臺灣綜合大學系統115學年度學士班轉學生聯合招生考試試題

科目名稱	普通物理C	類組代碼	共同考科
		科目碼	E0016

※本項考試依簡章規定所有考科均「不可」使用計算機。　　本科試題共計 3 頁

Some useful constants

Gas constant $R = 8.314$ J/mol·K

Mass of Sun $= 2.0 \times 10^{30}$ kg

Radius of Earth $= 6.4 \times 10^{6}$ m

Electron mass $m_e = 9.1 \times 10^{-31}$ kg

Electric constant (permittivity) $\epsilon_0 = 8.85 \times 10^{-12}$ C^2 /N·m^2

Magnetic constant (permeability) $\mu_0 = 4\pi \times 10^{-7}$ T·m/A

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

Boltzmann constant $k_b = 1.380 \times 10^{-23}$ J·K^{-1}

Gravitational constant $G = 6.68 \times 10^{-11}$ N·m^2 /kg^2

Mass of Earth $= 6.0 \times 10^{24}$ kg

Radius of Sun $= 7.0 \times 10^{8}$ m

Electron charge $e = 1.6 \times 10^{-19}$ C

1 eV $= 1.6 \times 10^{-19}$ J

選擇題（單選，總分 100 分）；共 20 題，每題 5 分。

1. A small particle moves back and forth along a straight track. Its position as a function of time is given by x(t) = 12 sin [(120 degree/s) t] where x is measured in meters and t is measured in seconds. What is the instantaneous speed of the particle at t = 1 s? (A) 1440 cos(120 degrees) m/s (B) −1440 cos(120 degrees) m/s (C) 12 cos(120 degrees) m/s (D) 8π cos(120 degrees) m/s (E) −8π cos(120 degrees) m/s.

2. A student sits on a bus seat. The bus makes a right turn, and the student does not slide relative to the seat. Besides gravity and the normal force, what horizontal force must act on the student? (A) No horizontal force (B) A friction force to the left (C) A friction force to the right (D) A friction force forward (E) A friction force backward.

3. A 2.0-kg block moves along the x-axis on a horizontal track. An external horizontal force acting on it is $\vec{F} = 6x\hat{\imath}$, where F is in newtons and x is in meters. The block moves from $x = 0$ m to $x = 3.0$ m. During the same motion, the normal force from the track also acts on the block. What is the total work done on the block by the horizontal force and the normal force? (A) 0 J (B) 9 J (C) 18 J (D) 27 J (E) 54 J.

4. A particle moves along the x-axis under the potential energy function $U(x) = 3.0x^2 + 1.0x^4$J, where x is in meters. If the total mechanical energy of the particle is 28 J, what are the limits of the particle's motion? (A) −1.0 m and +1.0 m (B) −1.5 m and +1.5 m (C) −2.0 m and +2.0 m (D) −2.5 m and +2.5 m (E) −3.0 m and +3.0 m.

5. A 1.0 kg cart is attached to one end of a spring, and a 2.0 kg cart is attached to the other end. The spring constant is 300 N/m. The carts are placed on a horizontal frictionless track, and the spring is initially compressed by 10 cm. The system is released from rest. When the spring first reaches its natural length, the 1.0 kg cart is observed to have a speed of 1.00 m/s. How much mechanical energy has been lost up to this moment? (A) 0 J (B) 0.25 J (C) 0.50 J (D) 0.75 J (E) 1.00 J.

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6. A wheel of radius 1.0 m is mounted on a frictionless axle. A light cord is wrapped around the wheel, and a 2.0-kg block is attached to the cord. After being released from rest, the block moves downward with an acceleration of 5.0 m/s^2. What is the moment of inertia of the wheel? Use g = 10 m/s^2. (A) 1.0 kg·m^2 (B) 2.0 kg·m^2 (C) 3.0 kg·m^2 (D) 4.0 kg·m^2 (E) 5.0 kg·m^2.

7. A solid cylinder of mass 2.0 kg and radius 1.0 m is initially at rest and can rotate freely about a fixed axle through its center. A 1.0-kg particle moving tangentially at 3.0 m/s hits the rim of the cylinder and sticks to it. What is the angular speed of the system just after the collision? (A) 0.75 rad/s (B) 1.0 rad/s (C) 1.5 rad/s (D) 2.0 rad/s (E) 3.0 rad/s.

8. A mass is hung from a vertical spring. At equilibrium, the spring is stretched by 0.40 m. The mass is then pulled downward an additional 0.20 m from equilibrium and released from rest. Let $y = 0$ be the equilibrium position and take upward as the positive direction. Which of the following gives the acceleration $a(t)$ of the mass (unit: m/s^2)? Use g = 10 m/s^2. (A) $a(t) = 5.0\cos(5t)$ (B) $a(t) = 5.0\cos(\sqrt{5}t)$ (C) $a(t) = 15\cos(\sqrt{5}t)$ (D) $a(t) = 15\cos(5t)$ (E) $a(t) = 3.0\cos(\sqrt{5}t)$.

9. A gas is kept in a rigid container with a fixed volume of 5.0×10^{-3} m^3. The gas is heated, and its pressure increases from 1.0×10^5 Pa to 3.0×10^5 Pa. During this process, the internal energy of the gas increases by 600 J. How much heat is absorbed by the gas? (A) 400 J (B) 600 J (C) 1000 J (D) 1600 J (E) 0 J.

10. A thermal-insulated container is divided into two parts by a removable partition. One side contains n moles of an ideal gas with volume V_i, and the other side is a vacuum. When the partition is removed, the gas freely expands until it occupies a final volume of $3V_i$. What is the change in entropy of the gas? (A) nR·ln3 (B) nR·ln2 (C) 3nR (D) 2nR (E) 0.

11. A thin nonconducting disk of radius R lies in the xy-plane. Its surface charge density varies with radial distance according to $\sigma = C\rho$, where ρ is the distance from the center and C is a positive constant. Taking V = 0 at infinity, what is the electric potential at the center of the disk? (A) kCR (B) πkCR^2 (C) $2\pi kCR^2$ (D) $(1/2)\pi kCR^2$ (E) 0

12. Two coplanar circular loops are centered at O. The inner loop has radius R and carries current I counterclockwise. The outer loop has radius $2R$ and carries current $2I$ clockwise. What is the net magnetic field at O? (A) 0 (B) $\mu_0 I/(2R)$, out of the page (C) $\mu_0 I/(2R)$, into the page (D) $\mu_0 I/R$, out of the page (E) $\mu_0 I/R$, into the page.

13. An N-turn square coil of area A is in a uniform magnetic field directed into the page. The field decreases linearly from B_0 to 0 during a time interval T. What are the magnitude of the induced emf and the direction of the induced current? (A) NAB_0/T, clockwise (B) NAB_0/T, counterclockwise (C) $AB_0/(NT)$, clockwise (D) $NB_0/(AT)$, counterclockwise (E) 0

14. A plane electromagnetic wave travels in the +x direction in vacuum. At one instant, the electric field

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points in the +y direction and has amplitude E_0. What are the direction and amplitude of the magnetic field? (A) +z direction, E_0/c (B) -z direction, E_0/c (C) +z direction, cE_0 (D) -y direction, E_0/c (E) +x direction, E_0/c.

15. A right-angle isosceles prism has refractive index $n_p = 3/2$. A narrow light ray enters one of the two equal side faces normally, so it does not bend when entering the prism. The ray strikes the hypotenuse from inside the prism with an angle of incidence 45°, measured from the normal. The hypotenuse is in contact with medium X. For which choice of medium X will total internal reflection occur at the hypotenuse? (A) Air, water, and oil (B) Air and water only, $n_{air} = 1$, $n_{water} = 4/3$ (C) Water and oil only, $n_{water} = 4/3$, $n_{oil} = 3/2$ (D) Air only, $n = 1$ (E) None of these media

16. A capacitor discharges through a resistor R. In the original circuit, the charge drops from Q_0 to $Q_0/4$ after a time t_1. If the resistor is replaced by $2R$, how long will it take for the same capacitor to drop from Q_0 to $Q_0/4$? (A) $t_1/2$ (B) $2t_1$ (C) $4t_1$ (D) t_1 (E) $t_1/4$.

17. Two small lights are separated by 1.2 m. An observer looks at them with a pupil diameter $D = 6.0$ mm using light of wavelength $\lambda = 500$ nm. Using Rayleigh's criterion $\theta_{min} = 1.2\lambda/D$, approximately what is the farthest distance at which the two lights can still just be resolved? (A) 6 km (B) 8 km (C) 12 km (D) 24 km (E) 120 km

18. A clean metal surface has a threshold wavelength $\lambda_0 = 620$ nm. It is illuminated by monochromatic light of wavelength $\lambda = 310$ nm. After that, the light intensity is doubled but the wavelength is kept the same. Use $hc = 1240$ eV nm. Which statement is correct? (A) No photoelectrons are emitted because the photon energy is below the work function. (B) The maximum kinetic energy is 1.0 eV, and it doubles when the intensity is doubled. (C) The maximum kinetic energy is 2.0 eV; doubling the intensity may increase the number of emitted electrons per second, but not their maximum kinetic energy. (D) The maximum kinetic energy is 4.0 eV; doubling the intensity leaves the emitted current unchanged. (E) The work function becomes 4.0 eV after the intensity is doubled.

19. A hydrogen atom is initially excited to the n = 4 state. It later returns to the ground state n = 1. Considering all possible direct and cascade downward transitions among n = 4, 3, 2, and 1, how many different photon energies can be emitted? (A) 3 (B) 4 (C) 5 (D) 6 (E) 7

20. Two monochromatic laser beams have the same power P. Beam A has wavelength λ, and beam B has wavelength $\lambda/2$. Which beam emits more photons per second? (A) Beam A emits twice as many photons per second as beam B. (B) Beam B emits twice as many photons per second as beam A. (C) Both beams emit the same number of photons per second. (D) Beam A emits four times as many photons per second as beam B. (E) Beam B emits four times as many photons per second as beam A.