- (17)  $\infty$ 長的電荷線其電荷密度為  $\lambda$  其電場：

- (a) 永遠與電荷線垂直 (b)  $\propto \frac{\lambda}{r}$   $r$  為該點到電荷線的距 (c)  $\propto \lambda r$   
(d) 平行於電荷線 (e) 以上皆非

The electric field of an infinite line charge with charge density  $\lambda$  is:

- (a) always perpendicular to the line charge  
(b)  $\propto \frac{\lambda}{r}$  where  $r$  is the distance from the line charge  
(c)  $\propto \lambda r$   
(d) always parallel to the line charge  
(e) None of the above.

- (18) 電荷  $Q$  在兩強度相同的平行電流  $I$  附近運動，如果電流之間的距離為  $D$ ，而

Q 與其中一電流之距離為  $5D$  而且它的運動方向也平行於電流，則以下哪個敘述是正確的：

- (a) Q 上的力  $F$  為 0                      (b)  $F$  平行於電流                      (c)  $F$  垂直於電流  
(d) 電流之間的力為吸引力   (e) 以上皆非

A charge  $Q$  is moving parallel to two currents which are parallel and have the same magnitude  $I$  with a distance  $D$  between them. If  $Q$  is at a distance  $5D$  from one of the current then which of the following statements is correct:

- (a) The force  $F$  on  $Q$  is zero  
(b)  $F$  is parallel to the currents  
(c)  $F$  is perpendicular to the currents  
(d) The force between the currents is attractive  
(e) None of the above.

(19) 交流電流  $I_0 \sin \omega t$  流過電阻  $R$ ，則消耗的平均功率為：

An alternating current  $I_0 \sin \omega t$  is passing through a resistor  $R$ . The average power dissipated on  $R$  is

- (a)  $I_0^2 R$               (b)  $0.5 I_0^2 R$               (c)  $(I_0 \sin \omega t)^2 R$               (d)  $\omega I_0 R^2$   
(e) None of the above.

(20) 氫原子的能階  $E_n$  為：

The energy level  $E_n$  of hydrogen atom is given by:

- (a)  $-13.6 \text{ eV}/n^2$               (b)  $13.6 \text{ eV}/n^2$               (c)  $-3.4 \text{ eV}/n^2$   
(d)  $3.4 \text{ eV}/n$               (e)  $-3.4 \text{ neV}$ .

(21) Einstein 引進光子來描述光，則可見光所對應的能量範圍是：

Photon was introduced by Einstein in 1905 to describe light as particles. The energy range of visible light is:

- (a)  $10 \sim 100 \text{ eV}$               (b)  $0.01 \sim 0.05 \text{ eV}$               (c)  $1 \sim 2 \text{ eV}$   
(d)  $1 \text{ meV} \sim 10 \text{ meV}$               (e)  $1 \text{ MeV} \sim 10 \text{ MeV}$ .

(22) 原子核的大小約為  $10^{-14} \text{ m}$ ，由此估計原子核中兩質子之平均位能約為：

The size of nucleus is about  $10^{-14} \text{ m}$ . From that what is the average potential energy between 2 protons in the nucleus?

- (a)  $\sim 10 \text{ meV}$               (b)  $\sim 100 \text{ eV}$               (c)  $\sim 1 \text{ keV}$               (d)  $\sim 100 \text{ keV}$               (e)  $\sim 1 \text{ MeV}$

(23) 以下波的性質哪一個是正確的 ( $A, f, \lambda$  及  $I$  分別是振幅、頻率、波長及強度)：

- (a)  $I \propto A$               (b) 波速  $= \lambda/f$               (c) 波的疊加還是波              (d) 不同介質的波速都一樣  
(e) 波沒有能量

Which of the following statements is correct for describing wave (where  $A, f, \lambda$  and  $I$  are the amplitude, frequency, wavelength and intensity respectively) :

- (a)  $I \propto A$   
(b) the wave speed  $= \lambda/f$   
(c) waves can be added together as a wave

- (d) wave always has the same speed in different medium
- (e) waves do not carry energy.

(24) 對光的繞射而言何者為正確:

- (a) 光的頻率會改變
- (b) 波長會變
- (c) 繞射圖案與孔無關
- (d) 有明亮及黑暗的区域
- (e) 波長在繞射現象中不重要

What is the correct statement after light being diffracted?

- (a) light changes into a different frequency
- (b) The wave length has changed
- (c) The diffraction pattern is independent of the hole for diffraction
- (d) There are bright and dark regions
- (e) wave length is unimportant for the diffraction pattern.

(25) 黑體輻射的強度 I 與溫度 T 的關係為:

For black body radiation at temperature T which of the following statement is correct for the intensity I:

- (a)  $I \propto T^2$
- (b)  $I = T^{1/2}$
- (c)  $I = T^{1/3}$
- (d)  $I \propto T^{3/2}$
- (e)  $I \propto T^4$ .