《物理》試題評析/命中事實

試題評析

本年度考題分佈非常不均勻，往年出題者在近代物理部分著墨不多，至多出個 1 至 2 題，今年則大手筆地出了 5 題，而且過去不曾出現過的波動力學(機率波)和軌道量子數問題，也成了出題重點，沒有學過這部分內容的同學，要拿到 90 分以上並不容易。

一、考題落點:
近代物理：5 題
熱力學：3 題
磁場與電磁感：3 題
質點運動：2 題
物理光學：2 題
電場與直流電路：2 題
功與能：2 題
剛體的轉動：2 題
交流電路：1 題
流體力學：1 題
碰撞：1 題
聲波：1 題

二、沒有任何艱澀的計算,考的仍是基本觀念和物理定義.絕大多數的題目都是一看就知道答案.

三、面對此種命題趨勢的變化.未來考生應捨棄涉及複雜計算的問題,而將研讀的範圍加大.

講義命中事實

徐白老師

考　題	類　似　題　目	相 似 度
1	題庫 B(s),ch2,ex60	95%
2	題庫 A(h),ch6,ex92	100%
3	題庫 B(s),ch7,ex13	80%
4	講義,P10-48,ex48	100%
5	講義,P11-75,計算分析	99%
6	題庫 A(h),ch16,ex88	80%
7	講義,P15-11, ex10	99%
8	題庫 A(h),ch10,ex125	90%
9	講義,P2-31, ex29	95%
10	題庫 B(s),ch27,ex45	100%
11	講義,P18-11,ex8	95%
12	講義,P14-44,ex47	90%
13	題庫 B(s),ch22,ex24	99%
14	題庫 B(s),ch28,ex62＜但此題未講解＞	90%
15	題庫 A(h),ch10,ex209	99%
16	講義,P10-24,內容敘述	70%
17	題庫 B(s),ch29,ex23＜題目完全相同,但已超出課程範圍.未發放＞	0%
18	總複習 ch5,ex6	95%
19	題庫 B(s),ch15,ex37,38	98%
20	講義,P5-24,ex23	95%
21	題庫 A(h),ch6,ex43	80%
22	總複習 ch7,ex52,53	95%
23	題庫 B(s),ch28,ex4	95%
24	實力測驗 T13,ex4	90%
25	講義,P4-30,ex30	100%

《物理》

【單選題】每題 4 分，共計 100 分，答錯一題倒扣 1 分，倒扣至零分爲止，未作答，不給分不扣分。

(B)1. Carts A and B have equal masses and travel equal distances D on side-by-side straight frictionless tracks while a constant
force F acts on A and a constant force 2F acts on B. Both carts start from rest. The velocities v_A and v_B of the bodies at the end of distance D are related by
(A) $v_B = v_A$ (B) $v_B = \sqrt{2}v_A$ (C) $v_A = 2v_B$
(D) $v_A = 4v_B$ (E) $v_B = 2v_A$

(A)2. A solid sphere, spherical shell, solid cylinder and a cylindrical shell all have the same mass *m* and radius *R*. If they are all
released from rest at the same elevation and roll without slipping, which reaches the bottom of an inclined plane first?
(A) solid sphere (B) spherical shell
(C) solid cylinder (D) cylindrical shell
(E) all take the same time

(C)3. Cubical blocks of mass *m* and side ℓ are piled up in a vertical column. The total gravitational potential energy of a column
of three blocks is
(A) 2.5 $mg\ell$ (B) 3 $mg\ell$ (C) 4.5 $mg\ell$ (D) 6 $mg\ell$
(E) 9 $mg\ell$

(A)4. An ideal gas is allowed to undergo a free expansion. If its initial volume is V_1 and its final volume is V_2, the change in
entropy is
(A) $nR \ln (V_2/V_1)$ (B) $nRT \ln (V_2/V_1)$ (C) $nk \ln (V_2/V_1)$
(D) 0 (E) $nR \quad V_2/V_1$

(E)5. A parallel plate capacitor of capacitance C_0 has plates of area *A* with separation *d* between them. When it is connected to a
battery of voltage V_0, it has charge of magnitude Q_0 on its plates. While it is connected to the battery, the space between the plates is filled with a material of dielectric constant 3. After the

dielectric is added, the magnitude of the charge on the plates and the potential difference between them are

(A) $3Q_0, 3V_0$ (B) $\frac{1}{3}Q_0, \frac{1}{3}V_0$ (C) $Q_0, \frac{1}{3}V_0$

(D) Q_0, V_0 (E) $3Q_0, V_0$

(C)6. To decrease the intensity of the sound you are hearing from your speaker system by a factor of 36, you can

(A) reduce the amplitude by a factor of 18 and increase your distance from the speaker by a factor of 2.

(B) reduce the amplitude by a factor of 4 and increase your distance from the speaker by a factor of 3.

(C) reduce the amplitude by a factor of 2 and increase your distance from the speaker by a factor of 3.

(D) reduce the amplitude by a factor of 3 and increase your distance from the speaker by a factor of 12.

(E) reduce the amplitude by a factor of 3 and increase your distance from the speaker by a factor of 4.

(C)7. If an $R = 1$ kΩ resistor, a $C = 1$ μF capacitor, and an $L = 0.2$ H inductor are connected in series with a $V = 150 \sin(377t)$ volts source, what is the maximum current delivered by the source?

(A) 0.007 A (B) 27 mA (C) 54 mA

(D) 0.308 mA (E) 0.34 A

(C)8. In which process will the internal energy of the system ***NOT*** change?

(A) An adiabatic expansion of an ideal gas.

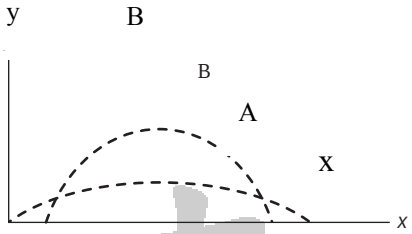
(B) The evaporation of a quantity of a liquid at its boiling point.

(C) An isothermal compression of an ideal gas.

(D) An isobaric expansion of an ideal gas.

(E) The freezing of a quantity of liquid at its melting point.

(B)9. Two balls, projected at different times so they don't collide, have trajectories A and B, as shown below.



Which statement is correct?

(A) v_{0B} must be greater than v_{0A}.

(B) Ball B is in the air for a longer time than ball A.

(C) Ball A is in the air for a longer time than ball B.

(D) Ball B has a greater acceleration than ball A.

(E) Ball A has a greater acceleration than ball B.

(B)10. A binary star system in the constellation Orion has an angular separation between the two stars of 1.2×10^{-5}radians.

If $\lambda = 5 \times 10^{-7}$ m, what is the smallest aperture (diameter) telescope that may be used to resolve the two stars?

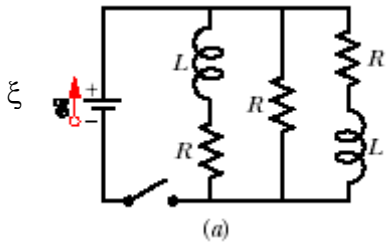
(A) 10 cm (B) 5 cm (C) 50 cm (D) 1 m (E) 4 m

(C)11. We wish to coat flat glass (n=1.5) with a transparent material (n=1.25) so that reflection of light at wavelength 600 nm is eliminated by interference. What minimum thickness can the coating have to do this?

(A) 30 nm (B) 100 nm (C) 120 nm (D) 400 nm (E) 480 nm

(A)12. The figure shows a circuit that contains three identical resistors with resistance R=9.0Ω, two identical inductors with inductance L=4.0 mH, and an ideal battery with emf ξ=36 V. I_A is the current just after the switch is closed, and I_B is the current through the battery long after the switch has been closed. What is the current ratio I_A/I_B?

(A) 1/3 (B) 1/2 (C) 1 (D) 2 (E) 3



(C)13. A long cylindrical wire (radius = 2.0 cm) carries a current of 40 A that is uniformly distributed over a cross section of the wire. What is the magnitude of the magnetic field at a point which is 1.5 cm from the axis of the wire?

(A) 0.53 mT (B) 28 mT (C) 0.30 mT

(D) 40 mT (E) 1.9 mT

(E)14. The average position, or expectation value, of a particle whose wave function $\psi(x)$ depends only on the value of *x*, is given by $<x>=?$

(A) $\int_{-\infty}^{+\infty}\sqrt{x}\psi(x)dx$ (B) $\int_{-\infty}^{+\infty}x\psi(x)dx$ (C) $\int_{-\infty}^{+\infty}(x/2)\psi^2(x)dx$

(D) $\int_{-\infty}^{+\infty}(x^2/2)\psi(x)dx$ (E) $\int_{-\infty}^{+\infty}\psi^*(x)x\psi(x)dx$

(A)15. A company that produces pulsed gas heaters claims their efficiency is approximately 90%. If an engine operates between 250 °C and 25 °C, what is its maximum thermodynamic efficiency?

(A) 43% (B) 56% (C) 65%

(D) 83% (E) 90%

(C)16. A quantum particle

(A) can be localized in space.

(B) can be represented by an infinitely long wave having a single frequency.

(C) can be represented by a wave packet.

(D) travels at the phase speed of the infinitely long wave having the highest frequency.

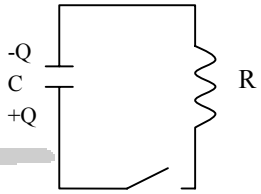
(E) has the highest probability of being present in those regions of space where its component waves interfere destructively.

(B)17. An electron is in a state with *l* =3. What is the smallest value of the semiclassical angle θ between the direction of $\vec{L}_z$ and $\vec{L}$?

(A) 0^o (B) 30^o (C) 60^o

(D) $\cos^{-1}(1/3)$ (E) 90^o

(C)18. A charged capacitor connected to a resistor and a switch, which is open for t<0. After the switch is closed at t=0, the capacitor C is discharged through the resistor R. The energy stored in the capacitor decreases with time as it discharges. After how many time constants is this stored energy one eighth of its initial value? (ln2=0.693)



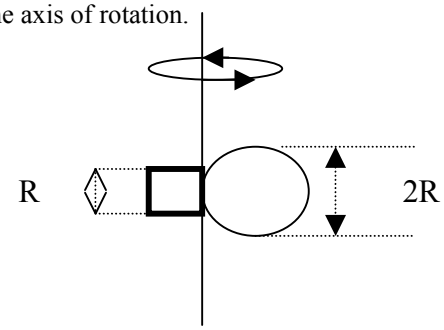
(A) 0.347 RC (B) 0.693 RC (C) 1.040 RC
(D) 1.386 RC (E) 2.079 RC

(E)19. Water enters a house through a pipe with an inside diameter of 2.0 cm at an absolute pressure of 4.0×10^5 Pa. A
1.0 cm-diameter pipe leads to the second-floor bathroom 5.0 m above. When the flow speed at the inlet pipe is 1.5 m/s, find the water pressure in the bathroom. (ρ_{water}=1000 kg/m^3)
(A) 0.17×10^5 Pa (B) 0.32×10^5 Pa (C) 0.49×10^5 Pa
(D) 0.66×10^5 Pa (E) 3.3×10^5 Pa

(A)20. A cart with mass 450 g moving on a frictionless linear air track at an initial speed of 1.5 m/s undergoes an elastic collision with an initially stationary cart of unknown mass. After the collision, the first cart continues in its original direction at
0.70 m/s. What is the mass of the second cart?
(A) 0.16 kg (B) 0.47 kg (C) 1.24 kg
(D) 2.14 kg (E) 3.40 kg

(D)21. The figure shows a rigid structure consisting of a circular hoop of radius R and mass m, and a square made of four thin bars, each of length R and mass m. The rigid structure rotates at a constant speed about a vertical axis, with a period of rotation of 2.5 s. Assuming R=0.5 m and m=2.0 kg, calculate the structure's rotational inertial about the axis of rotation.

$$\left(\begin{array}{l} I_{com}=\frac{1}{2}mR^2\ (\ for\ hoop) \\ I_{com}=\frac{1}{12}mL^2 \\ (\ for\ thin\ rod\ about\ axis\ through\ center \\ perpendicular\ to\ length\ L) \end{array}\right)$$



(A) $\frac{7}{12}mR^2$ (B) $\frac{5}{6}mR^2$ (C) $\frac{7}{6}mR^2$

(D) $\frac{19}{6}mR^2$ (E) $\frac{25}{6}mR^2$

(C)22. What is the de Broglie wavelength of an electron with a kinetic energy of 1.822×10^{-16} J?

($m_e = 9.11\times10^{-31} kg$, h=$6.63\times10^{-34}$ J•s)

(A) 0.3639 pm (B) 3.639 pm (C) 36.39 pm

(D) 363.9 pm (E) 3639.0 pm

(E)23. An LED is constructed from a p-n junction based on a certain Ga-As-P semiconducting material whose energy gap is 1.9 eV. What is the wavelength of the emitted light? (h=6.63×10^{-34} J•s, c=3.00×10^{8} m)

(A) 10.47 nm (B) 16.75 nm (C) 37.79 nm

(D) 113.37 nm (E) 654.28 nm

(D)24. An electron moves through a uniform magnetic field given by $\vec{B} = B_x\vec{i} + (4.0B_x)\vec{j}$. At a particular instant, the electron has velocity $\vec{v} = (2.0\vec{i} + 4.0\vec{j})$ m/s and the magnetic force acting on it is (6.4×10^{-19} N)$\vec{k}$. Find B_x.

(A) -1.6×10^{-19} T (B) -3.2×10^{-19} T (C) -0.22T

(D) -1.0T (E) -2.0T

(A)25.The potential energy of a diatomic molecule (a two-atom system like H_2 or O_2) is given by $U = \frac{A}{r^{12}} - \frac{B}{r^6}$ where r is the separation of the two atoms of the molecule and A and B are positive constants. This potential energy is associated with the force that binds the two atoms together. The force that one atom exerts on the other is:

(A) $\frac{12A}{r^{13}} - \frac{6B}{r^7}$ (B) $\frac{11A}{r^{11}} - \frac{5B}{r^5}$ (C) $\frac{13A}{r^{13}} - \frac{7B}{r^7}$

(D) $\frac{A}{r^{13}} - \frac{B}{r^7}$ (E) $\frac{12A}{r^{12}} - \frac{7B}{r^7}$

徐白老師詳解

1.$F=ma_A$ 且 $2F=ma_B$

$\therefore a_B=2a_A$

兩者均由靜止開始運動

$\therefore V_A^2=2a_AD$

$V_B^2=2a_BD=4a_AD$

$\therefore \frac{V_B^2}{V_A^2}=2 \Rightarrow V_B=\sqrt{2}\,V_A$ 答 : (B)

2.球 :$I=\frac{2}{5}mR^2$

球殼=$\frac{2}{3}mR^2$

圓柱體=$\frac{1}{2}mR^2$

圓柱殼=mR^2

I 最小的物體最先滾下. 答 : (A)

3.將三個物塊均視爲質點.則各質點所在高度由下往上依序爲 :

0.5L,1.5L,2.5L

$\therefore U=(0.5+1.5+2.5)mgL=4.5mgL$ 答 : (C)

4.對等溫過程而言:

$\triangle Q=nRT\ln\frac{V_2}{V_1}$

$\triangle S=\frac{\Delta Q}{T}=nR\ln\frac{V_2}{V_1}$ 答 : (A)

5.電容器插入電介質時,未拆除充電電池.故電壓 $V=V_0$

但已知電容變成 $C=kC_0=3C_0$

由 $C=\frac{Q}{V}$ 可知 $Q=3Q_0$ 答 : (E)

6.聲強 I 和距離 r 的關係爲 : $I\propto\frac{1}{r^2}$

聲強 I 和振幅 A 的關係爲 : $I\propto A^2$

故由題意可知:

(A) $I'=(\frac{1}{18^2}\times\frac{1}{2^2})I$

(B) $I'=(\frac{1}{4^2}\times\frac{1}{3^2})I$

(C) $I'=(\frac{1}{2^2}\times\frac{1}{3^2})I$

(D) $I'=(\frac{1}{3^2}\times\frac{1}{12^2})I$

(E) $I'=(\frac{1}{3^2}\times\frac{1}{4^2})I$ 答 : (C)

7.串聯交流電路之阻抗爲: $Z=\sqrt{(\omega L-\frac{1}{\omega C})^2+R^2}$

$=\sqrt{(377\times0.2-\frac{1}{377\times10^{-6}})^2+1000^2}$

=2764

$\therefore i_0=\frac{V_0}{Z}=\frac{150}{2764}$=0.054A=54Ma 答 : (C)

8.對理想氣體而言,內能僅爲溫度的函數.在等溫過程中△T=0, 故亦有△U=0.

至於涉及相變之等溫過程,因物質吸收(或釋放)潛熱,故內能會改變.

答 : (C)

9.由題目附圖可以看出:

(1) $H_B\rangle H_A$; (2) $R_A\rangle R_B$; (3) $\theta_B\rangle\theta_A$

由 $H_B\rangle H_A\Rightarrow\frac{{V_B}^2\sin^2{\theta_B}^2}{2g}\rangle\frac{{V_A}^2\sin{\theta_A}^2}{2g}$

故知 $\frac{2V_B \sin\theta_B}{g} \rangle \frac{2V_A \sin\theta_A}{g} \Rightarrow t_B \rangle t_A$　　答 : (B)

10. $\theta = 1.22\frac{\lambda}{d}$

$\Rightarrow d = \frac{1.22\times 5\times 10^{-7}}{1.2\times 10^{-5}} = 0.05m$　　答 : (B)

11.這是疏-密-更密型的反射.破壞干涉爲 :

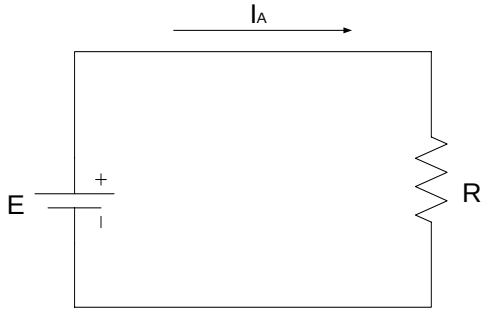
$2nt = (m+\frac{1}{2})\lambda$

$\therefore\ t = \frac{\frac{1}{2}\lambda}{2n} = \frac{\lambda}{4n}$　　(∵求最小厚度時取 m=0)

$= \frac{600}{4\times 1.25}$=120nm　　答 : (C)

12.switch 剛關上時,電感視同開路.

等效電路如圖 1 所示.故

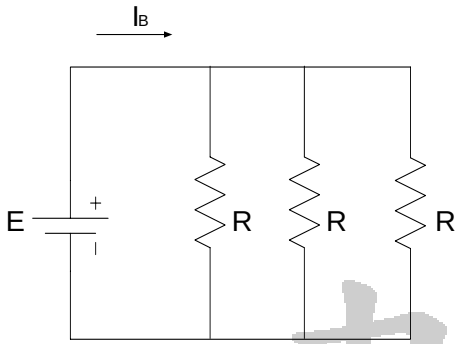


圖一

$I_A = \frac{\varepsilon}{R}$

當 $t \to \infty$,電感變成短路.

等效電路如圖 2 所示.



圖二

$$\therefore I_B = \frac{\varepsilon}{(\frac{R}{3})}$$

$$\frac{I_A}{I_B} = \frac{1}{3}$$

答 : (A)

13.由安培定律 :

$$\oint B \bullet d\ell = \mu_0 I$$

$$\Rightarrow B(2\pi r) = \mu_0 i(\frac{r^2}{R^2})$$

$$\therefore B = \frac{\mu_0 ir}{2\pi R^2}$$

$$= \frac{4\pi \times 10^{-7} \times 40 \times 0.015}{2\pi \times 0.02^2}$$

=0.3mT

答 : (C)

14.在 Shrodinger's Wave Equation 中,波函數 $\Psi(x)$ 代表能量 E 不隨時間變化之穩定態.

$\psi^2(x)$ dV 是在體積 dV 內找到粒子的機率;而粒子之平均位置則爲:

$$\langle x \rangle = \int_{-\infty}^{\infty} \psi(x) x \psi^*(x) dx$$

答 : (E)

15. $e = 1 - \frac{T_c}{T_H} = 1 - \frac{273+25}{273+250}$

=0.43= 43 %　　答 : (A)

16.此處所謂的 quantum particle 應是指物質波而言.一運動之質點可被視爲一個「波包」.

答 : (C)

17.當 $\ell = 3$ 時,軌道磁量子數 m_ℓ 的可能數值爲 0,±1,±2,±3

$$\cos = \frac{L_Z}{L} = \frac{m_\ell}{\sqrt{\ell(\ell+1)}}$$

取 m_ℓ =3 時 θ 有最小值,故

$$\cos\theta = \frac{3}{\sqrt{3\times 4}} = \frac{\sqrt{3}}{2}$$

$\therefore \theta = 30^0$　　答 : (B)

18.R-C 電路放電時, $q = q_0 e^{-t/RC}$

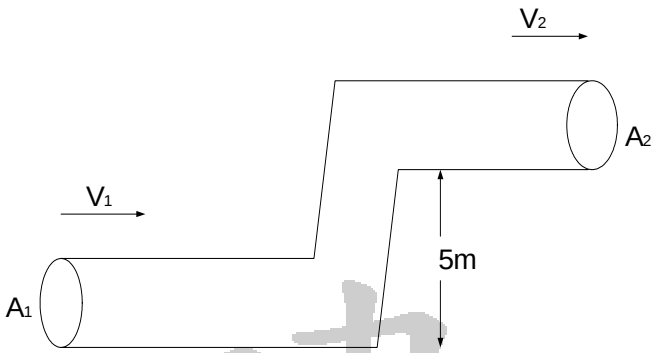
但 $U = \frac{q^2}{C}$

$U' = \frac{U}{8} \Rightarrow q = \frac{q_0}{\sqrt{8}}$

$\therefore \frac{1}{\sqrt{8}} = e^{-t/RC}$

$\frac{t}{RC} = \ell n\sqrt{8} \Rightarrow t = (\ell n\sqrt{8})RC = 1.04RC$　　答 : (C)

19.由連續方程式:



$A_1V_1 = A_2V_2 \Rightarrow 0.01^2\pi \times 1.5 = 0.005^2\pi V_2$

$V_2 = 6\,m/s$

由柏努利方程式可得:

$4\times10^5 + \frac{1}{2}\times1000\times1.5^2 = P + 1000\times9.8\times5 + \frac{1}{2}\times1000\times6^2$

$\Rightarrow P = 3.3\times10^5\,\text{Pa}$ 答 : (E)

20.入射球經碰撞後,速度變爲:

$V_1' = \frac{m-M}{m+m}V$

即 $0.7 = \frac{m-M}{m+m}\times1.5$

$\therefore\ M = \frac{0.8}{2.2}\times0.45 = 0.16Kg$ 答 : (A)

21.與軸垂直的兩段直線 $I_1 = 2\times\frac{1}{3}m\ell^2$

與軸重合的線段 $I_2 = 0$

與軸平行但距離 R 的線段 $I_3 = I_2 + mR^2 = mR^2$

圓環 $I_4 = \frac{1}{2}mR^2 + mR^2 = \frac{3}{2}mR^2$

（不會使用垂直軸定理者,豎直環的 I 可由積分輕易算出）

$\therefore I = I_1 + I_2 + I_3 + I_4$

$$=(\frac{2}{3}+1+\frac{3}{2})mR^2=\frac{19}{6}mR^2$$ 答 : (D)

22. $P=\sqrt{2mK}$

$$=\sqrt{(2\times 9.11\times 10^{-31}\times 1.822\times 10^{-6})}$$

$$=1.82\times 10^{-23}$$

$$\lambda=\frac{h}{P}=\frac{6.63\times 10^{-34}}{1.82\times 10^{-23}}$$

$$=3.64\times 10^{-11}m$$

=36.4 pm 答 : (C)

23.E=$\frac{12400}{\lambda}\Rightarrow\lambda=\frac{12400}{1.9}=6526\text{A}=653nm$ 答 : (E)

24. $F=-e\times\begin{vmatrix} i & j & k \\ 2 & 4 & 0 \\ B_x & 4B_x & 0 \end{vmatrix}=-4eB_xk$

$$B_x=\frac{F_Z}{-4e}=\frac{6.4\times 10^{-19}}{4\times(-1.6\times 10^{-19})}=\text{-1T}$$ 答 : (D)

25. $U=\frac{A}{r^{12}}-\frac{B}{r^6}$

$$F=-\frac{dU}{dr}=-[-12Ar^{-13}-(-6)Br^{-7}]$$

$$=\frac{12A}{r^{13}}-\frac{6B}{r^7}$$ 答 : (A)