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1. 一個球以 $v_0$ 速度垂直往上運動，如果不考慮空氣的阻力，則它下降至最大高度的一半之時間為：（$g$ 為重力加速度）

   A ball is projected vertically upward with initial velocity $\mathbf{v_0}$. If the air resistance is negligible, the time taken for it to reach half of its maximum height during the downward motion is: ($\mathbf{g}$ is the gravitational acceleration)

   （a）$\mathbf{v_0^2/g}$, （b）$\mathbf{v_0\ /g}$,

   （c）$\mathbf{v_0\ (\sqrt{2}+1)/g\sqrt{2}}$, （d）$\mathbf{v_0\ (\sqrt{3}-1)/g\sqrt{2}}$,

   （e）以上皆非. None of the above

2. 質量為 $\mathbb{m}$ 的物體以速度 $\mathbf{v}$ 及角度 $\boldsymbol{\theta}$（與地面的夾角）由地面上射出運動，如果不考慮空氣的阻力,則它在最高點時的動能為：

   An object of mass $\mathbf{m}$ is projected with a velocity of $\mathbf{v}$ at angle $\boldsymbol{\theta}$ with the horizontal surface. Neglecting the air resistance, its kinetic energy at the highest point is:

   (a) $\mathbf{1/\sqrt{2}mv^2sin\theta}$, (b) $\mathbf{1/2mv^2sin^2\theta}$,

   (c) $\mathbf{1/2mv^2cos\theta}$, (d) $\mathbf{1/2mv^2cos^2\theta}$,

   (e) $\mathbf{1/\sqrt{2}mvsin\theta}$.

3. 質量為 $\mathbb{m}$ 的物體以速度 $\mathbf{v}$，向另外一個靜止的物體（質量為 $\mathbb{M}$）碰撞，則彈性碰撞後，這個系統的質心運動速度為：

   An object of mass $\mathbf{m}$ moving with velocity $\mathbf{v}$ collides with another object (mass $\mathbf{M}$) initially at rest. After an elastic collision, the velocity of the center of mass of this system is given by:

   （a）$\mathbf{mv/(m+M)}$, （b）$\mathbf{Mv/(m+M)}$,

   （c）$\mathbf{v}$, （d）$\mathbf{m^2v/M^2}$,

   （e）以上皆非。None of the above.

4. 行星在萬有引力的影響下運動，以下敘述何者為錯誤：

   Which of the following statements is **incorrect** regarding the motion of a planet under the influence of gravity:

   (a) 角動量守恆 Angular momentum is conserved

   (b) 能量守恆 Energy is conserved

   (c) 動量守恆 Linear Momentum is conserved

   (d) 行星質量不變 Mass of planet is constant

   (e) 行星軌道周期不變 Orbital period of the planet is constant

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5. 物體受彈簧力 F=-kx 作用，如果物體質量為 m 則以下那一個敘述是**不正確**：
An object of mass **m** is acted by spring force $\mathbf{F} = -\mathbf{kx}$. Which of the following statements is **incorrect**?

(a) 總能量 The total energy $\mathbf{E} = \frac{1}{2}(\mathbf{mv^2} + \mathbf{kx^2})$,

(b) 總能量 The total energy $\mathbf{E} = \frac{1}{2}\mathbf{kx_m^2}$ ($\mathbf{x_m}$ 為最大位移 is the maximum displacement),

(c) 總能量 The total energy $\mathbf{E} = \frac{1}{2}\mathbf{mv_m^2}$ ($\mathbf{v_m}$ 為最大速率 is the maximum speed)

(d) $\mathbf{v_m}$ 出現在 occurs at $\mathbf{x = 0}$,

(e) 振盪的頻率 The frequency of oscillation is $\mathbf{f} = \sqrt{\mathbf{m/k}}$

6. 物體的運動為 $\mathbf{x(t) = Acos\omega t}$（A ， $\boldsymbol{\omega}$ 為常數），則物體的速度 **v(t)** 及加速度 $\mathbf{a(t)}$ 為：
If the motion of an object is represented by equation $\mathbf{x(t) = Acos\omega t}$ (**A** and $\boldsymbol{\omega}$ are constants), then the speed **v(t)** and acceleration $\mathbf{a(t)}$ are given by:

(a) $\mathbf{v = Asin\omega t}$ and $\mathbf{a = -Asin\omega t}$,

(b) $\mathbf{v = -A\omega cos\omega t}$ and $\mathbf{a = -A\omega^2 cos\omega t}$,

(c) $\mathbf{v = -A\omega sin\omega t}$ and $\mathbf{a = -A\omega^2 cos\omega t}$,

(d) $\mathbf{v = -A\omega sin\omega t}$ and $\mathbf{a = -A\omega sin\omega t}$,

(e) 以上皆非。None of the above.

7. 月球的質量為 M 及半徑為 R，則月球表面上質量為 m 之物體的重力位能為：（G 為牛頓常數）
The mass and radius of the Moon are **M** and **R**, respectively. An object of mass **m** on the surface of the Moon has gravitational potential energy: (**G** is universal gravitational constant)

(a) mGR, (b) GM/R,

(c) GMm/R, (d) $\mathbf{-GMm/R}$, (e) -Gm/R

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8. 物體在有摩擦的表面上做直線運動，如果它的初速為$\mathbf{v_0}$，而且摩擦力為 F 則當它的速度 v=$\mathbf{v_0/2}$時，该物體对摩擦力所做的功 W 為（設物體質量為 m）
An object of mass **m** is moving on a rough surface in a straight line. If its initial speed is $\mathbf{v_0}$ and the frictional force is **F**, then when its speed is $\mathbf{v=v_0/2}$, the work done **W** by the object against the frictional force is:
（a）$\mathbf{Fv_0}$, （b）$\mathbf{Fv_0^2}$
（c）$\frac{1}{4}\mathbf{mv_0^2}$, （d）$\frac{3}{8}\mathbf{mv_0^2}$,
（e）以上皆非。None of the above.

9. 一個質量為 m 之物體的速度 $\vec{\mathbf{v}} = \mathbf{v_0(cos\theta\hat{i} + sin\theta\hat{j})}$，它的位移向量 $\vec{\mathbf{r}} = \mathbf{x\hat{i} + y\hat{j} + z\hat{k}}$，則角動量的 z 分量為：
An object of mass **m** has velocity $\vec{\mathbf{v}} = \mathbf{v_0(cos\theta\hat{i} + sin\theta\hat{j})}$ and its displacement vector $\vec{\mathbf{r}} = \mathbf{x\hat{i} + y\hat{j} + z\hat{k}}$. The **z** component of its angular momentum is:
(a) $\mathbf{mv_0(xcos\theta + ysin\theta)}$, (b) $\mathbf{mv_0(xcos\theta - ysin\theta)}$,
(c) $\mathbf{mv_0 z}$, (d) $\mathbf{mv_0(xsin\theta - ycos\theta)}$,
(e) $\mathbf{mv_0(xsin\theta + ycos\theta)}$

10. 球的轉動慣量為 I ，它的轉動角速率為 $\boldsymbol{\omega}$，則以下敘述何者為正確：
The moment of inertia of a sphere is **I** and its angular speed is **ω**. Which of the following statements is correct?
(a) 動能為$\mathbf{I\omega}$, Kinetic energy is $\mathbf{I\omega}$,
(b) 動能為$\mathbf{I\omega^2}$, Kinetic energy is $\mathbf{I\omega^2}$
(c) 角動量為$\mathbf{I^2\omega}$, Angular Momentum is $\mathbf{I^2\omega}$
(d) 角動量為$\mathbf{I\omega}$, Angular Momentum is $\mathbf{I\omega}$
(e) 以上皆非 None of the above.

11. 在室溫下，声音在金属的速度 v 大約是：
At room temperature, the speed of sound **v** in metal is about:
（a）340 m/s （b）4000 m/s （c）0.60 km/s （d）34 km/s
（e）以上皆非 None of the above.

12. 兩個在一維空間上的波 $\mathbf{h(x,t) = Asin(kx - \omega t)}$ 及 $\mathbf{g(x,t) = Acos(kx - \omega t)}$之間的相位差為：
Two waves are propagating in one dimension. They are represented by equations $\mathbf{h(x,t) = Asin(kx - \omega t)}$ and $\mathbf{g(x,t) = Acos(kx - \omega t)}$ where **k** and $\boldsymbol{\omega}$ are constants. The phase difference between the waves is:
(a) $60^o$, (b) $30^o$, (c) π/3, (d) π/4. (e) π/2.

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13. 三個相同的電荷 q 放在一個邊長為 L 的等邊三角形之三個頂點上，則在三角形中心點的電場 E 的大小為：（k 為庫侖定律中的常數）

Three equal electric charges **q** are placed on the vertices of an equilateral triangle with a length of **L**. The magnitude of electric field **E** at the center of the triangle is: (**k** is the proportional constant in the Coulomb's Law)

（a）$\mathbf{3kq/L^2}$ ，（b）$\mathbf{3kq/2L}$，（c）$\mathbf{3kq/2L^2}$，

（d）$\mathbf{2kq/3L^2}$，（e） 0

14. 假設原子核的電荷為 ZQ >0，而且其質量為無窮大。一個電荷為 Q 的電荷從無窮處以$\mathbf{v_0}$與此**原子核**碰撞，電荷 Q 與原子核之間的最小矩離為：（k 為庫侖定律中的常數, 電荷質量為 m）

Assuming that a nucleus has an electric charge **ZQ >0** and its mass is infinite. When another charged particle of electric charge **Q** is moving from infinity toward this nucleus with velocity $\mathbf{v_0}$, the minimum distance between the charged particle and the nucleus is: (**k** is the proportional constant in the Coulomb's Law, mass of charge is **m**)

（a）$\mathbf{ZkQ/mv_0}$，（b）$\mathbf{2ZkQ^2/mv_0^2}$，

（c）$\mathbf{ZkQ^2/mv_0^2}$，（d）$\mathbf{ZkQ^2/v_0^2}$，

（e）以上皆非. None of the above.

15. 兩個電阻$\mathbf{R_1}$ 與 $\mathbf{R_2}$ 並聯，並且與電池連結成一個迴路，如電池的電動勢為 $\varepsilon$ ，內阻為 r，則在$\mathbf{R_1}$ 上的電流為：

Two resistors $\mathbf{R_1}$ and $\mathbf{R_2}$ are connected in parallel with a battery with electromotive force **ε** and internal resistance **r**. The current through the resistor $\mathbf{R_1}$ is:

（a）$\frac{\varepsilon \mathbf{R_1}}{\mathbf{rR_1+rR_2+R_1R_2}}$，（b）$\frac{\varepsilon \mathbf{R_2}}{\mathbf{rR_1+rR_2+R_1R_2}}$，

（c）$\frac{\varepsilon}{\mathbf{r+R_1+R_2}}$，（d）$\frac{\varepsilon}{\mathbf{r-R_1-R_2}}$，

（e）以上皆非 None of the above.

16. 在 RC 並聯且與電池連結成一個迴路的電路中，電容器上的電荷為 $\mathbf{Q = 10\ \mu C}$ ，而電容 C=1 **μF**，則電阻 R 上的電壓 V 為：

A parallel RC circuit consists of Resistance **R**, Capacitance **C** and a battery connected in parallel. If the charge stored in the capacitor is $\mathbf{Q = 10\ \mu C}$ and **C = 1 μF**, the voltage across the resistor is:

(a)1 V, (b) 1 μV, (c) 10 V, (d) 0.1 V (e) 0

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17. 在電感 L 及電容 C 的串聯電路中，如果電容器上的電荷為 $\mathbf{Q(t) = Q\cos\omega t}$，則對應的電流 $\mathbf{i(t)}$的最大值出現的時間 t 為：
A capacitor **C** and an inductor **L** are connected in series to form a closed loop. If the capacitor has an electric charge $\mathbf{Q(t) = Q\cos\omega t}$, the maximum current occurs at **t** equals to:
(a) π/4ω, (b) π/ω, (c) 3π/2ω, (d) 3π/4ω,
(e) 以上皆非 None of the above.

18. 電磁波具有能量密度 U，則 U 與電場 $\vec{\mathbf{E}}$ 的關係為：
An electromagnetic wave has energy density **U.** The relationship between **U** and the electric field $\vec{\mathbf{E}}$ is:
(a) $\mathbf{U} \propto |\vec{\mathbf{E}}|$, (b) $\mathbf{U} \propto \sqrt{|\vec{\mathbf{E}}|}$, (c) $\mathbf{U} \propto |\vec{\mathbf{E}}|^3$, (d) $\mathbf{U} \propto |\vec{\mathbf{E}}|^2$,
(e) 以上皆非。None of the above.

19. 電場 $\vec{\mathbf{E}}$=E î 及磁場 $\vec{\mathbf{B}}$=B(î+ ĵ). 當電荷 q 以速度 $\vec{\mathbf{v}}$=vk̂ 運動(它的質量為 m) 則它在 x 方向的加速度為：
An electric charge **q** is moving in an electric field $\vec{\mathbf{E}}$**=E** î and a magnetic field $\vec{\mathbf{B}}$**=B(**î**+** ĵ**)**. If its mass is **m** and velocity is $\vec{\mathbf{v}}$**=v**k̂, its acceleration in the **x**-direction is:
(a) **q(E-B)/m**, (b) **q(E-vB)/m**, (c) **q(E+vB)/m**,
(d) **q(E+2vB)/m**, (e) **q(E-2vB)/m.**

20. 白光經過一個稜鏡會顯示出彩虹的色帶，它的原因是在玻璃中：
White light passing through a glass prism will spread out as a rainbow. This is due to the effect of glass causing
(a) 波長改變 the change in wavelength
(b) 頻率改變 the change in frequency
(c) 強度改變 the change in intensity
(d) 不同頻率有不同的速率 light of different frequencies travel with different speeds
(e) 以上皆非 None of the above

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21. 光由折射率$\mathbf{n_1}$物質入射角$\theta$進入折射率$\mathbf{n_2}$物質，如果$\mathbf{n_1 > n_2}$，則發生全反射的最小角度$\theta$為：

Light is incident from one medium with index of refraction $\mathbf{n_1}$ at incident angle $\boldsymbol{\theta}$ into another medium with index of refraction $\mathbf{n_2}$. If $\mathbf{n_1 > n_2}$ then total internal reflection may occur. The minimum angle $\boldsymbol{\theta}$ for total internal reflection to occur is given by:

(a) $\mathbf{\tan^{-1}\frac{n_2}{n_1}}$, (b) $\mathbf{\tan^{-1}\frac{n_1}{n_2}}$, (c) $\mathbf{\sin^{-1}\frac{n_1}{n_2}}$,

(d) $\mathbf{\cos^{-1}\frac{n_2}{n_1}}$, (e) $\mathbf{\sin^{-1}\frac{n_2}{n_1}}$.

22. 理想氣體在壓力不變之下，它的體積 V 與絕对溫度 T 的關係為：

For an ideal gas at constant pressure, the relation between its volume **V** and the absolute temperature **T** is:

(a) $\mathbf{V \propto 1/T}$, (b) $\mathbf{V \propto T^2}$, (c) $\mathbf{V \propto T}$,

(d) $\mathbf{V \propto \sqrt{T}}$, (e) 以上皆非 None of the above

23. $\mathbf{0^\circ C}$ 的冰的每公斤融解熱為 h，以及每公斤水的比熱為 C。把 m 公斤的冰化為 $\mathbf{T^\circ C}$的水所需要的熱量為：

The specific latent heat of fusion of ice at $\mathbf{0^\circ C}$ is denoted by **h** and the specific heat capacity of water is **C**. The heat required for **m** kg of ice to change into water at temperature $\mathbf{T\ ^\circ C}$ is:

(a) m (h+CT), (b) m (h+C)T, (c) mCT,

(d) mhCT, (e) 以上皆非 None of the above.

24. Einstein 提出光子的觀念。他把 f 頻率的光賦與一個能量單位 E=hf，這樣一個觀念就被稱為一個光子，對應的光子也有動量 p，則以下敘述何者為正確：(c 為光速，h 為普朗克常數, $\boldsymbol{\lambda}$為波長)

Einstein proposed the concept of photon by giving an energy **E=hf** for light of frequency **f**. This amount of energy is viewed as a particle named Photon which also carries momentum **p**. Which of the following statement is correct: (**h** is the Planck's constant; **c** is the speed of light and $\boldsymbol{\lambda}$ is the wavelength of light)

(a) E=pc, (b) p=hf, (c) p=f/c,

(d) $\mathbf{E=h/\lambda}$, (e) 以上皆非 None of the above

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25. Bohr 提出氫原子模型，並且導出不連續的氫原子能階 $\mathbf{E_n = -13.6\,eV/n^2}$ $(\mathbf{n = 1,\ 2,\ 3,\cdots\cdots})$。這個結果是由以下那一個條件達成：
Bohr proposed a model for hydrogen atom which has discrete energy levels $\mathbf{E_n = -13.6eV/n^2}$. This result is mainly due to the condition that:
(a) 角動量不連續 Angular momentum is not continuous
(b) 電磁力不連續 Electrostatic force is discrete
(c) 電荷之間的排斥力 Repulsion force among charges
(d) 能量不守恆 Energy is not conserved
(e) 角動量不守恆 Angular momentum is not conserved

26. 波長為 $4.5\text{x}10^{-13}$ m 的伽码射線的光子質量是
A photon of gamma ray of wavelength $4.5\text{x}10^{-13}$ m has a mass of
[ $\mathbf{m_e}$ = 电子质量, mass of electron]
(a) 2.75 $\mathbf{m_e}$ (b) 4.40 $\mathbf{m_e}$ (c) 4.89 $\mathbf{m_e}$
(d) 5.39 $\mathbf{m_e}$ (e) 9.11 $\mathbf{m_e}$

27. 两個核子之間的核力在非常短的範圍內具有很强的吸引力。造成此原子核中强烈相互作用的可能範圍是多少？
The nuclear force between two nucleons is strongly attractive for a very short range. What is the possible range for this strong interaction in the nucleus?
(a) $10^{-10}$ m (b) $10^{-12}$ m (c) $10^{-15}$ m
(e) $10^{-18}$ m (e) $10^{-20}$ m

28. 使伽码射线光子產生電子与正電子对的最小能量是
What is the minimum energy of gamma ray photon which can cause electron–positron pair production?
(a) 0.512 MeV (b) 0.819 MeV (c) 1.025 MeV
(d) 1.638 MeV (e) 9.110 MeV

29. 施加到 X 射線管以產生 1Å 的 X-射線光子的最小電壓是
What is the minimum voltage applied to an **X**-ray tube to produce **X**-ray photon of 1Å?
(a) 1.6 kV (b) 10.0 kV (c) 12.4 kV
(d) 24.8 kV (e) 以上皆非 None of the above

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30. 氦-氖雷射光（波长 λ = 633 nm）穿過直径為 0.50 mm 的孔洞。觀察屏應放置多遠以觀察其中心最大直径為 3.0 mm 的衍射圖案？

Light from a helium-neon laser (wavelength λ = 633 nm) passes through a 0.50 mm diameter hole. How far away should a viewing screen be placed to observe a diffraction pattern whose central maximum is 3.0 mm in diameter?

(a) 0.97 m (b) 1.94 m (c) 2.37 m
(d) 6.33 m (e) 以上皆非 None of the above

31. 黑洞的半径为 R。其質量和以下那項成正比？

A black hole has radius **R**. Its mass is proportional to:

(a) $R^{1/2}$ (b) $R^{3/4}$ (c) $R$
(d) $R^{2}$ (e) $R^{3}$

32. 1.0 TeV 質子的德布羅意波的波長是

What is the de Broglie wavelength of a 1.0 **TeV** proton?

(a) $1.00\times10^{-12}$ m (b) $0.96\times10^{-15}$ m (c) $2.87\times10^{-17}$ m
(d) $1.30\times10^{-20}$ m (e) 以上皆非 None of the above

33. 在核裂變過程中，一个原子核被分解為两個較小的原子核。最可能產生核裂變的同位素是

During nuclear fission process, an atomic nucleus is broken into two smaller nuclei. Which of the following isotopes has the largest fissionability?

(a) $^{140}_{54}\mathrm{Xe}$ (b) $^{235}_{92}\mathrm{U}$ (c) $^{240}_{94}\mathrm{Pu}$
(d) $^{254}_{98}\mathrm{Cf}$ (e) $^{258}_{100}\mathrm{Fm}$

34. 現今宇宙的可能年齡是

What is the possible age of our present universe?

(a) $1.375\times10^{6}$ 年 years (b) $13.75\times10^{6}$ 年 years
(c) $1.375\times10^{9}$ 年 years (d) $13.75\times10^{9}$ 年 years
(e) $137.5\times10^{9}$ 年 years

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35. 最先證明原子核存在的實驗是

Which of the following experiments first proved the existence of the nucleus?

(a) 斯特恩－革拉赫實驗 Stern - Gerlach experiment

(b) 詹姆斯·查德威克實驗 James Chadwick experiment

(c) 密立根油滴實驗 Millikan oil - drop experiment

(d) 光電效應實驗 Photoelectric Effect experiment

(e) 拉塞福散射實驗 Rutherford scattering experiment

*The following constants may be used in your calculations, unless stated otherwise:*

*Speed of light* $c = 3.00 \times 10^{8} ms^{-1}$

*Electron charge* $e = -1.60 \times 10^{-19} C$

*Electron mass* $m_e = 9.11 \times 10^{-31} kg$

*Proton mass* $m_p = 1.67 \times 10^{-27} kg$

*Planck's constant* $h = 6.63 \times 10^{-34} Js$