臺灣綜合大學系統

106 學年度

轉學生聯合招生考試

試　題

類組：C02/D04

科目名稱：普通物理C

科目代碼：E0016

臺灣綜合大學系統106學年度學士班轉學生聯合招生考試試題

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Some useful constants

Gas constant $R = 8.314$ J/mol·K	Gravitational constant $G = 6.68\times10^{-11}$ N·m^2/kg^2
Mass of Sun $= 2.0\times10^{30}$ kg	Mass of Earth $= 6.0\times10^{24}$ kg
Radius of Earth $= 6.4\times10^{6}$ m	Radius of Sun $= 7.0\times10^{8}$ m
Electron mass $m_e = 9.1\times10^{-31}$ kg	Electron charge $e = 1.6\times10^{-19}$ C
Electric constant (permittivity) $\epsilon_0 = 8.85\times10^{-12}$ C^2/N·m^2	
Magnetic constant (permeability) $\mu_0 = 4\pi\times10^{-7}$ T·m/A	
Plank's constant $h = 6.63\times10^{-34}$ J·s	1 eV $= 1.6\times10^{-19}$ J
Boltzmann constant $k_b = 1.380\times10^{-23}$ J·K^{-1}	

第一部分：單選題（80 分）

共 20 題，每題 4 分，請於答案卷上標明題號並依序作答。

1. A particle moving along the x-axis has a position function given by $x(t) = (4.00\ \text{m/s}^3)\,t^3 - (5.00\ \text{m/s})\,t + (6.00\ \text{m})$. What is the average acceleration of the particle between $t = 1.00$ s and $t = 2.00$ s. (A) 24 m/s^2 (B)12 m/s^2 (C) 36 m/s^2 (D) 18 m/s^2 (E) 30 m/s^2.
2. A dog's hair has been cut and is now getting longer by 1.04 mm each day. With winter coming on, this rate of hair growth is steadily increasing, by 0.132 mm/day every week. By how much will the dog's hair grow during 5 weeks? (A) 12.0 mm (B) 24.0 mm (C) 36.0 mm (D) 48.0 mm (E) 60.0 mm
3. A cube of side $2a$ and mass M is sliding on a frictionless surface with uniform velocity v_0, as shown in the right Fig. a. It hits a small obstacle at the end of the table, which causes the cube to tilt as in Fig. b. Find the minimum value of v_0 such that the cube will fall off the table (g is the gravitational acceleration constant on earth). (A) $\sqrt{2ag(\sqrt{2}-1)}$ (B) $\sqrt{\frac{16}{3}ag(\sqrt{2}-1)}$ (C) $\sqrt{4ag(\sqrt{2}-1)}$ (D) $\sqrt{\frac{3}{4}ag(\sqrt{2}-1)}$ (E) $\sqrt{\frac{8}{3}ag(\sqrt{2}-1)}$

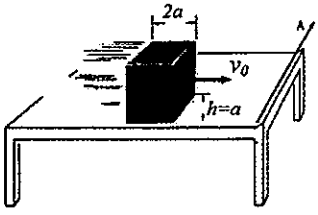


Fig. a

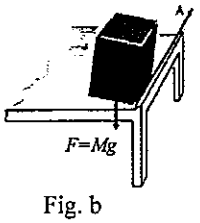
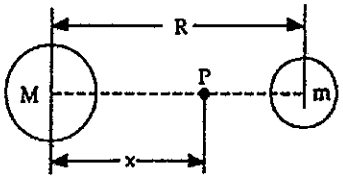


Fig. b

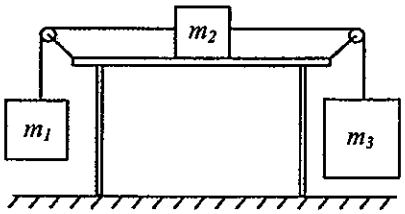
4. Two planets have masses M and m, and the ratio $M/m = 25$. The distance between the planets is R. The point P is between the planets as shown in the right, and the distance between M and P is x. At P, the gravitational force on an object due to M and m are equal in magnitude. The value of x is (A) $5R/6$ (B) $25R/36$ (C) $R/25$ (D) $6R/5$ (E) none of these.



5. A mass $m_2 = 1.5$ kg rests on a horizontal table. The static and kinetic coefficients of friction between m_2

 背面有題，請繼續作答。

and the table are $\mu_s = 0.3$ and $\mu_k = 0.25$, respectively. The mass m_2 is attached by strings to masses $m_1 = 2.5$ kg and $m_3 = 4.5$ kg as shown in the right. Masses m_1 and m_3 hang freely. The system is initially held at rest. After it is released, the acceleration of m_2 is approximately (A) 1.9 m/s^2 (B) 2.4 m/s^2 (C) 3.0 m/s^2 (D) zero (E) 13 m/s^2.



6. If the coefficient of static friction between your coffee cup and the horizontal dashboard of your car is $\mu_s = 0.800$, how fast can you drive on a horizontal roadway around a right turn of radius 30.0 m before the cup starts to slide? (A) 25.2 m/s (B) 20.8 m/s (C) 10 m/s (D) 15.3 m/s (E) 12.6 m/s
7. A 2.00-kg object is attached to a spring and placed on a horizontal, smooth surface. A horizontal force of 20.0 N is required to hold the object at rest when it is pulled 0.200 m from its equilibrium position (the origin of the x axis). The object is now released from rest with an initial position of $x_i = 0.200$ m, and it subsequently undergoes simple harmonic oscillations. The total energy of the oscillating system is (A) 0.50 J. (B) 1.25 J. (C) 1.50 J. (D) 1.75 J. (E) 2.00 J.
8. The "Principle of Equipartition of Energy" states that the energy of a gas is shared equally: (A) among the molecules (B) between kinetic and potential energy (C) between translational and vibrational kinetic energy (D) among the relevant degrees of freedom (E) between heat and work.
9. A source at rest emits light of wavelength 500 nm. When it is moving at 0.90 C (C is light speed) away from an observer, the observer detects light of wavelength: (A) 26 nm (B) 115 nm (C) 500 nm (D) 2200 nm (E) 9500 nm
10. The specific heat of a substance is: (A) the amount of heat energy to change the state of one gram of the substance. (B) the amount of heat energy per unit mass emitted by oxidizing the substance. (C) the amount of heat energy per unit mass to raise the substance from its freezing to its boiling point. (D) the amount of heat energy per unit mass to raise the temperature of the substance by 1°C. (E) the temperature of the object divided by its mass.
11. A Carnot refrigerator extracts 35 kJ as heat during each cycle, operating with a coefficient of performance of 4.60. What is the energy per cycle transferred as heat to the room? (A) 15.0 kJ (B) 21.0 kJ (C) 25.9 kJ (D) 30.4 kJ (E) 42.6 kJ
12. Consider the following procedural steps: 1. ground an electroscope. 2. remove the ground from the electroscope. 3. touch a charged rod to the electroscope. 4. bring a charged rod near, but not touching, the electroscope. 5. remove the charged rod. To charge an electroscope by induction, use the sequence: (A) 1, 4, 5, 2 (B) 4, 1, 2, 5 (C) 3, 1, 2, 5 (D) 4, 1, 5, 2 (E) 3, 5
13. Three particles, each with positive charge Q, form an equilateral triangle, with each side of length d. Then the magnitude of the electric field produced by the particles at the midpoint of any side is (A) $Q/(4\pi\epsilon_0 d^2)$. (B) $Q/(3\pi\epsilon_0 d^2)$. (C) $2Q/(3\pi\epsilon_0 d^2)$. (D) $Q/(\pi\epsilon_0 d^2)$. (E) $4Q/(3\pi\epsilon_0 d^2)$.
14. Two charged point particles are located at two vertices of an equilateral triangle and the electric field is zero at the third vertex. We conclude: (A) the two particles have charges with opposite signs and the same

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magnitude. (B) the two particles have charges with opposite signs and different magnitudes. (C) the two particles have identical charges. (D) the two particles have charges with the same sign but different magnitudes. (E) at least one other charged particle is present.

15. Two conducting spheres are far apart. The smaller sphere carries a total charge Q. The larger sphere has a radius that is twice that of the smaller and is neutral. After the two spheres are connected by a conducting wire, the charges on the smaller and larger spheres, respectively, are: (A) $Q/2$ and $Q/2$ (B) $Q/3$ and $2Q/3$ (C) $2Q/3$ and $Q/3$ (D) zero and Q (E) $2Q$ and $-Q$

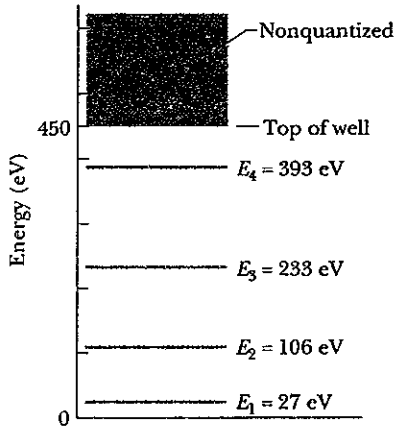
16. An electron has velocity $v = (32\,\boldsymbol{i} + 40\,\boldsymbol{j})$ km/s as it enters a uniform magnetic field $\mathbf{B} = (60\,\boldsymbol{i})$ μT. (A) The radius of the helical path taken by the electron is 0.38 m. (B) The pitch of that path is 1.9 m. (C) The period of the revolution is 60 μs. (D) To an observer looking into the magnetic field region from the entrance point of the electron, the electron spirals counterclockwise as it moves. (E) The magnetic force points in the $+\boldsymbol{k}$ direction.

17. Relative to reference frame 1, reference frame 2 moves with speed v in the negative x direction. When the origins of the two frames coincide the clocks in both frames are set to zero. An event occurs at coordinate x_1 and time t_1 as measured in reference frame 1 and at coordinate x_2 and time t_2 as measured in frame 2. If $\gamma = 1/\sqrt{1 - v^2/c^2}$, then the coordinates and times of the event are related by: (A) $x_2 = \gamma [x_1 - vt_1]$ and $t_2 = \gamma [t_1 - vx_1 / c^2]$ (B) $x_2 = \gamma [x_1 - vt_1]$ and $t_2 = \gamma [t_1 + vx_1 / c^2]$ (C) $x_2 = \gamma [x_1 + vt_1]$ and $t_2 = \gamma [t_1 - vx_1 / c^2]$ (D) $x_2 = \gamma [x_1 + vt_1]$ and $t_2 = \gamma [t_1 + vx_1 / c^2]$ (E) none of the above are correct

18. A thin film with an index of refraction of 1.60 is placed in one of the beams of a Michelson interferometer. If this causes a shift of 8 bright fringes in the pattern produced by light of wavelength 580 nm, what is the thickness of the film? (A) 1.5 μm (B) 2.9 μm (C) 3.9 μm (D) 7.7 μm (E) 16 μm

19. A free electron and a free proton have the same momentum. This means that, compared to the matter wave associated with the proton, the matter wave associated with the electron has: (A) a shorter wavelength and a greater frequency (B) a longer wavelength and a greater frequency (C) the same wavelength and the same frequency (D) the same wavelength and a greater frequency (E) the same wavelength and a smaller frequency

20. The figure shows the energy levels for an electron in a finite potential energy well. If an electron in the $n = 2$ state absorbs a photon of wavelength 2.0 nm, what happens to the electron? (A) It makes a transition to the $n = 3$ state. (B) It makes a transition to the $n = 4$ state. (C) Nothing; this photon does not have an energy corresponding to an allowed transition so it is not absorbed. (D) It escapes the well with a kinetic energy of 730 eV. (E) It escapes the well with a kinetic energy of 280 eV.



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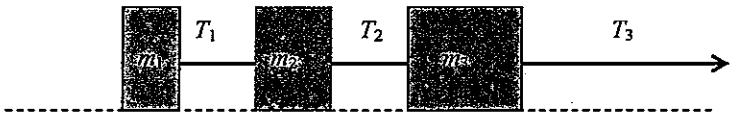
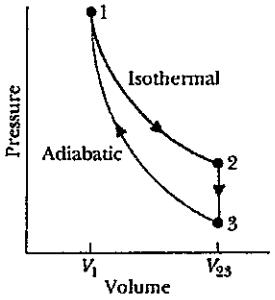
第二部分：複選題（20 分）

共 4 題，每題 5 分，**全對才給分**，請於答案卷上**標明題號**並**依序作答**。

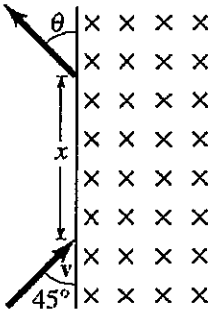
1. As shown in the following, three blocks are connected and pulled to the right on a horizontal frictionless table by a force of $T_3 = 72$ N. Here $m_1 = 12$ kg, $m_2 = 24$ kg, and $m_3 = 36$ kg. In the following, which statements are correct? (A) The acceleration of m_1 is 1 m/s^2. (B) The acceleration of m_2 is 2 m/s2. (C) The acceleration of m_3 is 2 m/s^2. (D) The tension T_1 in the interconnecting cords is 12 N. (E) The tension T_2 in the interconnecting cords is 24 N.



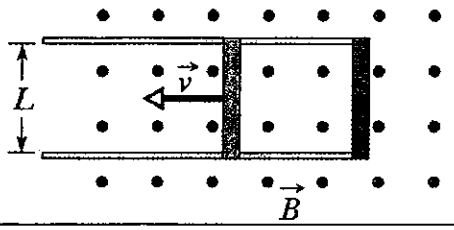
2. In the right figure $V_{23} = 3V_1$, and n moles of a diatomic ideal gas are taken through the cycle with the molecules rotating but not oscillating. Which of the following is/are correct?
(A)The molar heat capacity $C_V = (5/2)R$ (B) The ratio of the pressures $P_1/P_3 = 3$ (C) The ratio of the temperatures $T_1/T_3 = 3^{0.4}$ (D) Change in the internal energy for the complete cycle is $\Delta E_{int} = 0$ (E) In process $1 \rightarrow 2$, the work done is $W_{12} = RT_1 \ln 3$



3. A proton moving with mass m and speed v in a field-free region abruptly enters an essentially uniform magnetic field $\boldsymbol{B}$ as shown in the right figure ($\boldsymbol{B} \perp v$). If the proton enters the magnetic field region at a 45^0 angle as shown, (A) the leaving angle θ of proton is 135^0. (B) the leaving angle θ of proton is 45^0. (C) the distance x exiting from the field is $\sqrt{2}mv/eB$. (D) the distance x exiting from the field is $2mv/eB$. (E) the distance x exiting from the field is $mv/2eB$.



4. The conducting rod shown in the following figure has length L and is being pulled along horizontal, frictionless conducting rails at a constant velocity v. The rails are connected at one end with a metal strip. A uniform magnetic field $\boldsymbol{B}$, directed out of the page, fills the region in which the rod moves. Assume that $L = 10$ cm, $v = 5.0$ m/s, and $B = 1.2$ T. Assume that the resistance of the rod is 0.40 Ω. Which of the following statements are correct? (A)The magnitude of the *emf* induced in the rod is 1.20 Volt. (B) The



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direction of the current in the conducting loop is counter clockwise? (C) The current in the conducting loop is 1.5 A. (D) To keep the rod moving at constant velocity, therefore, a rightward force must be continuously supplied to the rod. (E) To keep the rod moving at constant velocity, therefore, a 0.18 N external force must be continuously supplied to the rod.