

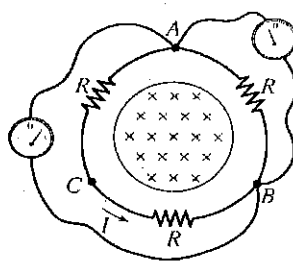
國立中央大學104學年度碩士班考試入學試題

所別：物理學系碩士班 不分組(一般生) 科目：普通物理 共 2 頁 第 2 頁  
 物理學系碩士班 不分組(在職生)

本科考試禁用計算器

\*請在答案卷(卡)內作答

參考用

10. A gas mixture contains monatomic argon and diatomic oxygen. Suppose the temperature range is such that the numbers of degrees of freedom are 3 for the monatomic argon and 5 for the diatomic oxygen. An adiabatic expansion that doubles its volume results in the pressure dropping to one-third of its original value. What fraction of the molecules are argon?  
 (a) 45% (b) 62% (c) 79% (d) 85% (e) 93%
11. A satellite is in circular orbit at an altitude of 1500 km above the surface of a non-rotating planet with an orbital speed of 9.2 km/s. The minimum speed needed to escape from the surface of the planet is 14.9 km/s. The orbital period of the satellite is closest to  
 (a) 72 min. (b) 65 min. (c) 58 min. (d) 51 min. (e) 44 min.
12. A constant current is sent through a helical coil. The coil:  
 (a) tends to rotate about its axis (b) tends to get longer (c) tends to get shorter  
 (d) produces zero magnetic field at its center (e) none of the above
13. Electrons (mass  $m$ , charge  $-e$ ) are accelerated from rest through a potential difference  $V$  and are then deflected by a perpendicular magnetic field  $B$ . The radius of the resulting electron trajectory is:  
 (a)  $\sqrt{2eV/m}/B$  (b)  $B\sqrt{2meV}$  (c)  $B\sqrt{2mV/e}$  (d)  $\sqrt{2mV/e}/B$   
 (e)  $\sqrt{2meV}/B$
14. The figure shows three resistors in series surrounding an infinitely long solenoid with a changing magnetic field; the resulting induced electric field drives a current counterclockwise, as shown. Which statement is true?  
 (a) Both meters read 0. (b) Both meters read  $2IR$ . (c) Both meters read  $IR$ .  
 (d) Left-hand meter reads  $IR$ . (e) Right-hand meter reads  $IR$ .
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15. The main reason that alternating current (AC) replaced direct current (DC) for general use is:  
 (a) AC minimizes magnetic effects. (b) AC voltage may be conveniently transformed.  
 (c) Electric clocks do not work on DC. (d) AC generators do not need slip rings.  
 (e) A given AC current does not heat a power line as much as the same DC current.
16. The intensity of sunlight at Earth's orbit is about  $1.4 \text{ kW/m}^2$ . A 100-kg sailing spacecraft with  $1\text{-km}^2$  sail area would experience an acceleration of about  
 (a)  $5 \text{ mm/s}^2$  (b)  $5 \text{ cm/s}^2$  (c)  $5 \text{ m/s}^2$  (d)  $50 \text{ m/s}^2$  (e)  $500 \text{ m/s}^2$
17. The speed of light in a material is  $0.50c$ . What is the critical angle of a light ray at the interface between the material and a vacuum?  
 (a)  $21^\circ$  (b)  $24^\circ$  (c)  $27^\circ$  (d)  $30^\circ$  (e)  $33^\circ$
18. A police radar operates on a frequency of 1GHz. What is the value of the frequency shift received by the police after the signal is reflected by a car moving away from the police at the velocity 150 km/hr?  
 (a) 278 Hz (b) 2.78 kHz (c) 27.8 kHz (d) 278 kHz (e) 2.78 MHz
19. Light of wavelength 310 nm falls on a lithium surface. The work function of lithium is 2.3 eV. The De Broglie wavelength of the fastest emitted photoelectrons roughly is  
 (a) 310 nm (b) 23.2 nm (c) 13.5 nm (d) 4.6 nm (e) 0.96 nm
20. A particle detector has a resolution 15% of the width of a one-dimensional infinite square well. What is the probability that the detector will find a particle in the ground state of the square well if the detector is centered on the midpoint of the well?  
 (a) 0.13 (b) 0.21 (c) 0.29 (d) 0.35 (e) 0.42

注意：背面有試題

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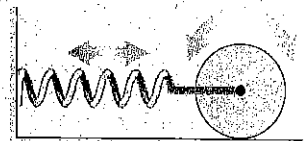
Physical constants and some mathematical equations:

gravity of Earth: $g = 9.8 \text{ m/s}^2$	gravitational constant: $G = 6.67 \times 10^{-11} \text{ N} \cdot \text{m}^2/\text{kg}^2$
universal gas constant $R = 8.314 \text{ J/K mol}$	velocity of light in vacuum: $c = 299792458 \text{ m/s}$
permeability of vacuum: $\mu_0 = 4\pi \times 10^{-7} \text{ T} \cdot \text{m/A}$	permittivity of vacuum: $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2$
Planck's constant: $h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s}$	electron rest mass: $m_e = 9.11 \times 10^{-31} \text{ kg}$
$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$	$1 \text{ atm} = 10^5 \text{ Pa}$
$\ln 2 = 0.693$	$\ln 3 = 1.099$
	$1 \text{ Pa} = 1 \text{ N/m}^2$
	density of water = $1000 \text{ kg/m}^3$
	$e = 2.718$
	$\sin(0.85) = 0.454$

參考用

本試題卷共有單選題20題，每題5分。

- A 1.5-m-long pipe has one end open and the other end closed. Among its possible standing-wave frequencies is 225 Hz; the next higher frequency is 375 Hz. The sound speed in the pipe is  
 (a) 600 m/s. (b) 450 m/s. (c) 350 m/s. (d) 300 m/s. (e) 150 m/s.
- Consider a simple model for earth's atmosphere by neglecting winds, convection and variation in gravity etc. The distribution of molecules is varying with height. Assume that the atmosphere is isothermal (at 273 K) and the average molecular weight of the atmosphere is 30 g/mol, the height below which half the molecules lie approximately is  
 (a) 3.5 km (b) 4.2 km (c) 5.4 km (d) 6.7 km (e) 8.1 km
- The volume charge density inside a solid sphere of radius  $a$  is  $\rho = \rho_0 r^2/a$ , where  $\rho_0$  is a constant. The electric field strength within the sphere, as a function of distance  $r$  from the center is  
 (a)  $\rho_0 r^3/5\epsilon_0 a$  (b)  $\rho_0 r^2/4\epsilon_0 a$  (c)  $\rho_0 r/3\epsilon_0 a$  (d)  $\rho_0/2\epsilon_0 a$  (e)  $\rho_0/\epsilon_0 a$
- Eight identical spherical raindrops are each at a potential  $V$ . They coalesce to make one spherical raindrop whose potential is:  
 (a)  $V/8$  (b)  $V/2$  (c)  $2V$  (d)  $4V$  (e)  $8V$
- A parallel plate capacitor, with air dielectric, is charged by a battery after which the battery is disconnected. A slab of glass dielectric is then slowly inserted between the plates. As it is being inserted,  
 (a) a force repels the glass out of the capacitor. (b) the glass makes the plates repel each other.  
 (c) no force acts on the glass. (d) a net charge appears on the glass.  
 (e) a force attracts the glass into the capacitor.
- An uncharged 2.0- $\mu\text{F}$  capacitor is connected in series with a 50-k $\Omega$  resistor, an ideal 10.0-V battery, and an open switch. What is the voltage across the capacitor 100ms after closing the switch?  
 (a) 2.0V (b) 3.7V (c) 5.0V (d) 6.3V (e) 10.0V
- A 1500-m-wide dam holds back a lake 95 m deep. The torque that the water exerts about the bottom edge of the dam is  
 (a)  $2.1 \times 10^{12} \text{ N} \cdot \text{m}$  (b)  $1.3 \times 10^{11} \text{ N} \cdot \text{m}$  (c)  $2.1 \times 10^{10} \text{ N} \cdot \text{m}$  (d)  $1.3 \times 10^{10} \text{ N} \cdot \text{m}$  (e)  $2.1 \times 10^9 \text{ N} \cdot \text{m}$
- A solid cylinder of mass  $M$  and radius  $R$  is mounted on a axle through its center. The axle is attached to a horizontal spring of constant  $k$ , and the cylinder rolls back and forth without slipping (as shown in the figure). The angular frequency of the motion is  
 (a)  $\sqrt{\frac{3k}{2M}}$  (b)  $\sqrt{\frac{2k}{3M}}$  (c)  $\sqrt{\frac{2M}{3k}}$  (d)  $\sqrt{\frac{3M}{2k}}$  (e)  $\sqrt{\frac{k}{M}}$
- The mass of a deuteron is about 2 u, compared with a neutron's 1u. The fraction of a neutron's kinetic energy that's transferred to an initially stationary deuteron in a head-on collision is  
 (a) 11% (b) 25% (c) 50% (d) 75% (e) 89%



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