

本試題卷共有單選題 25 題，每題 4 分，答錯每題倒扣 1 分。

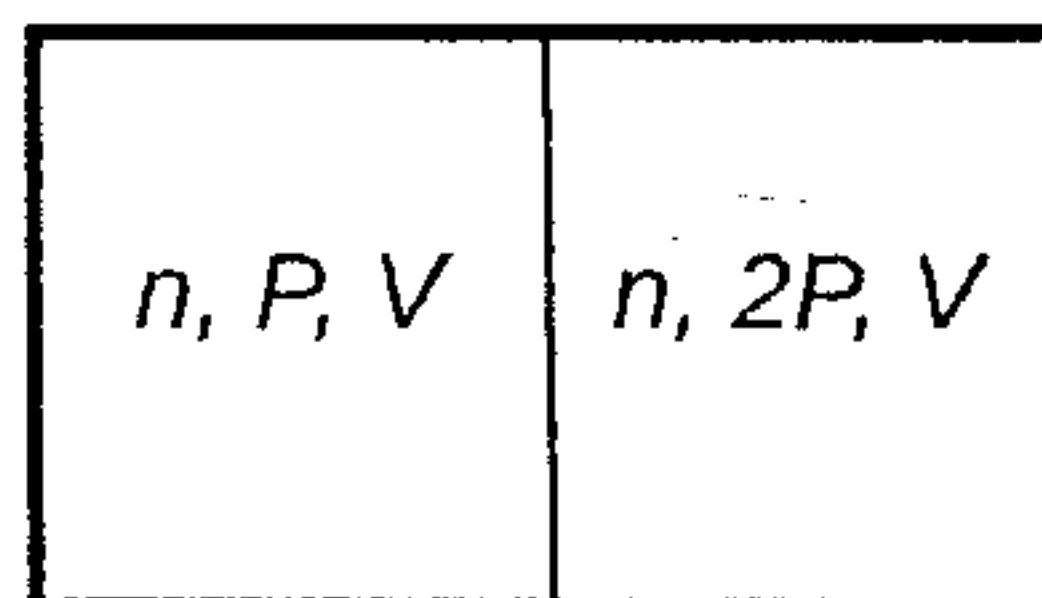
1. Which of the following has the correct dimensions of inductance (in SI units)? (A) $V \cdot s^2/A$; (B) $V \cdot s/C$; (C) $V \cdot s/A$; (D) $J \cdot s/C^2$; (E) none of the above.
 2. Which of the following has the correct dimensions of bulk modulus (in SI units)? (A) Pa; (B) $Pa \cdot m/s$; (C) N/m; (D) $N \cdot m$; (E) none of the above.
 3. Which of the following has the correct dimensions of the permeability constant μ_0 (in SI units)? (A) $T \cdot m/A^2$; (B) $N \cdot m^2/C^2$; (C) N/A^2 ; (D) J/A; (E) none of the above.
 4. Which of the following has the correct dimensions of the Boltzmann's constant k (in SI units)? (A) J·mol/K; (B) J/(K·mol); (C) N/K; (D) J/K; (E) none of the above.
 5. Which of the following has the correct dimensions of the Planck's constant h (in SI units)? (A) J·m; (B) $J \cdot s^2$; (C) $kg \cdot m/s^2$; (D) $kg \cdot m^2/s$; (E) none of the above.
 6. A pinhole camera has a hole of diameter 1 mm. The film is placed 10 cm from the hole. Consider two point objects located 10 m from the hole. Assuming the light has a wavelength of 500nm, what is the minimum separation between the source objects for them to be resolved? (A) 32 cm; (B) 0.32 mm; (C) 6.1 cm; (D) 6.1 mm; (E) 6.1 m.
 7. Suppose the intensity of sunlight (solar radiation) at the surface of the earth is 3000 W/m^2 . What force does it exert on a mirror of area 2 m^2 , assuming normal incidence and total reflection of light? (A) $2 \times 10^{-5} \text{ N}$; (B) $4 \times 10^{-5} \text{ N}$; (C) $4 \times 10^{-4} \text{ N}$; (D) 10^{-4} N ; (E) 10^{-2} N .
 8. Consider a cube of density ρ and horizontal cross-sectional area L^2 with vertical height L . The cube is floating in a liquid with density ρ_L . At equilibrium a fraction L_0/L of the cube is immersed in the liquid. Now let's push down the cube a little bit and release it. What is the period of the subsequent oscillation? (A) $2\pi\sqrt{\frac{\rho L}{\rho_L g}}$; (B) $2\pi\sqrt{\frac{\rho_L L}{\rho g}}$; (C) $2\pi\sqrt{\frac{\rho_L L - L_0}{\rho g}}$; (D) $2\pi\sqrt{\frac{L}{g}}$; (E) none of the above.
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- [9-10] A hollow sphere of mass M and radius R rolls without slipping down an incline of angle ϕ (with respect to the horizontal plane). Its moment of inertia about the central axis is $\frac{2}{3}MR^2$.
9. What is the linear acceleration of the CM (center of mass)? (A) $\frac{2}{7}g \sin \phi$; (B) $g \sin \phi$; (C) $\frac{1}{2}g \sin \phi$; (D) $\frac{3}{5}g \sin \phi$; (E) none of the above.
 10. What is the minimum (static) coefficient of friction required for the hollow sphere to roll without slipping? (A) $\frac{2}{7}$; (B) $\frac{2}{7} \tan \phi$; (C) $\frac{2}{5}$; (D) $\frac{1}{2} \tan \phi$; (E) none of the above.
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- [11-12] Considering the effect of Coriolis force due to earth's self-rotation. Use the approximation that $g \gg \omega^2 R_E$, where ω is the angular frequency of the earth's self rotation, and R_E is the radius of earth.
11. The Deflection angle δ of a plumb line from the true vertical (radial line) at latitude λ is approximately (all angles are represented in radians) (A) $\omega^2 R_E (\sin \lambda)/g$; (B) $\omega^2 R_E (\cos \lambda)/g$; (C) $\omega^2 R_E (\sin 2\lambda)/2g$; (D) $\omega^2 R_E (\cos 3\lambda)/2g$; (E) none of the above.

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12. At which latitude (in radians) does one observe the largest deflection? (A) 0; (B) $\pi/6$; (C) $\pi/4$; (D) $\pi/2$; (E) none of the above.

- [13-14] In Compton's scattering experiment, suppose a high-energy photon of wavelength λ moves in the $+x$ direction and collides with a particle at rest (with rest mass m). After the collision the scattered photon moves backwards (in the $-x$ direction) with a wavelength λ' .
13. The wavelength of the scattered photon λ' is equal to (A) $\lambda - 2h/(mc)$; (B) $\lambda + 2h/(mc)$; (C) $\lambda/(1 + mc\lambda/h)$; (D) $\lambda/(1 - mc^2\lambda/h)$; (E) none of the above.
14. What is the momentum of the scattered particle? (A) $-hc(1/\lambda + 1/\lambda')$; (B) $hc(1/\lambda - 1/\lambda')$; (C) $h(1/\lambda + 1/\lambda')$; (D) $h(1/\lambda - 1/\lambda')$; (E) none of the above.

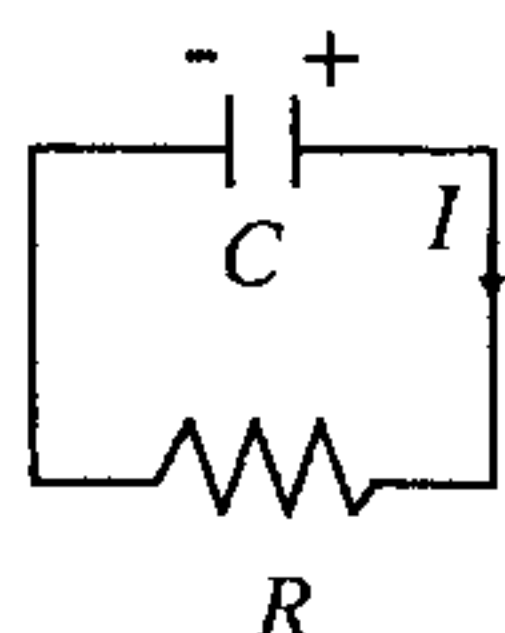


Probs. 15-18

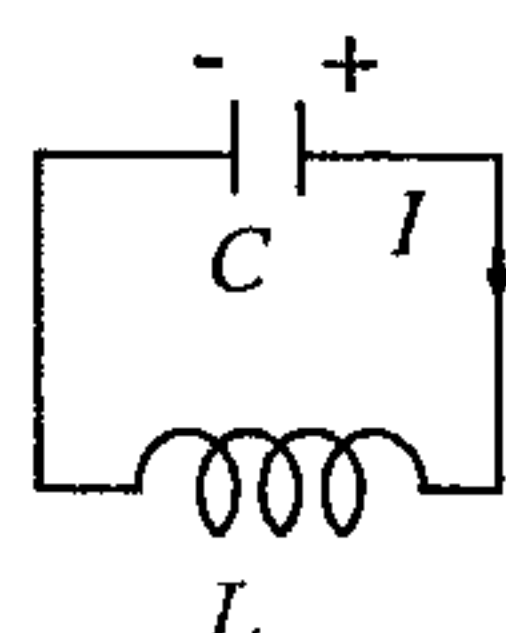
- [15-18] A thin partition divides an heat-insulated container into two equal volumes (each with volume V). Initially, the volume on the left side contains n moles of monatomic ideal gas at pressure P , while the volume on the right side contains n moles of the same ideal gas at a different pressure $2P$. If heat can be conducted through the partition, the two sides eventually come to a thermodynamic equilibrium. Assume the partition is fixed in position so the volumes at the two sides remain unchanged throughout the process.
15. How much heat is transported from the right volume to the left during this process? (A) PV ; (B) $\frac{1}{2}PV$; (C) $\frac{2}{3}PV$; (D) $\frac{3}{4}PV$; (E) none of the above.
16. What is the change in total entropy of the system? (A) $\frac{3}{2}nR \ln \frac{9}{8}$; (B) $\frac{3}{2}nR \ln \frac{8}{9}$; (C) $\frac{3}{8}nR$; (D) 0; (E) none of the above.
- [17-18] Now let's consider a different situation, in which the partition is a valve that can move freely in the horizontal direction. Moreover, let's assume that the partition is heat-insulating, and therefore there is no heat transfer between gases at the two volumes. We assume the expansion/compression to be adiabatic (note that $\gamma = 5/3$ for a monatomic ideal gas).
17. What is magnitude of the change in volume ΔV when mechanical equilibrium is achieved (where the net force on the partition is zero)? (A) $(2^{5/3} - 1)/(2^{5/3} + 1)V$; (B) $(2^{3/5} - 1)/(2^{3/5} + 1)V$; (C) $(1/3)V$; (D) $2^{3/5}/(2^{3/5} + 1)V$; (E) none of the above.

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Probs. 19-20



Probs. 21-22

18. What is the ratio of temperatures T'_R/T'_L at mechanical equilibrium? ('R': right side; 'L': left side.) (A) 2; (B) 1; (C) $2^{3/5}$; (D) $2^{5/3}$; (E) none of the above.

- [19-22] A circuit contains a series combination of a resistor (of resistance R) and a capacitor (of capacitance C). The capacitor is initially (at $t = 0$) charged by Q_0 .

19. What is the maximal current I_{\max} in this circuit? (A) Q_0/C ; (B) Q_0R/C ; (C) Q_0/\sqrt{RC} ; (D) Q_0/RC ; (E) none of the above.

20. What is the behavior of the current $I(t)$ in this circuit? (A) $I_{\max} \exp(-t/RC)$; (B) $I_{\max}(1 - \exp(-t/RC))$; (C) $I_{\max} \exp(-t/\sqrt{RC})$; (D) $I_{\max}RC/(t + RC)$; (E) $I_{\max} \cos(2\pi t/RC)$.

- [21-22] Let's replace the resistor with an inductor of inductance L . And again, the capacitor is initially charged by Q_0 .

21. What is the maximal current I_{\max} in this circuit? (A) Q_0/LC ; (B) Q_0/\sqrt{LC} ; (C) Q_0L/C ; (D) Q_0C/L ; (E) none of the above.

22. What is the behavior of the current $I(t)$ in this circuit? (A) $I_{\max} \exp(-t/\sqrt{LC})$; (B) $I_{\max} \exp(-t/LC)$; (C) $I_{\max} \sin(t/\sqrt{LC})$; (D) I_{\max} , a constant; (E) $I_{\max} \cos(2\pi t/\sqrt{LC})$.

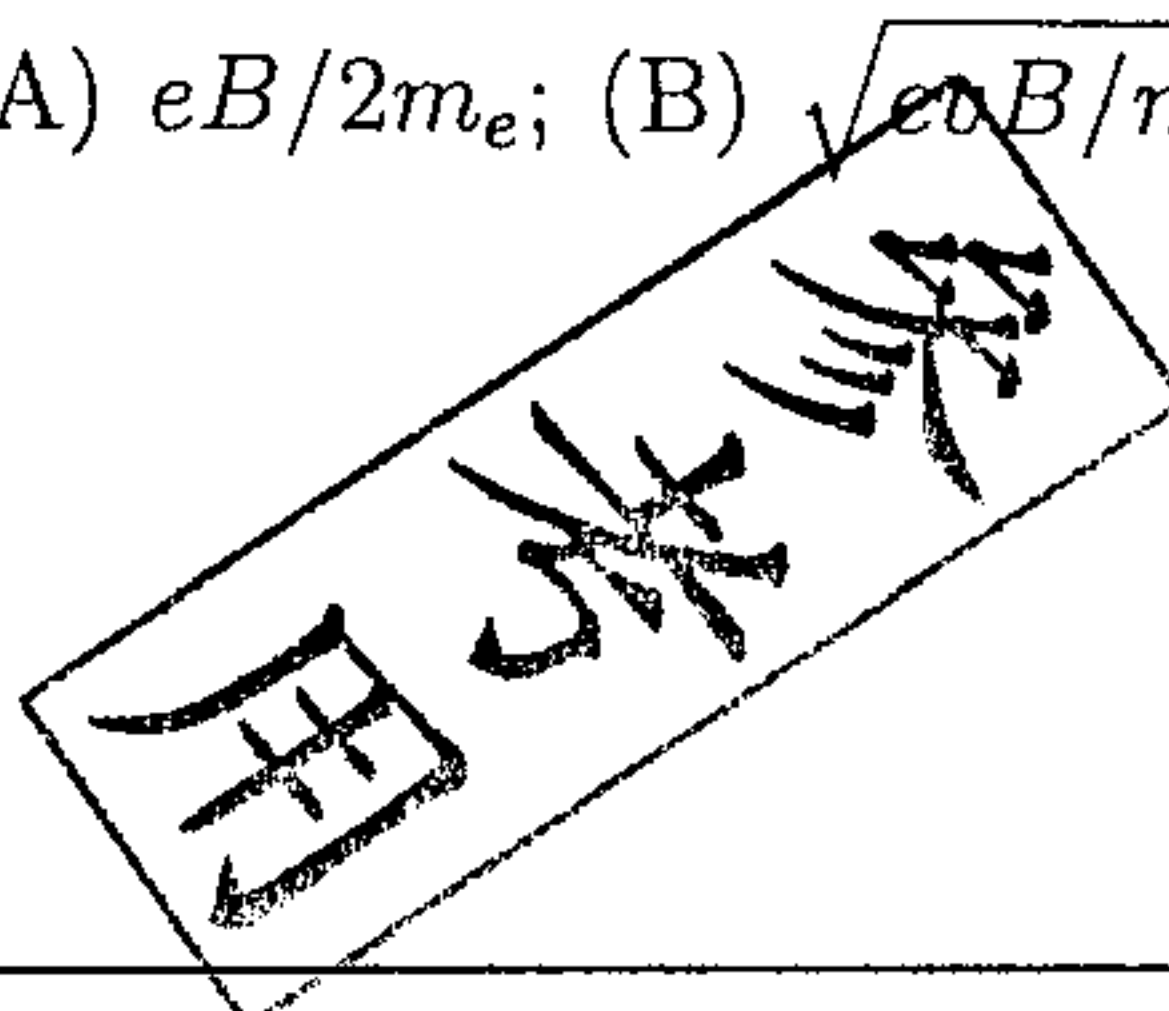
- [23-25] As described in the Bohr model, an electron is circularly orbiting a proton in a hydrogen atom with radius r_B and velocity v . The orbital angular momentum of the electron is in the $+\hat{z}$ direction.

23. What is the magnitude of magnetic field at the center of the orbit due to the electron's motion? (A) $\frac{\mu_0 I}{\pi r_B^2}$; (B) $\frac{\mu_0 I}{2\pi r_B}$; (C) $\frac{\mu_0 I}{2r_B}$; (D) $\frac{\mu_0 I}{r_B}$; (E) none of the above.

24. What is the magnitude of magnetic (dipole) moment $\vec{\mu}$ associated with this motion? (A) $evr/2$; (B) evr ; (C) evr^2 ; (D) $e\pi r^2$; (E) none of the above.

- Now suppose a weak (in the sense that $eB \ll 2m\omega$, where ω is the original angular frequency) magnetic field $\vec{B} = B\hat{z}$ is turned on normal to the plane of this orbit. The original angular frequency ω becomes $\omega' = \omega + \Delta\omega$.

25. Suppose the orbital radius is unchanged. What is $\Delta\omega$? (A) $eB/2m_e$; (B) $\sqrt{e\hbar B/m_e r_B}$; (C) $evB/m_e r_B$; (D) v/r_B ; (E) none of the above.



台灣聯合大學系統 101 學年度學士班轉學生招生

「普通物理」考科試題修正及補充說明

第 17 題: "change in volume" 改爲 "change in the left volume"

第 23 題: 補充敘述: ' I ' is the electron current

參考用