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 A	類組代碼	共同考科
		科目碼	E0014

※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

Plank'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 particle moves along a straight horizontal path. Its acceleration as a function of time is $a(t) = 4t + 1$, where a is measured in m/s^2 and t is measured in s. If the particle has an velocity of 3.0 m/s at t = 2.0 s, what is its velocity at t = 4.0 s? (A) 13 m/s (B) 23 m/s (C) 26 m/s (D) 29 m/s (E) 36 m/s.

2. A 1.0-kg ball attached to a string moves in a vertical circle of radius 5.0 m. At one instant, the ball is below the center, and the string makes an angle of 60° with the downward vertical direction. The tension in the string is 25 N. Take g = 10 m/s^2. What is the instantaneous tangential speed of the ball at this instant? (Choose the closet answer) (A) 0 m/s (B) 5.0 m/s (C) 7.0 m/s (D) 10 m/s (E) 11 m/s.

3. A 2.0-kg block moves along a frictionless horizontal track. It starts from rest at x = 0. The only horizontal force acting on the block is $\vec{F}_x = 2x\hat{\imath}$, where F_x is in newtons and x is in meters. What is the instantaneous power delivered by this force when the block reaches x = 4.0 m? (A) 8 W (B) 24 W (C) 32 W (D) 45 W (E) 64 W.

4. A mass is attached to the lower end of a vertical spring. Before the mass is attached, the spring is unstretched, and the gravitational potential energy is defined to be zero at this position. The mass is m = 2.0 kg, the spring constant is k = 200 N/m, and g = 10 m/s^2. After the mass is attached, it slowly comes to rest at its new equilibrium position. What is the total potential energy of the mass-spring-Earth system at this equilibrium position? (A) +1.0 J (B) –1.0 J (C) 0 J (D) +2.0 J (E) –2.0 J.

5. Two astronauts are initially at rest in deep space, far from any planet or star. Astronaut A has a mass of 50 kg, and astronaut B has a mass of 75 kg. They are connected by a light rope of length 10 m. They pull on the rope and move toward each other. When they meet, how far has astronaut A moved from his original position? (A)8 m (B) 6 m (C) 5 m (D) 4 m (E) 2 m.

6. A thin hoop rolls without slipping up a 30° incline. Its initial speed at the bottom is 4.0 m/s. How far does it roll along the incline before stopping? Use g = 10 m/s^2. (A) 0.8 m (B) 1.2 m (C) 1.6 m (D) 2.4 m (E) 3.2 m.

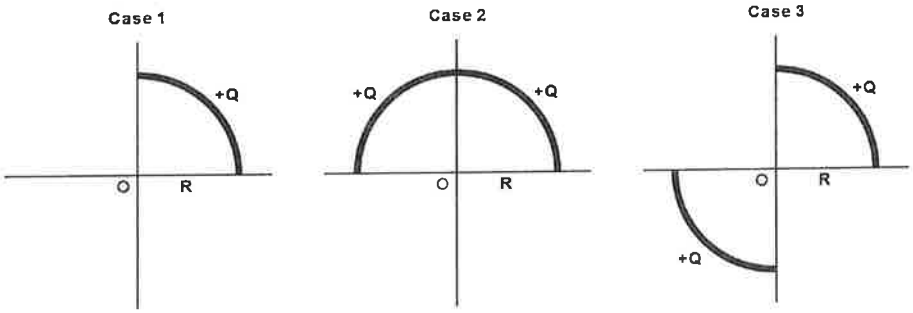
7. Two blocks are connected by a light string over a pulley. The pulley has radius R = 1.0 m and moment of inertia I = 2.0 kg ·m^2. The masses are m_1 = 1.0 kg and m_2 = 3.0 kg. The string does not slip on the pulley. What is the acceleration of the blocks? Use g = 10 m/s^2 and choose the closet answer. (A) 3 m/s^2 (B) 4 m/s^2 (C) 5 m/s^2 (D) 6 m/s^2 (E) 7 m/s^2.

8. A mass is hung from a vertical spring. At equilibrium, the spring is stretched by 0.25 m. The mass is then pulled downward an additional 0.10 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 motion y(t) (unit: m)? Use g = 10 m/s^2. (A) y(t) = –0.10 cos(2t); (B) y(t) = –0.10 cos(4t); (C) y(t) = –0.35 cos(2t); (D) y(t) = –0.35 cos(4t); (E) y(t) = –0.25 cos(4t).

9. An ideal gas is kept at a constant temperature of 300 K while it slowly expands in a cylinder. During the process, its volume increases from V to 4V. If the gas contains 2.0 mol and R = 8.314 J/mol·K, how much heat flows into the gas? Choose the closet answer: (A) -2.5×10^3 ln 4 J (B) 0 J (C) 1.2×10^3 ln 4 J (D) 2.5×10^3 ln 4 J (E) 5.0×10^3 ln 4 J.

10. A sample of liquid with mass m and specific heat c is slowly heated from an initial absolute temperature T_1 to a final absolute temperature T_2. Assume that the specific heat c remains constant during the process. What is the change in entropy of the liquid? (A) $mc(T_2 - T_1)/T_1$ (B) $mc(T_2 - T_1)/T_2$ (C) $mc \cdot \ln(T_2/T_1)$ (D) $mc \cdot \ln(T_1/T_2)$ (E) $mc(T_2/T_1)$.

11. Three cases are made from identical quarter-circle insulating arcs of radius R centered at O. Each individual quarter-circle arc shown carries a uniformly distributed positive charge +Q. Rank the magnitude of the net electric field at O, greatest first. (A) 1, 2, 3 (B) 2, 1, 3 (C) 2, 3, 1 (D) 1, 3, 2 (E) 1=2=3.



12. A parallel-plate capacitor has plate area A and plate separation d. Its capacitance when empty is $C_0 = \varepsilon_0 A/d$. The lower half of the space between the plates is completely filled with a liquid dielectric of dielectric constant $\kappa = 3$, while the upper half remains air. What is the new capacitance of the capacitor? (A) (1/2) C_0 (B) C_0 (C) (3/2) C_0 (D) 2 C_0 (E) 3 C_0.

13. A cylindrical metal wire has length L, cross-sectional area A, electron drift speed v_d, and resistance R. It is stretched uniformly to length $2L$ without changing its volume or temperature. If the same current is then passed through the new wire, what happens to its resistance (R') and electron drift speed (v_d')? (A) R' =

$2R$ and $v_d' = 2\,v_d$ (B) $R' = 4R$ and $v_d' = 2\,v_d$ (C) $R' = 4R$ and $v_d' = v_d/2$ (D) $R' = R/2$ and $v_d' = 2\,v_d$ (E) $R' = R$ and $v_d' = v_d$

14. Two circuits use identical ideal batteries and identical bulbs. Case I has one bulb A connected to the battery. Case II has two bulbs B and C connected in series to an identical battery. Rank the brightness of the bulbs. (A) A > B = C (B) A = B = C (C) B = C > A (D) A = B > C (E) B > A > C.

15. A positive ion moves to the right between two parallel plates. The electric field points upward. Which magnetic-field direction and speed condition allow the ion to pass undeflected? (A) B into the page, $v = E/B$ (B) B out of the page, $v = E/B$ (C) B out of the page, $v = B/E$ (D) B upward, $v = E/B$ (E) B into the page, $v = B/E$.

16. A resistor R, inductor L, and capacitor C are connected in series to an AC source. Let Z be the impedance of the circuit. At the angular frequency $\omega_0 = \frac{1}{\sqrt{LC}}$, which statement is correct? Here X_L is the inductive reactance and X_C is the capacitive reactance. (A) $Z = R$, and the current is in phase with the source voltage (B) $Z = 0$, and the current leads the voltage by 90 degrees (C) $Z = X_L + X_C$, and the current lags the voltage by 90 degrees (D) $Z = R + X_L + X_C$, and the current is in phase with the voltage (E) Z is infinite, so no current flows.

17. For a plane electromagnetic wave in vacuum, the electric-field amplitude is doubled. What happens to the magnetic-field amplitude and to the average intensity? (A) B_0 doubles and intensity doubles. (B) B_0 is unchanged and intensity quadruples. (C) B_0 doubles and intensity quadruples. (D) B_0 quadruples and intensity doubles. (E) B_0 halves and intensity is unchanged.

18. In a Young's double-slit experiment, the entire apparatus is placed in a liquid of refractive index $n = 4/3$. Compared with the pattern in air, what happens to the fringe spacing? (A) It becomes 4/3 as large. (B) It becomes 3/2 as large. (C) It becomes 3/4 as large. (D) It becomes 1/2 as large. (E) It is unchanged.

19. A quantum particle is represented by a single infinite plane wave with a definite wavelength λ. Which statement best describes the particle? (A) Its position is well localized, and its momentum is very uncertain. (B) Its position and momentum are both exactly known. (C) It cannot have a de Broglie wavelength. (D) Its kinetic energy must be zero. (E) Its momentum is well defined, but its position is highly uncertain.

20. In the Earth frame, two lightning strikes A and B are simultaneous. Strike B is 600 m in front of strike A along the +x direction. A spaceship moves in the +x direction at 0.60c relative to Earth, for which $\gamma = 1.25$. According to observers on the spaceship, which strike occurs first and by how much? (A) A occurs 1.5 μs before B. (B) B occurs 1.5 μs before A. (C) A occurs 2.0 μs before B. (D) B occurs 2.0 μs before A. (E) They are still simultaneous.