

國立成功大學

111學年度碩士班招生考試試題

編 號：94

系 所：材料科學及工程學系
(綠色應用材料碩士班)

科 目：物理

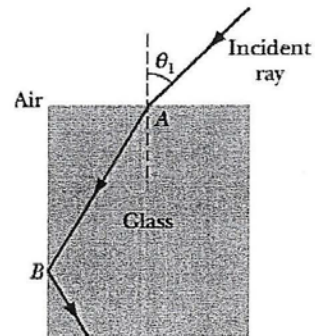
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備 註：可使用計算機

※ 考生請注意：本試題可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。物理共 50 題選擇題，每題答對得 2 分，答錯倒扣 0.5 分；滿分 100 分，倒扣至 0 分為止。

- The Hubble's law (a) describes the relationship between the recession speed of a remote star and the distance between the earth and the star, (b) suggests that the universe is not expanding, (c) indicates the recession speed of a remote star is an exponential function of the distance between the earth and the star, or (d) does not support the big bang theory.
- A closely wound coil has a diameter of 40 cm and carries a current of 2.5 A. How many turns does it have if the magnetic field at the center of the coil is 1.26×10^{-4} T? (a) 15 (b) 16 (c) 18 (d) 20.
- If the ground state energy of the electron in hydrogen atom is -13.6 eV, what is the first excited state energy of the electron in helium ion (He^+)? (a) -1.5 eV (b) -3.4 eV (c) -13.6 eV (d) -54.4 eV.
- A single slit 0.20mm wide is illuminated by monochromatic light of waviness 600nm, producing a diffraction pattern on a screen 1.5m away. Find the distance between the first and fifth diffraction minima. (a)9mm (b)18mm (c)27mm (d)36mm.
- A beam of light in air strikes a slab of glass ($n=1.56$) and is partially reflected and partially refracted. What is the angle of incidence if the angle of reflection is twice the angle of refraction? (a) 47.5° (b) 57.5° (c) 67.5° (d) 77.5° .
- If the magnetic field of a light wave oscillates parallel to a y axis and is given by $B_y = B_m \sin(kz - \omega t)$, parallel to which axis does the associated electric field oscillate? (a) x (b) y (c) z (d) random.
- In the right figure, a light ray enters a glass slab at point A at incident angle $\theta_1 = 45.0^\circ$ and then undergoes total internal reflection at point B. (The reflection at A is not shown.) What minimum value for the index of refraction of the glass can be inferred from this information? (a) 1.22 (b) 1.23 (c) 1.24 (d) 1.25.



- The capacitance of a parallel-plate capacitor can be increased by:
 - increasing the charge
 - decreasing the plate area
 - increasing the plate separation
 - decreasing the plate separation.
- A block of density ρ_b and mass M_b floats in a fluid of density ρ_f . The block has height H , width W , and length L . By what depth is the block submerged? (a) $\frac{\rho_f}{\rho_b} H$ (b) $\frac{\rho_b M_b}{\rho_f} H$ (c) $\frac{\rho_b}{\rho_f} H$ (d) $\frac{\rho_b}{\rho_f M_b} H$.
- L_β X-rays are generated when electrons transfer: (a) from the orbital quantum number $l=4$ to $l=3$ (b) from the orbital quantum number $l=4$ to $l=2$ (c) from the principal quantum number $n=4$ to $n=3$ (d) from the principal quantum number $n=4$ to $n=2$

11. If the Iron man travels at a speed of $0.8c$ while you are on the earth, then when your heart beats 5 times, how many heart beats does the Iron man have? (c is the speed of light.) (a) 5, (b) 4, (c) 3, or (d) 2.
12. Consider the isothermal compression of 0.10 mol of an ideal gas at $T = 0^\circ\text{C}$. The initial pressure is 1 atm and the final volume is $1/5$ the initial volume. Determine the work required. (a) 364 J (b) 366 J (c) 368 J (d) 370 J.
13. Find the amplitude of air-molecule oscillation in a plane sound wave that has a frequency of 3000 Hz and intensity level of 60 dB. Use 343 m/s as the speed of sound and 1.21 kg/m^3 as the density of air.
(a) 3.68 nm (b) 36.8 nm (c) 368 nm (d) $3.68 \mu\text{m}$.
14. A uniform magnetic field, with magnitude 1.2 mT, is directed vertically upward throughout the volume of a laboratory chamber. A proton with kinetic energy 5.3 MeV enters the chamber, moving horizontally from south to north. What magnetic deflecting force acts on the proton as it enters the chamber? The proton mass is $1.67 \times 10^{-27} \text{ kg}$ and charge is $1.60 \times 10^{-19} \text{ C}$. (Neglect Earth's magnetic field.) (a) $6.1 \times 10^{-15} \text{ N}$ (b) $6.1 \times 10^{-10} \text{ N}$ (c) $6.1 \times 10^{-5} \text{ N}$ (d) $6.1 \times 10^0 \text{ N}$.
15. A 32-cm-long solenoid, 1.8 cm in diameter, is to produce a 0.30-T magnetic field at its center. If the maximum current is 4.5 A, how many turns must the solenoid have? (a) 170 (b) 1700 (c) 17000 (d) 170000.
16. What inductance must be connected to a 17 pF capacitor in an oscillator capable of generating 550 nm electromagnetic waves? (a) $5.0 \times 10^{-19} \text{ H}$ (b) $5.0 \times 10^{-20} \text{ H}$ (c) $5.0 \times 10^{-21} \text{ H}$ (d) $5.0 \times 10^{-22} \text{ H}$.
17. A ray of white light traveling through fused quartz is incident at a quartz-air interface at angle θ_1 . Assume that the index of refraction of quartz is $n = 1.456$ at the red end of the visible range and $n = 1.470$ at the blue end. If θ_1 is 44.00° , what is the refracted light? (a) white (b) white dominated by the red end of the visible range (c) white dominated by the blue end of the visible range (d) no refracted light.
18. A 2- μF and a 1- μF capacitor are connected in parallel and a potential difference is applied across the combination. The 2- μF capacitor has: (a) twice the charge of the 1- μF capacitor (b) half the charge of the 1- μF capacitor (c) twice the potential difference of the 1- μF capacitor (d) half the potential difference of the 1- μF capacitor.
19. A nucleus (a) may not have angular momentum, (b) may have angular momentum and magnetic moment, (c) may not have magnetic moment, or (d) may not have angular momentum or magnetic moment.
20. A 2-kg mass hangs on the end of a spring in the position of rest. It requires a force of 2 N to stretch the spring an additional 4 cm. If the force is then suddenly removed, the mass executes simple harmonic motion (SHM) vibration. Find the total energy ($=a \text{ J}$), and the frequency ($=b \text{ s}^{-1}$). What is (a, b) ? (a) (0.769, 0.04) (b) (0.04, 0.769) (c) (0.04, 0.122) (d) (0.122, 0.769).

21. Which of the following describes identical particles having odd half-integral spins and being undistinguishable? (a) Maxwell-Boltzmann distribution, (b) Bose-Einstein distribution, (c) Fermi-Dirac distribution, or (d) Maxwell distribution.
22. A Carnot engine whose high-temperature reservoir is at 400 K takes in 100 cal of heat at this temperature in each cycle, and gives up 80 cal to the low-temperature reservoir. What is the thermal efficiency of the cycle? (a) 10% (b) 20% (c) 30% (d) 40%.
23. The E-string on a violin is 33cm long and its mass per unit length is $5.46 \times 10^{-4} \text{ kg/m}$. What tension F is required to make it vibrate in its fundamental mode at 660Hz? (a) 546N (b) 436N (c) 218N (d) 104N.
24. A coil has an inductance of 53 mH and a resistance of 0.35 Ω . If a 12 V emf is applied across the coil, how much energy is stored in the magnetic field after the current has built up to its equilibrium value? (a) 51 J (b) 41 J (c) 31 J (d) 21 J.
25. Which of the following is the benefit of Maxwell equation? (a) Antenna that can be designed (b) Any parameter that can be calculated (c) Polarisation of the wave that can be calculated (d) Transmission line constants that can be found.
26. Some neodymium-glass lasers can provide 100 TW of power in 1.0 ns pulses at a wavelength of 0.26 μm . How much energy is contained in a single pulse? (a) 0.38 MJ (b) 0.26 MJ (c) 0.13 MJ (d) 0.10 MJ.
27. The temperature of n moles of an ideal monatomic gas is increased by ΔT at constant volume. The energy Q absorbed as heat, change ΔE_{int} in internal energy, and work W done by the environment are given by: (a) $Q = (5/2)nR \Delta T$, $\Delta E_{\text{int}} = 0$, $W = 0$ (b) $Q = (3/2)nR \Delta T$, $\Delta E_{\text{int}} = (3/2)nR \Delta T$, $W = 0$ (c) $Q = (3/2)nR \Delta T$, $\Delta E_{\text{int}} = (1/2)nR \Delta T$, $W = -nR \Delta T$ (d) $Q = (3/2)nR \Delta T$, $\Delta E_{\text{int}} = 0$, $W = -(3/2)nR \Delta T$.
28. A 60-watt light bulb carries a current of 0.5A. The total charge passing through it in one hour is: (a) 3600 Coul (b) 1800 Coul (c) 3000 Coul (d) 2400 Coul.
29. If the bond energy for H_2^+ is 2.65 eV, then the bond energy for H_2 is (a) 2.65 eV, (b) 5.3 eV, (c) more than 5.3 eV, or (d) less than 5.3 eV.
30. The stream of water emerging from a faucet necks down as it falls. This change in the horizontal cross-sectional area is characteristic of any laminar (non-turbulent) falling stream because the gravitational force increases the speed of the stream. Assume the cross-sectional areas of the faucet is $A_0 = 1.2 \text{ cm}^2$ and the cross-sectional areas of water stream that is 45 mm below the faucet is $A = 0.35 \text{ cm}^2$. What is the volume flow rate from the tap? (a) $33 \text{ cm}^3/\text{s}$ (b) $34 \text{ cm}^3/\text{s}$ (c) $72 \text{ cm}^3/\text{s}$ (d) $56 \text{ cm}^3/\text{s}$.
31. Particles having odd half-integral spins have wave functions that are (a) symmetric, (b) antisymmetric, (c) either symmetric or antisymmetric, or (d) none of the above.
32. An ice cube of weight 546 g melts into water at 0°C . What is the entropy change of the mass? (Latent heat of ice is $3.335 \times 10^5 \text{ J/kg}$.) (a) 167 J/K (b) 334 J/K (c) 667 J/K (d) 946 J/K.
33. An air wedge is formed between two glass plates in contact along one edge and slightly separated at the opposite edge. When illuminate with monochromatic light from above, the reflective light reveals a

- total of 85 dark fringes. Calculate the number of dark fringes that would appear if water ($n=1.33$) were to replace the air between the plates. (a)78 (b)88 (c)103 (d)113.
34. A whistle of frequency 540 Hz moves in a circle of radius 60.0 cm at an angular speed of 15.0 rad/s. What are the lowest, f_l , and highest frequencies, f_h , heard by a listener a long distance away, at rest with respect to the center of the circle? (a) $f_l=526$ Hz; $f_h=564.6$ Hz (b) $f_l=517.4$ Hz; $f_h=554.6$ Hz (c) $f_l=526$ Hz; $f_h=554.6$ Hz (d) $f_l=517.4$ Hz; $f_h=564.6$ Hz (e) $f_l=530$ Hz; $f_h=550$ Hz.
35. A plane electromagnetic wave, with wavelength 3.0 m, travels in vacuum in the positive direction of an x axis. The electric field, of amplitude 300 V/m, oscillates parallel to the y axis. The wave uniformly illuminates a surface of area 2.0 m². If the surface totally absorbs the wave, what is the radiation pressure on the surface? (a) 4.0×10^{-4} Pa (b) 4.0×10^{-5} Pa (c) 4.0×10^{-6} Pa (d) 4.0×10^{-7} Pa.
36. An ideal gas expands into a vacuum in a rigid vessel. As a result there is: (a) a change in entropy (b) an increase of pressure (c) a change in temperature (d) a decrease of internal energy.
37. Force $\vec{F} = (3x^2)\mathbf{i} + (4y)\mathbf{j}$ (N), with x in meters, acts on a particle, changing only the kinetic energy of the particle. How much work is done on the particle as it moves from coordinates (2 m, 3 m) to (3 m, 0 m)? (a) 7.0 J (b) 15.0 J (c) 18.0 J (d) 20.0 J.
38. A piece of ice falls from rest into a lake at 0°C, and one-half of one percent of the ice melts. Compute the minimum height from which the ice falls. (a) 171 m (b) 172 m (c) 173 m (d) 174 m.
39. What is the thermal efficiency of an engine that operates by taking an ideal gas through the following cycle? Let $C_V = 12 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$. 1. Start with n moles at P_0, V_0, T_0 . 2. Change to $2P_0, V_0$, at constant volume. 3. Change to $2P_0, 2V_0$, at constant pressure. 4. Change to $P_0, 2V_0$, at constant volume. 5. Change to P_0, V_0 , at constant pressure. (a) 15.6% (b) 15.7% (c) 15.8% (d) 15.9%.
40. The Mach number used by the aerodynamicists is the ratio of the speed of an air-craft to the speed of sound in the air through which the plane is flying. If the supersonic jet Concorde flies at Mach 2.1, where the local speed of sound is 320m/s, find the half-angle of the resultant conical shock wave. (a) 24.8 degrees (b)28.4 degrees (c)42.8 degrees (d)48.2 degrees.
41. A cylindrical conductor of circular cross section has a radius of α and a resistivity ρ and carries a constant current I . What are the magnitude and direction of the H-vector at the same point? (a) $Ir/\pi\alpha^2$, parallel to wire (b) $Ir/\pi\alpha^2$, perpendicular to wire (c) $Ir/2\pi\alpha^2$, perpendicular to wire (d) $Ir/2\pi\alpha^2$, parallel to wire.
42. How many possible directions in space for the vector of orbital angular momentum with the orbital quantum number $l=3$? (a) 4 (b) 5 (c) 6 (d) 7.
43. The ballistic pendulum was used to measure the speeds of bullets. It consists of a large block of wood of mass $M=5.4$ kg, hanging from two long cords. A bullet of mass $m=9.5$ g is fired into the block, coming quickly to rest. The block & bullet then swing upward, their center of mass rising a vertical distance $h=6.3$ cm before the pendulum comes momentarily to rest at the end of its arc. What is the speed of the bullet just prior to the collision? (a) 450 m/s (b) 200 m/s (c) 630 m/s (d) 600 m/s.
44. A camera lens with index of refraction greater than 1.30 is coated with a thin transparent film of index of refraction 1.25 to eliminate by interference the reflection of light at wavelength λ that is incident

- perpendicularly on the lens. What multiple of λ gives the minimum film thickness needed? (a) 0.5λ (b) 0.4λ (c) 0.3λ (d) 0.2λ (e) 0.1λ .
45. The electric potential in a certain region of space is given by $V = -7.5x^2 + 3x$, where V is in volts and x is in meters. In this region the equipotential surfaces are: (a) planes parallel to the yz plane (b) planes parallel to the x axis (c) concentric spheres centered at the origin (d) concentric cylinders with the x axis as the cylinder axis.
46. One end of a steel rod of radius $R = 9.5 \text{ mm}$ and length $L = 81 \text{ cm}$ is held in a vise. A force of magnitude $F = 62 \text{ kN}$ is then applied perpendicularly to the end face (uniformly across the area) at the other end, pulling directly away from the vise. Young's modulus for steel is $2.0 \times 10^{11} \text{ N/m}^2$. What is the strain of the rod? (a) 0.41% (b) 0.31% (c) 0.21% (d) 0.11%.
47. During an adiabatic expansion, the temperature of 0.1 mol of oxygen drops from 30°C to 10°C . How much work does the gas do? (a) 40.0 J (b) 41.0 J (c) 42.0 J (d) 43.0 J.
48. The amplitude of the vibrations of a certain sound wave is increased by 50%. What is the increase in the decibel level of the sound? (a) 3.52dB (b) 35.2dB (c) 1.76dB (d) 17.6dB.
49. When the rectangular metal tank in the below figure is filled to the top with an unknown liquid, observer O , with eyes level with the top of the tank, can just see corner E . A ray that refracts toward O at the top surface of the liquid is shown. If $D = 85.0 \text{ cm}$ and $L = 1.10 \text{ m}$, what is the index of refraction of the liquid? (a) 1.26 (b) 1.28 (c) 1.30 (d) 1.32.
50. To throw an 80 kg opponent with a basic judo hip throw, you intend to pull his uniform with a force and a moment arm $d_1 = 0.30 \text{ m}$ from a pivot point (rotation axis) on your right hip. Before you throw him, you bend your opponent forward to bring his center of mass to your hip. If you wish to rotate him about the pivot point with an angular acceleration of 6.0 rad/s^2 what must the magnitude of the force be? Assume that his rotational inertia relative to the pivot point is $15 \text{ kg}\cdot\text{m}^2$. (a) 300 N (b) 15680 N (c) 39 N (d) 2940 N.

