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Some useful constants:

氣體常數 Gas constant R = 8.31 J/mol·K
電子質量 Electron mass $m_e = 9.1\times10^{-31}$ kg
電子電荷 Electron charge $e = 1.6\times10^{-19}$ C
磁導率 Magnetic constant (permeability) $\mu_0 = 4\pi\times10^{-7}$ T·m/A
重力常數 Gravitational constant $G = 6.67\times10^{-11}$ N·m^2/kg^2
太陽質量 Mass of the Sun $M_S = 1.99\times10^{31}$ kg
地球半徑 Radius of Earth = 6.4×10^6 m
水的比熱 Specific heat of water= 4.2 Joule/gram °C
地面上的重力加速度 g= $10\text{m}/s^2$
光速 speed of light $c = 3.0\times10^8 m/s$
庫倫常數 Coulomb's constant $k = 9.0\times10^9 Nm^2/C^2$
普朗克常數 Planck constant $h = 6.6\times10^{-34} J\cdot s$

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1. 將一顆小石頭，以初速 v_0=10m/s 向上拋出，當石頭抵達最高點時，小石頭上升多少公尺？
   A small stone is thrown upward with an initial velocity v_0=10m/s. When the stone reaches the highest point, how high up has it traveled?

   (a) 5　(b)10　(c) 15　(d)20　(e) 25。

2. 一個物體以水平的速度 5 m/s 由距離地面高為 10 公尺的平台射出，如果開始時則它在 2 秒後的速率為：
   An object is projected horizontally out of a platform with a speed of 5m/s. If its initial height from the ground is 10m, its speed after moving for 2 seconds will be:

   (a) 20 m/s　(b) $\sqrt{425}$ m/s　(c) $\sqrt{125}$ m/s　(d) 10 m/s
   (e) 以上皆非 (None of the above)。

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3. 一質量為 10 公斤的物體，靜止置於桌面上，施以一水平拉力 F。若物體與桌面的靜摩擦係數為 0.2，動擦係數為 0.1。則使物體自靜止開始滑動所需的最小水平拉力 F 為何？
   A 10 kg block resting on the table is suddenly pulled by a horizontal force *F*. If the coefficient of static friction between the block and the table's surface is 0.2, while the coefficient of kinetic friction is 0.1, what will be the minimal horizontal force needed to move the block?

   (a) 10 公斤重(kg-W)　(b)20 公斤重(kg-W)　(c)10 牛頓(N)
   (d) 20 牛頓 (N)　(e) 以上皆非 (None of the above) 。

4. 兩質量分別為 m_1 與 m_2 的木塊，相互接觸至於光滑平面上。今以水平力 *F* 作用於 m_1 的木塊上並使兩木塊一起移動，若此時 $m_1>m_2$，則 m_2 的木塊作用 m_1 的木塊的反作用力為何？
   Two blocks with masses of m_1 and m_2 are in close contact with each other on a smooth surface. Now a horizontal force acts on m_1 to move both blocks. If $m_1>m_2$, what will be the reaction force from m_2 to m_1?

   (a) $\frac{m_1}{m_1+m_2}F$　(b) $\frac{m_2}{m_1+m_2}F$　(c) $\frac{m_1}{m_2}F$　(d) $\frac{m_2}{m_1}F$　(e) $\frac{m_1-m_2}{m_1+m_2}F$

5. 若有一顆小行星，以近乎圓形軌道繞太陽公轉，且其公轉週期為 64 年，則此一小行星繞行太陽的平均距離，約為地球繞太陽的軌道半徑的多少倍？
   An asteroid orbits the Sun in a nearly circular orbit with a period of 64 years. In terms of the orbital radius of the Earth to the Sun, what will be the average distance between the asteroid and the Sun?

   (a) 2　(b) 4　(c) 8　(d) 16　(e)32

6. 若地球半徑約為月球半徑的 4 倍，地球表面的自由落體加速度約為月球表面的 6 倍，求月球與地球的質量比值為何？
   If the radius of the Earth is about 4 times that of the Moon and the gravitational acceleration on Earth is about 6 times that on Moon, what will be the mass ratio between Moon and Earth?

   (a) 2/3　(b) 1/24　(c) 1/96　(d) 1/ 144　(e) 1/576

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7. 在 *x*-*y* 平面上兩個帶相同電量 Q 的點電荷分別位於(0,0)與(2*a*,0)處，求出位於(*a*,0)處的電場為何？
On the *xy*-plane, two particles with identical charge Q are located at (0,0) and (2*a*,0), respectively. What will be the magnitude of the *E*-field at (*a*,0)?

(a) $\frac{kQ}{a^2}$ (b) $\frac{2kQ}{a^2}$ (c)$\frac{kQ}{2a^2}$ (d)$\frac{kQ}{4a^2}$ (e) 0

8. 兩條長度為 L 相距為 d 的平行導線，分別各載以電流 I_1 與 I_2。若兩電流方向相反，則兩平行導線之間的作用力為
Two parallel conducting wires with length L and separation d carries the currents I_1 and I_2, respectively, and in opposite to each other. Find the force between these two wires.

(a) 吸力 attractive，$F = \frac{\mu_0 I_1 I_2}{2\pi d} L$ (b) 斥力 repulsive，$F = \frac{\mu_0 I_1 I_2}{2\pi d} L$

(c) 吸力 attractive，$F = \frac{\mu_0 I_1 I_2}{2\pi d^2} L^2$ (d) 斥力 repulsive，$F = \frac{\mu_0 I_1 I_2}{2\pi d^2} L^2$

(e) 吸力 attractive，$F = \frac{\mu_0 I_1 I_2}{d^2} L^2$

9. 一質子以速度$v = 5.0 \times 10^6$m/s，射入均勻的磁場 B=0.4T，射入時質子的速度與磁場方向夾角為 30°，則質子受力的大小為
A proton moving at $v = 5.0 \times 10^6$m/s enters a uniform magnetic field region of *B*=0.4T. If the angle between the velocity and the *B*-field is 30°, the force experienced by the proton is:

(a) 1.6×110^{-13}N (b)3.2×10^{-13}N (c) 1.6×10^{-19}N
(d) 3.2×10^{-19}N (e) 0N

10. 聲波由空氣傳入水中的過程中，下列有關聲波性質的敘述，何者正確？
A sound wave propagates from air into water. Which of the following statement is true?

(a) 在水中與空氣中聲波前進的方向皆相同
The sound wave has the same propagating direction in air and water.
(b) 聲波的速率在水中比在空氣的速率較小
The speed of the sound wave is smaller in water than in air.
(c) 聲波的頻率在水中與在空氣中皆相同
The frequency of the sound wave is the same in water and in air
(d) 聲波的波長在水中與在空氣中皆相同
The wavelength of the sound wave is the same in water and in air.
(e) 以上皆非 (None of the above)

11. 下列敘述何者正確？Which of the following statement is true?

(a) 電磁波在所有的介質中的傳播速度均為3×10^8m/s
The propagating speed of electromagnetic waves is3×10^8m/s in every medium.
(b) 紅外線為不可見光，所以不是電磁波
Infrared is invisible, and hence it is not an electromagnetic wave.
(c) β 粒子帶正電
β particle carries positive charge.
(d) γ 射線的頻率大於 X 射線的頻率
The frequency of a γ-ray is higher than that of a X-ray.
(e) 紅外線波長大於無線電波的波長
The wavelength of an infrared light is higher than that of a radio wave.

12. 若有一瀑布其落差高達 1000m。假設當流水從瀑布頂部垂直下瀉到底部之後，流水的位能全部轉換成熱能。則瀑布頂部和底部兩處的最大水溫差約為多少℃？
The altitudinal difference between the top and the base of a waterfall is 1,000m. If all the potential energy is converted into heat when the water reaches the base, what will be the temperature difference of the water at the top and at the base in °C?

(a) 1.4 (b) 1.7 (c) 2.0 (d) 2.3 (e) 2.6

13. 氫原子 n=1,2,3,4 的 4 個能階之內，經由電子在不同能間的躍遷，會產生幾條不同頻率的發射譜線：
For the first four energy levels in a hydrogen atom, how many distinct spectrum lines can be formed?

(a) 3 (b) 4 (c) 6 (d)9 (e) 12

14. 在光電效應的實驗中，若欲增加釋放出光電子的動能，則該如何操作？
In the photoelectric experiment, if there is a need to increase the kinetic energy of the photo-electron, what should you do?

(a) 增加照射光的光子數目
Increase the number of incident photons
(b) 增高照射光的頻率
Increase the frequency of the incident light
(c) 增長照射光的波長
Increase the wavelength of the incident light
(d) 將照射光的亮度調強
Increase the intensity of the incident light
(e) 以上皆非 (None of the above)

15. 下列哪些實驗，可以證明電子具有波動性？
In the following experiments, which one shows that electrons can behave like a wave?

(a) 密立根油滴實驗 Millikan oil drop experiment
(b) 電流的磁效應實驗 Current's magnetic effect experiment
(c) 光電效應實驗 Photoelectric effect experiment
(d) 康普吞散射實驗 Compton scattering experiment
(e) 電子繞射實驗 Electron diffraction experiment

16. 一個氘與一個氚經核融合反應後產生一個氦與一個質子，在此過程中質量減少了約$3 \times 10^{29} kg$，也就是會釋放出能量約為
When a deuterium and a tritium fuse to produce a helium and a proton, the mass reduction is 3×10^{29} kg. How much energy does this reaction produce?

(a) $2.7 \times 10^{-12} J$， (b) $1.4 \times 10^{-1}\ J$ (c) $3.0 \times 10^{-19} J$
(d) $4.5 \times 10^{-19} J$ (e) $9.0 \times 10^{-19} J$

17. 若一個固定不動的點電荷電量為$4.0 \times 10^{-6}\ C$，自距離該點電荷 10cm 處 A 點移動至 20cm 之 B 點，則電位變化 V_A-V_B 為何？
A stationary particle carrying a charge of $4.0 \times 10^{-6}\ C$. If one moves from point A (10 cm away from the particle) to point B (20 cm away from the particle), the change in the electric potential (V_A-V_B) is:

(a) $1.2 \times 10^{5} V$， (b) $1.8 \times 10^{5} V$ (c)$2.7 \times 10^{5} V$
(d) $3.6 \times 10^{5} V$ (e) $5.4 \times 10^{5} V$

18. 下列敘述何者不正確？Which of the following statement is incorrect?

(a) 電荷在均勻磁場中的受力與磁場垂直
The force experienced by a charge in the uniform *B*-field is perpendicular to the *B*-field
(b) 靜止的電荷在均勻磁場中不受力
Stationary charge experiences no force in a uniform *B*-field.
(c) 電場可以加速電子
Electric field can accelerate electrons
(d) 磁場可以增加帶電粒子的動能
Magnetic field can increase the kinetic energy of charged particles
(e) 沒有單獨存在 N 極或 S 極的磁鐵
There is no isolated magnetic N-pole or S-pole.

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19. 一容器內裝理想氣體，以一可以自由無摩擦的滑動且完全隔熱的板子隔開成左、右二室。最初，當板子靜止時，左右兩室的溫度均為 27℃，體積均為 V，壓力均為 1atm。若右室保持 27℃，左室緩慢加熱至 327℃，則板子會向右緩慢移動；當板子再度靜止不再移動時，此時
Anidea gas-filled container is partitioned by a frictionless and movable divider into two chambers. Initially, the divider is stationary, the chambers are equally divided (each having volume V), the gas pressure is 1 atm, and the gas temperature is 27 °C. Now the temperature of right chamber maintains at 27°C, but the temperature of the left chamber is slowly heated to 327 °C. In response, the divider will move to the right. When the divider reaches the equilibrium position, then

(a) 左室的體積為$\frac{3}{2}V$; volume of the left chamber is $\frac{3}{2}V$

(b) 右室的體積為$\frac{3}{4}V$; volume of the right chamber is $\frac{3}{4}V$

(c) 左室的體積為$\frac{4}{3}V$; volume of the left chamber is $\frac{3}{4}V$

(d) 右室的體積為$\frac{3}{2}V$; volume of the right chamber is $\frac{3}{2}V$

(e) 右室的體積為$\frac{1}{2}V$; volume of the right chamber is $\frac{1}{2}V$。

20. 承 Q(19)，此時右室的壓力為何？
Continuing from Q (19), the pressure in the right chamber is:

(a) 0.8atm (b) 1.2 atm (c)1.5 atm (d) 1.8 atm (e)2.0 atm

21. 一物體連接於彈性係數為 50N/m 的彈簧上，並在光滑的水平面上，離平衡點為 40cm 與– 40cm 的範圍內來回振盪。則當物體位於 20cm 處的彈性位能為何？
A block is connected to a spring with a spring constant of 50N/m. The block oscillates about an equilibrium position on a smooth surface with amplitude of 40 cm (- 40 cm to +40 cm with respect to the equilibrium position at zero). What will be the spring potential energy when the block is at 20 cm?

(a) 0 J (b) 1 J (c) 2 J (d) 3 J (e) 4 J

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22. 承 Q(21)上題，當物體自 40 cm 處移動至-20cm 處時，彈力對物體所做的功為何？
Continuing from Q(21), when the block moves from 40 cm to -20 cm, what is the work done by the spring force?

(a) 0 J (b) 1 J (c) 2 J (d) 3 J (e) 4 J

23. 一變壓器之主線圈為 1800 匝，如果欲將 6600V 的交流電，變壓成家庭用 220V，則副線圈的匝數應為多少？
A transformer has 1,800−turnprimary winding. If the input of 6,600 VAC is reduced to 220VAC for the home use, how many turns should the secondary winding should have?

(a) 60 (b)120 (c)300 (d) 360 (e) 600

24. 承 Q(23)，若在室內使用一電阻為 44Ω的灯泡，將消耗多少電功率
Continuing from Q(23), if a light bulb has resistivity of 44 Ω, how much power does it consume?

(a) 55W (b)1210W (c)5500W (d)9680W (e) 290400 W

25. 質量為 100g 的棒球，以速率 22m/s 拋出。其物質波波長為何？
A 100g baseball is traveling at speed of 22m/s. What would be the wavelength of its matter wave?

(a) $5 \times 10^{-35}\, m$， (b) $1.0 \times 10^{-34}\, m$ (c)$2.2 \times 10^{-34}\, m$
(d) $3.0 \times 10^{-3}\ \ m$ (e) 2200 m